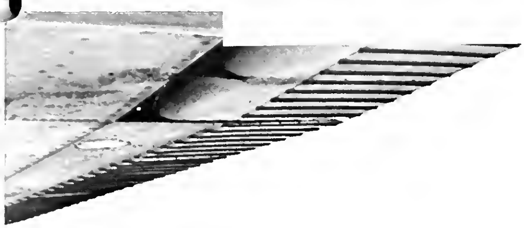
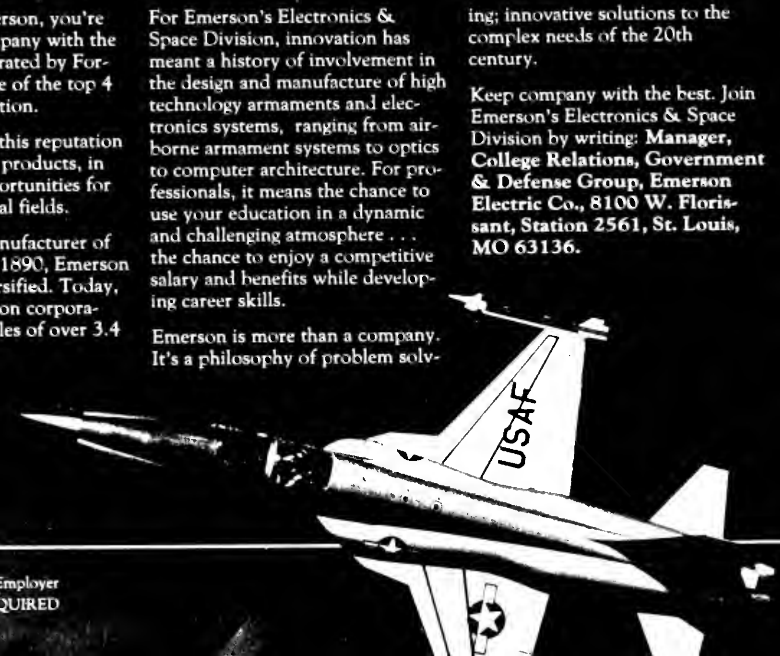
ILLINOIS TECHNOGRAPH



October 1982 Volume 98 issue 1
Newsstand $1.00

From taking off to hitting the target, skydiving provides a needed lift.



USAF

ILLINOIS
TECHNOGRAPH

October 1982 Volume 98 issue 1

6 Chalk One Up for Education
Larry Mallak transmits the latest in education technology.

10 The Dream to Fly
Phil Hardin holds the line on local skydivers.

14 Peddling Technology
The synergy of sales and engineering employed Raymond Hightower this past summer.

16 Speculations on Interactive Videodisk Systems
Dave Padgitt reports on what might gobble up Pac-Man in the future.

24 Defending Nuclear Power
Professor Magdi Ragheb accounts for the economic bind of these power plants.

29 Engineering Family Album
There's a society for every engineer; is one just right for you?

30 Biological Effects of Smoking
One of man's oldest vices is researched by Yuki Spellman.

Departments
Tech Teasers 4, Forum 5, Technovisions 18, Technotes 20, Tech Profiles 33, Technovations 35

On the Cover: Ed Baron, Teresa Brown and Brian Conway all take to the air in a somewhat unorthodox manner as members of a parachute club. (photo by Karlis Ulmanis)

EDITORIAL

Will High Technology Ever Come to Illinois?

Our governor, Jim Thompson, had an idea. He decided that to spur the economy of Illinois, he should join other states in the race to attract high technology firms to this state. In pursuit of this goal, Thompson formed the Governor's Task Force on High Technology.

The task force worked for about two months setting their goals and assessing the possibilities for forming a positive atmosphere to draw high technology businesses to Illinois. In March the task force presented its report to the governor.

The committee concluded that the state could strongly support four main areas: electronics, biotechnology, materials technology, and automated manufacturing techniques. These should be organized into a "network of high technology facilities associated with various universities and other centers of technical excellence throughout Illinois." This university fits that description very well.

The task force suggested that the governor form a High Technology Research and Development Commission to make long range plans and advise the Governor. They also requested $10 million per year for the next three years to support this committee. Thompson, though he probably agreed with the task force's conclusions, said the state could not afford $30 million.

We shouldn't scrap this idea immediately, however, because it does have many advantages. Illinois has the sixth highest unemployment rate in the country at 12.3%. Bringing high technology firms to Illinois would help to ease this problem. Not only engineers would benefit from this. Many different avocations would be necessary to support high technology companies.

Illinois would also gain badly needed revenue from the added corporate income taxes. Some of this money could be used to support the proposed commission. Added state revenue would lead to added revenue for the University. Faculty salaries could be brought up to par with industry, allowing the University to keep valuable people. Also, outmoded equipment could be replaced with state of the art. The quality of education would improve with more money.

Some people will point out the disadvantages of this plan, but most of these are minor in comparisons to the benefits. It will be quite expensive to begin this project and also to maintain it. Thompson has said the state cannot afford $30 million to fund the research and development committee. How can the state afford to not capitalize on the multi-million dollar industries which could be drawn here?

Another potential problem with the plan is that the state could put too much emphasis on high technology firms. Could putting so much into supporting high technology business lead to neglect of education? The task force spoke to this question in its report to the Governor when they called for "the Governor and the university system to rededicate the state's commitment to excellence in its institutions of higher learning."

The relationship between university faculty and industry could also cause problems. Faculty might begin to let industry dictate their research. The task force called for a balance between industrial support and academic freedom.

A related problem would result from patent laws. If a professor invents something while working for a company, does the company own the patent or does the University? This has yet to be ironed out.

Basically Jim Thompson had a good idea. Why haven't we heard anything since March? It's past time to jump in the race.

Kevin W. Wenzel

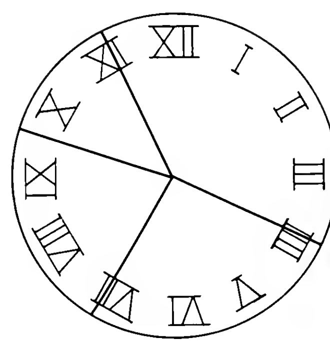
TECH TEASERS

1. Janet spent half the money in her pocket on a frivolous knick-knack. Upon leaving the store, she realized that she had just as many cents as she had dollars before her purchase, and half as many dollars as she had cents. Can you use your sense to figure out how much money she had when she entered the store?

2. A number is composed of five successive digits, not necessarily in the proper order (i.e. if the number was 97865, the 5 successive digits would be 5,6,7,8,9). If the first two digits are multiplied by the middle digit, they form the last two digits, e.g. if the number was 12560, you would have 12x560. But 1,2,5,6,0 are not successive digits, so this solution is incorrect. What is the number?

3. For services rendered, a greedy baker ate one tenth of all the cookies he made. A customer ordered a certain weight of cookies from the baker, and after the baker ate his toll, the customer had exactly one pound of cookies left. How many pounds of cookies did the customer initially order?

4. Can you divide an ancient clock into 4 pieces so that the sum of all the roman numerals in each piece add up to 20? One solution is shown, there is only one other.



EOH Provides Key to Problem Solving

by Kevin Lacey

"It was the best of times,
it was the worst of times. . ."
A Tale of Two Cities,
by Charles Dickens

This pretty well sums up the engineering field today; the advances have never been so rapid, and the economics never so depressed. The engineering student sees and hears of super-sohpisticated equipment and is then asked to perform his experiment on a ten year old, outdated instrument. If he's been here for a while, he has seen increases in both class size and tuition. He has watched the admission standards rise to a point where most of last year's graduates wouldn't have been admitted with this year's freshman class.

The situation is equally bad, if not worse, for the faculty. Enrollment has increased, forcing teachers to spend more time working with their classes. Reductions in funding for research have made for almost cut-throat behavior in the quest for money. All of this happens while professors see their counterparts in industry making two or three times as much as they do for the same work. And if this wasn't enough, the challenge to stay technically up-to-date increases with every passing day. These factors have caused a substantial number of professors to throw in the towel and move to industry.

Despite all this gloom, things are fairly bright here. Any student admitted here can be confident that he would have been admitted to any other engineering school in the country. Further, he can be sure he's getting one of the best possible engineering educations anywhere. A faculty member here is one of the most admired engineering educators in the field. This is evidenced by the consistently high ranking the University receives when rated by professors from all over the country. In addition, this respect has been partially responsible for keeping the University in the forefront of engineering research. The reputation earned by the University over the years continues to make it a dominant force in today's engineering community.

Enhancing and reinforcing this reputation is Engineering Open House (EOH). To some, EOH is a trivial event not worth serious thought. These people are wrong, for EOH serves vital functions for both the College of Engineering and the University. EOH emphasizes one of the engineer's primary responsibilities—education of the public. Open house provides the public with basic information about engineering today. Students who participate in EOH gain valuable hands-on experience in their chosen fields. EOH shows students that they are accountable to the public for their trade.

Open house directly benefits the faculty, as well. In addition to providing a means of further educating their students, EOH is the ideal place for presenting current research. This is an important point which is often overlooked: Research, even basic research, is geared toward eventually benefitting mankind. It is silly to spend months or even years researching something only to keep the results hidden away. Further, EOH can be used to promote one's research in order to gain additional funds and support. There is no reason why this University, second in overall research expenditures, can't share more of its research with the public.

Right now, we of the engineering college are under more pressure than ever before. We must band together, faculty and student alike. Everyone here places a premium on knowlege. Knowlege is one of the keys to problem solving. The other key is communication. Open house unites these two keys. For this reason, EOH deserves our support.

Lacey is a junior in Computer Engineering, and chairman of Engineering Open House Central Committee.

Forum is intended as an open exchange of views and ideas on areas of interest to the Engineering campus. All University students and faculty members are invited to contribute articles for Forum. Articles may be editorial in nature, and must be signed

STAFF

Editor	**Kevin Wenzel**
Production Editor	**Larry Mallak**
Business Manager	**Jim Lee**
Copy Editor	**Charley Kline**
Asst. Copy Editor	**Raymond Hightower**
Photo Editor	**Randy Stukenberg**
Features Editor	**Langdon Alger**
Design	**Nancy Grunthaner**
Asst. Designer	**Beth Beauvais**
Publisher	**E. Mayer Maloney, Jr.**
Production Manager	**Geoff Bant**
Adviser	**Ed Mast**

Staff

Steve Alexander	Mary Kay Flick
Rob Busse	Eric Guarin
Doug Campoli	Chris Konitzer
Tushar Chande	Laura Kosper
Joe Culkar	James O'Hagan
Tad Dierkes	John Przybysz
James Ehrhart	Doug Shaw
Robert Ekblaw	Andrew Saporoschenko
Jane Fiala	Yuki Spellman
Elayne Fletcher	Robert Strahanowski

Illinois Technograph
(USPS 258-760)
Vol 98 No 1 October 1982

Illinois Technograph is published five times during the academic year at the University of Illinois at Urbana-Champaign

Published by Illini Publishing Co., 620 East John St., Champaign, Illinois, 61820 Editorial and Business offices of the Illinois Technograph Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3730

Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001, 221 N. LaSalle Street, Chicago, IL., 60601

Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879

Illinois Technograph is a member of Engineering College Magazines Associated

Chalk One Up for Education

Electronic blackboards aid in remote education.

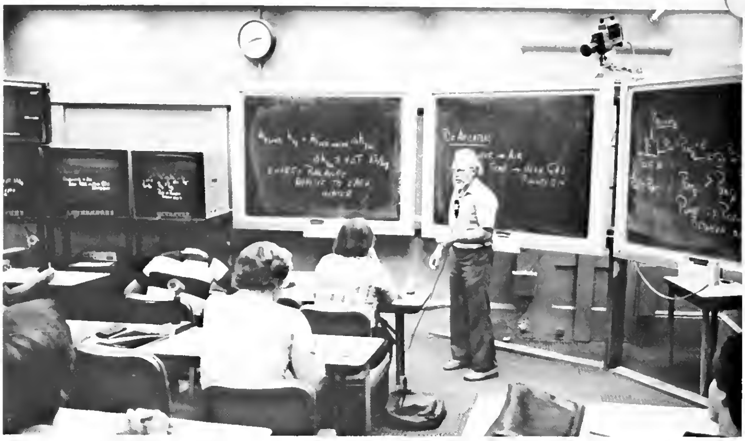
by Larry Mallak

The scene is familiar: the students file into the classroom, randomly spaced apart in time like lumped and distributed elements. The bell rings and the professor enters, prepared to lecture to his class full of students. Let us make a few changes so that a group of students across the state may enjoy the same quality of instruction offered in the university classroom without having the professor flown to them.

By placing a camera in the classroom and providing the professor with a microphone, one can collect sufficient audio and video for transport to remote sites. But what of the blackboard? It sure is hard to see on a TV, especially with the professor constantly standing in front of it, the glaring sun streaming in through the window, and the guy in the front row with the frizzed hair.

If the blackboard could be viewed with no interference, in a manner similar to direct-line taping (in which your little brother can scream all he wants when you're taping while none of his noise permeates the closed recording system), the quality of educational extension would increase. This would eliminate the need for flying the professor out of town for a three-hour power lecture which would leave the student's minds quivering with newly obtained information until the next treatment. Such an improvement evolved from Bell Labs in the late Sixties, a prototype of the present electronic blackboard.

The electronic blackboard utilizes a board with a pressure-sensitive grid backing which translates a "picture" of the writing into a signal which is digitized at Illinois Bell in downtown Champaign and sent through regular audio grade phone lines to the remote sites. There, a small box called a blackboard memory decodes the signal into black and white video. Each of the three blackboards has its own characteristic frequency to enable the simultaneous transmission of all three boards on one line while securing each board's respective information.



The Office of Continuing Engineering Education (OCEE), under direction of Jim Seyler, first learned of the electronic blackboard from a pamphlet distributed by Bell Labs. An entourage went to see a demonstration at a convention in Chicago. Impressed by this display, the same group traveled to Holmdel, New Jersey, where an electronic blackboard was in use.

Bell Labs, noticing the University's interest in the electronic blackboard as a possible consumer of the product, arranged to have it tested at the University in 1974. During this testing, a couple of areas for improvement surfaced. These would have to be resolved before the University would accept the electronic blackboard on a long-term basis.

The original one-year test period was stretched to four years, due mainly to design changes and necessary improvements. The single board system was not sufficient for efficient instruction, and the problem was to develop a three board system which would activate an individual board as the instructor touched the chalk to the board. A method by which a small portion of the board could be erased while preserving the rest of the board's contents was also developed.

In 1978, the final product was delivered to the University. At the same time, it was being offered commercially. Jim Seyler believes that the University was the first of its kind to utilize the electronic blackboard. Wright-Patterson Air Force Base in Dayton, Ohio was using a single board around this time to educate men without having to transport them to the base.

Currently, the University has two classrooms set up with the electronic blackboard: 103 Engineering Hall and 143 Mechanical Engineering Building. The MEB electronic blackboard facility features three boards and two-way audio system between remotes. 103 EH has three boards, one camera each for the instructor and the class, a two-way audio system, and a monitor which receives information from an electronic blackboard at the remote site.

Clockwise from far left:
Professor Savage gives a lecture on cooling systems to an ME 335 class which will be shown to another class on television sets.
This panel controls the cameras and electronic blackboard, and what is recorded on tape.
Rich Glinka, head engineer, adjusts video recording equipment before a taping session.
(photos by Randy Stukenberg)

In the EH facility, each class is videotaped, and the blackboard writing is transmitted to the remote sites. The videotapes are kept by OCEE to be sold for instuctional purposes to various companies and institutions, while the electronic blackboard carries the day's lecture live to a remote site, often for college credit.

103 EH, simply put, is a classroom equipped for TV production. Bright lighting, robot cameras, and stacks of electronic gadgetry are located in a soundproof partition between the classroom and OCEE offices. Among the electronics are five Sony videotape recorders, robot camera controls, a switching board to select the video display for the monitors, and a small cassette deck which is used to tape the audio portion of the lecture.

The system works as follows. Rich Glinka, technical operator, receives a signal from the instructor that he is ready to teach. Glinka then sets five video recorders and a cassette recorder into action, and then he focuses the camera on the instructor. When the instructor writes on a board, the video display switches to a direct picture of the board being written upon. The video monitor is on the boards when the instructor is using them, and a robot camera, operated by a joystick under Glinka's control, is focused on the instructor when he standing in front of the boards explaining a concept or answering a question. A second camera is used to capture a member of the class when a question is raised.

As with any project, the advantages and disadvantages must be weighed with the economic rewards to be reaped from the investment. Jim Seyler told of an interesting example exhibiting the quality of education being relayed via the electronic blackboard. Sundstrand Aviation in Rockford sent one of its employees, who was studying for his master's degree through the electronic blackboard hookup at Rockford, to the University to finish up. Coincidentally, he ended up in a class which met in 103 EH using the electronic blackboard.

The student then realized the benefits of learning at the remote site: if a question arose, the microphones could be turned off and a resolution could be made without interrupting the class. Students enrolled in electronic blackboard classes here are often reluctant to ask questions which may be trivial and tie up valuable electronic blackboard teaching time. A seci nd advantage cited by the Sundstrand employee was the fact that the board was always clearly visible since the marks are transmitted electronically. A major drawback at the remote sites is not being able to see the professor personally. However, the Sundstrand employee wished he were back in Rockford where he could see the board with no interruption.

Financial aspects of the electronic blackboard made pursuit of the project attractive to Seyler and his colleagues. Before the electronic blackboard was used, the professor would have to be flown to the remote site and perhaps lecture for three hours and then fly back. The entire venture easily killed an eight hour day. Obviously, having the professor drive to the site took too much time out of his busy schedule.

The electronic blackboard environment could be brought to the professor without him having to alter his normal style substantially. Besides wearing a microphone around his neck and hitting a button to electronically erase the screen, very little else is needed to conform to the situation. Professor Savage teaches ME 335 on the electronic blackboard and notices that one must watch certain actions such as pointing to a spot on the board and saying, "This is a significant point." Remote classmates cannot tell the object of the professor's statement.

Paul Witkowski, assistant head of the Office of Instructional Resources, describes the electronic blackboard as "bringing TV into the classroom, not the reverse," and minimizing interferences to the professor's manner of teaching. He likens teaching to acting: the professor is the main character and his notes are the script. Unlike a play, no prior development is needed. The professor comes into the classroom, lectures, and then leaves, a purely normal routine requiring no additional preparation.

Witkowski also cited a study which concluded that students preferred to copy notes off handwritten sources, rather than from an artistic presentation (Remember the last time you took notes from a filmstrip?). Students like the personal feeling of having the professor's own writing placed in front of them. Another advantage of offering videotaped classes is to accomodate for the employee who cannot make it to the class as easily as the college student. Pressure to get a certain project done and other external forces create a demand for the videotapes; they are a reaction to a need. Just pop in the tape and learn; "fast forward" over the boring parts and "pause" on the complicated proofs.

The tremendous savings of the professor's valuable time and the virtual elimination of "jet-set" instruction gleamed in the eyes of OCEE. Additional clout and prestige would also be added to the College of Engineering, since it is the first to expand its high quality education statewide. Studies have been undertaken to attempt to rate the quality of education enjoyed by the remote students. Course grades were used as the basis, and no significant difference was found between those taking courses here on campus and those taking it via the electronic blackboard.

Remote sites as of this fall dot the Illinois map in various locations, including the Beloit Corporation of South Beloit, Barber-Colman of Loves Park, Sundstrand Aviation of Rockford, Caterpillar Tractor of Rossville, Harris Corp. of Quincy, and Illinois Power in Clinton. The electronic blackboard was first transmitted out of state to AT&T in Bedminster, New Jersey.

Courses offered by OCEE on the electronic blackboard system include many essential upper level and graduate engineering courses such as Differential Equations, Strength of Materials, a variety of EE and ME courses, and others. Prospective customers of this service may elect to receive electronic blackboard transmissions live, or rent or purchase a course which has previously been videotaped.

A library of videotaped classes is gradually being built as more engineering classes are offered on the network. The order form lists rental on taped credit courses at $2000 and a purchase price of $10,000. Those seem like big bucks, but this is a big college with a big reputation. Actually, for example, if Sundstrand were to send a $30,000 engineer to the University for just one semester at full pay besides paying tuition and plane fare, the cost would be in the $10,000 range for a single student. For that much, Sundstrand could buy ME 432—Theory of Rotary Compressors, or any of the 300- and 400-level courses offered by OCEE. Better yet, Sundstrand could rent the courses as they need them for $2000 each and keep their employees at work during the term of study. The economic appeal is easily seen.

The electronic blackboard has seen the chalk of over ninety professors. Plans are in the works to convert 143 MEB into a replica of 103 EH. Right now, the network boasts six classrooms on campus and thirty remote sites. Until recently, Seyler says, Chicago was avoided when contracting electronic blackboard business because of the responsibility of the University, as a state institution, to accomodate all firms wanting the electronic blackboard. Now, Seyler states, "we are geared to expand as rapidly as necessary" and Chicago will soon see the lines of downstate thought. Additions to the network will be modular with six units added on campus with thirty remote hookups.

The introduction of the electronic blackboard to OCEE's network has certainly caused a quantum leap in the quality of educational extension and a drastic slash in the time and money constraints of modern technological firms. Although the professors will not take to the skies as often, most see this as a relief. They realize that the electronic blackboard is a high-quality educational tool. Paul Witkowski echoed a quote that "innovation in education takes fifty years." With only eight years into the project and plans of routing courses nationwide through the national U.S. Air Force communication base at Wright-Patterson Air Force Base in Dayton, one has to say that this innovation in education has matured quickly. T

The Dream to Fly

Beginning skydivers pull the cord.

by Phil Hardin

The dream of flying like a bird has stimulated creativity in many men throughout history. From the first designs of a flying machine by Leonardo da Vinci in the early 1500's to the first flight at Kitty Hawk, man has always longed to soar through the skies. But right here in Champaign-Urbana there are a number of individuals who have realized this dream. They are the members of the Champaign County Parachute Center, a skydiving club started in the spring of this year.

The club was virtually unknown until five of its members floated into the limelight during halftime of the Michigan State football game. Ed Baron, one of those five privileged jumpers, is the president of the Champaign County Parachute Center and a junior in Mechanical Engineering. He was accompanied on the jump by his father, Jim Baron, 1976 Industrial Engineering graduate Bob Ryan, Brian Barret, and Byron Marshall.

This of course was not one of the first jumps made by any of these skydivers. They are all seasoned veterans of the sport and each has a great deal of experience. Jim Baron, the most experienced skydiver in the group, with over 2000 jumps, is the instructor for the first jump class offered by the club. He is a certified United States Parachute Association instructor and has over fifteen years of experience as a jump trainer.

The words "Learn To Skydive" are possibly one of the greatest attractions to the class. The words themselves seem to spell excitement. Over seventy people showed up for the first class of the semester. Many turned away, however, after learning more about the program. The class, which is held on Thursday nights at the Armory, is a three to four hour crash course on "how to make a safe parachute jump." One class, seventy five dollars, and a lot of guts is all it takes to make your initial jump.

Contrary to what some people may imagine, the first jump, is not a jump out the door of a plane, a "Geronimo" yell, and a pull the ripcord sort of thing. It is a controlled static line jump. This type of jump is comparable to massive military parachute drops where a cord directly attached to the parachute, or canopy, as it is called, is hooked to a cable inside the aircraft.

The parachutist then sits in the doorway of the aircraft and dives into 3000 feet of the wild blue yonder, the canopy opening automatically seconds later. On these first few static line jumps, with average air time of about two and a half minutes, the student goes through the motions of pulling a dummy ripcord attached to the canopy pack. This familiarizes the student with the proper procedure for making a free fall jump. A minimum of five static line jumps is required before the student is able to advance to the free fall style identifiable with skydiving.

Since its beginning last spring, the club has been using the grass landing strip at Wronke Airovet Service near Homer for the majority of their jumps. This strip, even though it is almost a half hour drive from Champaign-Urbana, offers several advantages over both Willard and Frasca airports. The air traffic in the area is minimal, and it also provides an excellent landing surface. There are, however, a few problems with the current landing site in the early fall season, when crops remain in the surrounding fields. Landing in an unharvested corn field can be quite harmful to the equipment, not to mention the parachutist.

Weather is also a skydiving concern. The ideal day to go skydiving is one with a clear blue sky and a warm mild breeze. Rain, excessive wind, and low cloud cover are just a few of the hampering effects nature can have on a day of fun in the sky. The skydiving season usually runs late into the fall months and occasionally into the early winter months, but when those northern winds start to pick up, it's about time to pack up the chute for the winter.

The equipment used by the Champaign County Parachute Center comes from the Hinkley Parachute Center in Hinkley, Illinois. Jim Baron, in addition to being an expert skydiver and instructor, owns this skydiving center which is located west of Chicago. They supply the equipment needed to make the first jump. From the airplane you jump out of to the boots you land in, Jim Baron has your coins jingling in his pocket. Eventually, the club expects to be able to purchase its own equipment which will make things more convenient for all involved.

Static line jumping is truly a fantastic experience, but the real excitement in skydiving comes when the student learns to free fall. This is the moment when the dream of flying comes closest to reality. When the students first begin free fall skydiving, their jumps are very similar to static line jumps. The only difference is that they now have the responsibility of opening the chute themselves. This is a "tremendously" crucial step in becoming a successful skydiver. As the skydiver gains confidence and experience with the basic free fall, he or she can then attempt a wide variety of aerial body maneuvers before opening the chute.

Any maneuvers that can be executed on a trampoline or a diving board can also be done in the air. To perform maneuvers, the skydiver must jump from a higher altitude than for static line jumps, due to a mandatory canopy opening altitude of 2500 feet specified by the USPA. Opening below this altitude introduces a high degree of risk to the skydiver.

Teresa Brown prepares to let loose the wing and then a great "Geronimo. (photo by Karlis Ulmanis)

The next step up on the skydiving experience ladder is the changeover from the round canopy to the more maneuverable square canopy. A minumum of fifty jumps is usually required before this step can be made. Another advantage of the square canopy is that it has a much larger glide ratio than the round chutes.

The glide ratio, which is a measure of the distanced traveled horizontally compared to the vertical drop, is around 4.5:1 for most square canopies. Compared to the glide ratio of a glider, which can go as high as 40:1, this doesn't seem like much, but compared to the round canopy glide ratio of 1.5:1, it makes a great difference. It is possible, given adequate altitude and the right conditions, to travel as far as ten to fifteen miles horizontally with a square canopy.

However, there are a few drawbacks. First of all, since the airspeed of a square canopy is approximately twenty five to thirty miles per hour, there are greater hazards involved with it than with the round canopy. Also, the square canopy has the tendency to stall, which could be potentially hazardous.

The square canopy is used almost exclusively by the more experienced skydivers, especially in skydiving competitions. These tournaments are held throughout the world and include both professional and amateur or collegiate competitions. There are basically three events that comprise all skydiving tournaments: style, accuracy, and elative work.

The first of these events, the style competition, consists of a number of precision aerial maneuvers completed during a given amount of time. Contestants are judged on how well they execute and the number of maneuvers completed during the alloted time limit.

In the accuracy event, the skydiver makes a number of attempts to hit a five millimeter disk (about half the size of a dime). There are usually quite a few perfect scores in this particular event. For example, in the past, a ten millimeter disc was used, and the world record for that size target was over 200 perfect landings in a row.

The last event of skydiving competition, the elative work, consists mainly of the four man sequential. In this event the four team members attempt to make as many formations as possible. Jim Baron has competed nationally in another event called the ten man speed star. The object of this event is to form a star as quickly as possible. The world record now stands at 9.2 seconds, measured from the first man out the door till the last man formed up. By the end of this jumping season, the Champaign County Parachute Center hopes to be able to send a few members of the club to the National Collegiate Skydiving Tournament held during December in Arizona.

Skydiving is a truly one of the most fascinating sports in the world. The freedom felt by an individual flying through the air on his own power is like none other known to man. There are obvious dangers involved in the sport, and many people would not even consider jumping out of an airplane at 3000 feet. Yes, skydiving is definitely not the most ideal sport for the faint-hearted, but as Jim Baron said at the first class of the semester, "Fear is the unknown." **T**

SCIENCE/SCOPE

For his pioneering contributions to geostationary communications satellites, Dr. Harold Rosen of Hughes has been given the prestigious Alexander Graham Bell Medal by the Institute of Electrical and Electronic Engineers. Rosen is credited with conceiving the first practical geostationary communications satellite, which orbits 22,300 miles high and covers over a third of the globe. Early satellites orbited lower and would have required a large fleet and complicated tracking procedures if continuous communications were to be provided.

Computers are being called upon to help create the "super chips" that will give military electronics systems a tenfold increase in data processing capability. Hughes is using computer-aided design programs to develop Very High Speed Integrated Circuits (VHSIC) and the systems in which these chips will be used. Computer help is essential because VHSIC chips are as complex as 100 Los Angeles street maps printed on a thumb tack, and they themselves are mere components of larger, more complex systems. Computer programs will help engineers design, lay out, and test a chip. They describe an entire system at many levels of detail simultaneously to predict performance under various operating conditions.

Landsat 4, the new second-generation Earth-watching satellite, is studying crops and other resources in greater detail than ever before possible. The spacecraft carries two primary instruments. One is a multispectral scanner like the ones on previous Landsat missions. The other is a thematic mapper, whose remote-sensing capabilities are a considerable improvement over the scanner's. The new mapper gathers different kinds of data and has a spatial resolution of 30 meters versus 80 meters of earlier scanners. Hughes and its Santa Barbara Research Center subsidiary built both instruments for NASA.

More than 4,500 men and women have furthered their professional careers through the Hughes Fellowship Programs since 1949. Those who qualify are given the opportunity to earn advanced degrees in scientific and engineering disciplines. Under full-study programs, employees study at selected schools and work at a company facility during the summer. Under work-study programs, employees work part-time and carry about one-half of a full academic load at nearby schools. More than 100 fellowships are awarded annually.

Scientists have tracked the ash plume from the Mexican volcano El Cinchon using a weather satellite. Daylight and infrared pictures from GOES-5 (Geostationary Operational Environmental Satellite) clearly showed the April 4 eruptions even from 22,300 miles in space. Subsequent images revealed the plume rising high into the stratosphere and across the Yucatan peninsula. GOES-5 was built by Hughes and is operated by the National Oceanic and Atmospheric Administration.

Hughes needs graduates with degrees in EE, computer science, physics, ME, and math. To learn how you can become involved in any one of 1,500 high-technology projects, ranging from submicron microelectronics to advanced large-scale electronics systems, contact: College Relations Office, Hughes Aircraft Company, P.O. Box 90515, Dept. SS, Los Angeles, CA 90009. Equal opportunity employer.

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY
CULVER CITY, CALIFORNIA 90230

Peddling Technology

Sales engineers are a breed of their own.

by Raymond Hightower

As far as many people are concerned, the fields of engineering and sales are totally unrelated. Upon hearing the word "engineer", one might conjure up images of someone sitting behind a drafting table, shaping the technological future. If one is trying to describe someone in sales, words like "charm" and "charisma" might be tossed about. Engineers are looked upon as technical whizzes, while sales people are known to be masters of the art of persuasion. These two fields seem far from each other, but are they really? Could there be a career which challenges both the technical expertise of the engineer and the charisma of the salesman? Does the engineering-salesperson exist? The answer is definitely yes.

Hewlett-Packard (HP) is one company which makes extensive use of engineering-salespeople. A worldwide electronics manufacturer, HP's products include electronic instruments, components, computers, and handheld calculators. The engineering-salespeople at HP fall into two main groups: Sales Representatives and Systems Representatives.

In order to understand the difference between a sales-rep and a systems-rep, one must first take a look at the training each group receives. Upon graduation, the new employee is known as a "Staff Representative", which could be interpreted as "sales/systems-rep in training". He is then sent through the neophyte training program.

The staff-rep will spend his first few weeks of neophyte training at a production facility, where he will review basic instrument measurement techniques. Knowledge of these techniques is a must for the product training sessions which follow. The staff-rep then returns to his home office for the next two to six weeks for some on-the-job training. He might assist sales reps on customer calls, write software for instrument demonstrations, or find applications for a new piece of equipment.

Finally, the staff-rep is ready for the product training seminars. Like the measurement seminars, these are conducted at one of the manufacturing divisions. It is here that he will be exposed to the major features and benefits of HP's products, along with some side-by-side comparison with competitive equipment. He will also learn applications for the products he will be selling.

The product training seminars mark the final stage in neophyte training. If he hasn't already, the staff-rep must now choose between two routes: that of the sales-rep, or that of the systems-rep.

If he chooses the sales-rep route, he will soon be assigned a sales territory by his district manager. The sales-rep's primary duty is to be out in the field meeting the needs of his customers. In short, one could say that the sales-rep acts as a liaison between the customer and HP.

If the staff-rep decides on the systems-rep route, his training will continue. Sales-reps are required to know a broad line of products, while systems-reps are required to know a narrow line of products—in depth. A large portion of a system-rep's time is spent making factory visits, where he learns more about new and existing products. He then uses this knowledge to train sales-reps and customer employees. In short, one could say that the systems-rep is the liason between the sales-rep and the factory.

At times, it is necessary for a sales-rep and a systems-rep to call upon a customer as a team. For example, a client might need highly technical information about a specific product. On these occasions, the systems-rep for that product is called in. The team members can then put their heads together to solve the customer's problem in the most efficient manner possible.

Just recently, there was a sales-rep who had to demonstrate an instrument so new that its instruction manuals had yet to be completed. His client, a large manufacturer of communications equipment, was having some problems with a device they were developing. Upon hearing of the new HP product, the sales-rep realized that it was the solution to his client's problem. He contacted the factory to arrange a demonstration for his customer.

The instrument was hand-carried from the factory by an engineer who had worked with it since its inception. After a brief meeting at the local HP sales office, the two proceeded to the site of the demonstraton. Engineers from various departments of the customer facility were in attendence.

First, there was a general run-through of the product's capabilities, along with some discussion on how the client could make use of the product's features. Next, comparisons were made between the new product, similar HP products, and similar products manufactured by HP's competitors. In making the comparisons, both the factory engineer and the sales-rep showed that they were well versed as far as the products of the competition were concerned. None of the questions posed by the customer's engineering team were left unanswered.

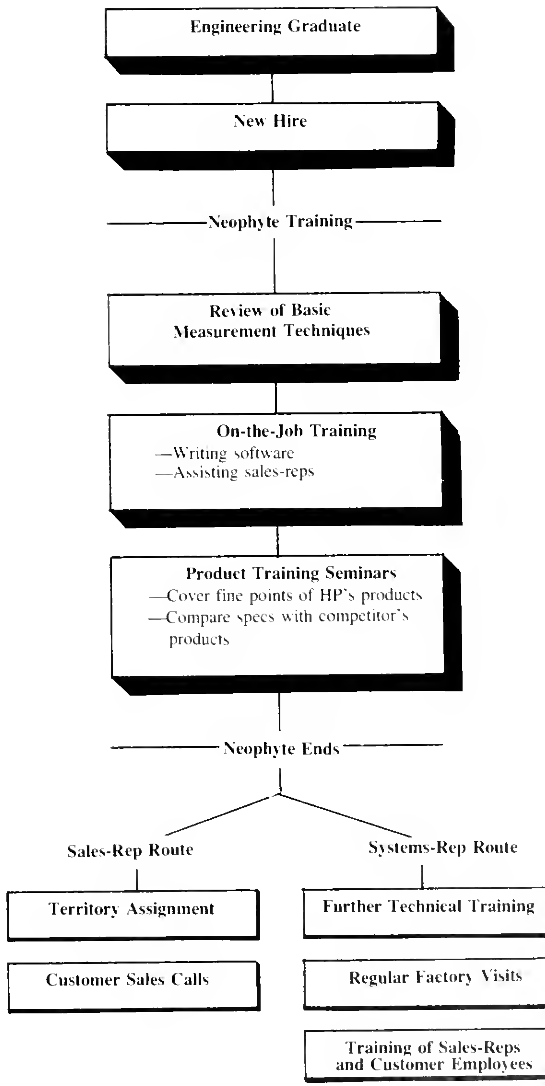
Not all of a sales-rep's customers are large companies. There are also the smaller customers who dream of becoming larger. Such companies usually want to avoid spending a large amount of money on a large system; they would rather buy a smaller system which they can upgrade as they grow. For example, several years ago a small manufacturer of contact lenses purchased a microprocessor development system to aid in the production of their lenses. Since then, they had grown, and upgrade their system. The client was asked to send a representative to the local HP sales office to take a look at what HP had to offer.

During the demonstration, the sales-rep placed strong emphasis on the potential for system expansion. Questions like "What if micro-technology heads in this directon?" were asked. The customer had to be assured that the system could easily be re-organized in the event of a major technological breakthrough. Both sales-reps and systems-reps must keep abreast of the research being done in the electronics field so that they may answer the "what if" questions customers usually ask. As the sales-rep who gave the demonstration put it, "The learning never ends."

Some sales-reps deal directly with end-users, as seen in the previous examples. Others deal with distributors, who, in turn, sell the products to the end-user. HP, like some other companies, markets certain products through distributors so that they may satisfy a large number of customers while using fewer resources. Products sold in this manner include hand-held calculators and components.

The skills and techniques a sales-rep uses when dealing with a distributor can be quite different from those he uses when dealing with an end-user, as seen during one demonstration session led by a sales-rep in the components group. In attendence were representatives from various distribution firms. The product on display was a fiber optics multiplexer, which is a device used to transfer data between a computer and its terminals. Unlike end-user demonstrations, this event focused on the marketing potential of the product, and therefore the job of the sales-rep was to convince the distributors that it was in demand. In using this approach, a sales-rep becomes more dependent on his knowlege of business and less dependent on his knowlege of engineering. Had this session involved end-users, he would have been selling this device as a solution to an engineering problem instead.

Most engineering students have their sights set on either the design or research and development departments of the company they hope to work for. Relatively few consider the fact that a company that deals in engineering sales is a company that depends on teamwork. One could say that the fate of the company rests on a tripod, whose three legs are the lab, the factory, and the sales force. If any one leg is removed, the tripod will fall. The engineering salesperson doesn't just exist; he is a necessity. T



Speculations on Interactive

"The child emerges from the dreamworld, marvelling that TV actually 'listened' to him."

by Dave Padgitt

Imagine walking into a video arcade some Friday night in the not-too-distant future and seeing all of the Pac-Man, Defender, and Tron games standing deserted and silent. In futile attempts to exhume one last quarter from the pockets of school children, they desperately scroll through their colorful demo displays, like barkers at a sideshow, but without acknowledgement. In the glowing neon reflection of their screens a crowd has gathered, and is huddled in a ring like midwives in a maternity ward, anxious, in awe. The sound of quarters diving into coin slots is heard, and soon a familiar electronic cry breaks the silence. A new electronic game has come to life.

As you nudge your way through the thickening crowd, music rocks the smoke-filled air. It's a familiar beat, one you heard every week on television as a child. You squirm to the front of the crowd to see what has unglued even the full-time video addicts from their favorite joysticks. In front of you, low on the floor, is a large color monitor with a touch screen in front of a streamlined bucket seat with speakers to each side. The entire unit is covered in an arc of tinted Plexiglas, and looks much like one of those road race games, but without the steering wheel.

You look at the video screen and see an incredible display of graphics. "Just like TV," a young girl remarks. A glowing fuse is burning across the screen accompanied to the frenzied beat of the music. An eager child, who was first in line, fidgets impatiently under the Plexiglas. Suddenly it all adds up. That theme music and burning fuse are part of the title sequence for the TV series *Mission Impossible*. The child is playing *Mission Impossible*.

Such ability to interact with real video images is very likely to become a reality in just a few short years. Optical videodisk technology (such as that used in the design of the Pioneer VP-1000 videodisk player) has made it possible to store an hour of audio and video on a single 12-inch disk. This fact alone is quite a feat; a similar technology is being used to develop very high density optical computer memories. However, coupling it to a microcomputer and associated software used to select video frames and sequences will have a revolutionary effect on the video medium.

The main feature of such a system which will cause this impact is its interactive capabilities. Many have argued that the primary shortcoming of commercial TV is that unlike radio, it requires very little active audience involvement. The TV viewer is given all of the necessary aural and visual information, in correct sequence, to tell a story. It is an open loop in which the viewer provides no direct feedback to alter the storyline. Only via the Nielsen ratings or through the consumption of a sponsor's product can viewers affect a program, and then it is merely a collective action which occurs after the fact.

There have been attempts to let the viewer participate in commercial TV which have met with some success. The most obvious attempt is the common call-in talk show. The inherent problem is that only a select few of the viewers actually participate, and this is often at the expense of the rest of the viewers' time. The subject of such talk shows isn't pure entertainment but usually politics and social issues.

Attempts to provide interactive entertainment via two-way cable TV systems have met with favorable audience reaction. On one cable system, the cable audience is shown the first part of a program, and then collectively votes on one of two possible outcomes. This is a collective decision rather than an individual choice, but at least provides the viewer with some sort of feedback. Interactive videodisk systems promise to provide immediate viewer feedback and involvement in many levels of decision making.

The great success of the videogame industry indicates that the public has already accepted video interaction in an elementary form. It is the videogame industry which will most likely be responsible for the introduction of interactive videodisk systems to the general public. Their high profits will induce product development, and as fresh ideas for conventional videogames become scarce, interactive videodisks will be the logical step for the following generation of videogames. The interactive videodisk system designers will initially team up with independent film production houses, but the large movie studios will soon jump on the bandwagon, seeing how profitable interactive videodisks can be.

Thus, the first interactive videodisks on the commercial market will most likely be similar to standard Hollywood fare, only with the interactive user in the director's chair. The popularity of contemporary videogames like Pac-Man will drop to the current popularity of pinball as interactive

Videodisk Systems

Video sweeps the industry. Gradually videodisk software will diversify from James Bond or Star Wars type adventures to sophisticated historical recreations and simulations which will attract an older segment of the market. The education industry will benefit from the research and development by the videogame industry and will become a large user of educational interactive disks.

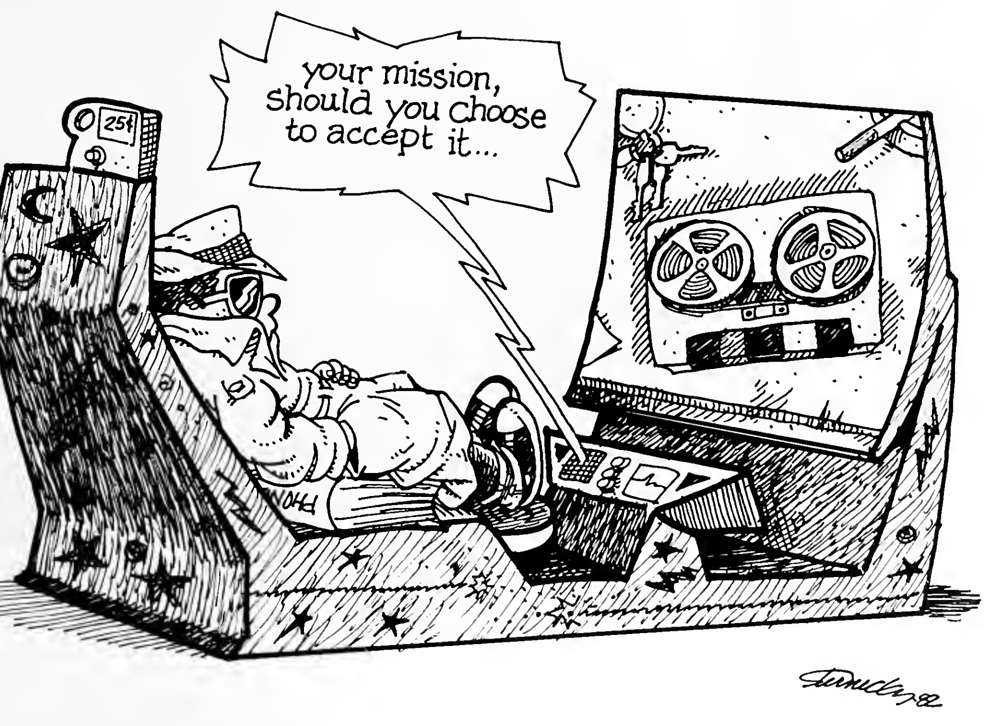
But let us return now to our hypothetical video arcade. The kid is asked from the screen by a voice on a tape recorder inside a cigarette machine if he chooses to accept the mission of rescuing a Russian diplomat and restoring world peace. "Sure", replies the player, and the computer responds to his voice, and the image of tape recorder self-destructing is seen on the screen. Theme music plays, and he enters the next scene.

Kennedy Airport in New York. Our hero meets a contact at a snack shop who informs him that a ransom has been posted, and that they have forty-eight hours before the diplomat is to be executed. He is given the choice on the touch screen of taking a night flight, or waiting until the morning for a courier to bring a top secret dossier containing information on the diplomat and then taking a morning flight (first class, non-smoking).

The flight is at first fairly routine. After the in-flight film, drinks are served, and the kid chooses a small glass of Amaretto. The hostess serves it with a smile, and he chooses to drink it (again via the touch screen).

Meanwhile, on the video screen, solid objects begin to turn fuzzy, and straight lines become wavy. Had the child chosen to wait for the top secret dossier, he would have found out that the cheerful hostess was actually a spy for the Russian Secret Service. With this knowledge, he could have avoided being drugged by her, but still would have had to successfully land the airplane.

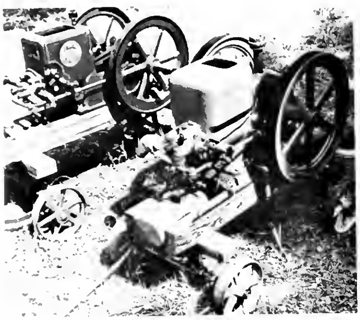
Points are tallied, credits roll along with the theme music, and the message "Deposit Coins" appears on the screen. The child emerges from the Plexiglas dreamworld unphased by his quick defeat, marvelling at the fact that the TV actually 'listened' to him. A tall middle-aged salesman and his wife, out on a date, are the next ones to attempt the mission, and try to fit a few more pieces into the puzzle. Meanwhile, Pac-Man stands silent and alone in the corner of the arcade, feeling like Pong.T



Text and Photos by Randy Stukenberg

Steam Power

In the beginning was the horse. Then along came steam power in the late 1800's. Steam engines were produced in all makes and sizes. In addition to the giant locomotives and farm tractors, miniature steam engines powered washing machines and wood saws. Eventually steam power gave way to electric motors and gasoline tractors, and now appear mostly in exhibitions. Steam power shows such as this one in Sycamore, IL., draw crowds of old—timers to reminisce or to show off their miniature engines. Other steam enthusiasts bring working models for demonstrations. Many people come just to see turn—of—the—century farming.



LETTERS

Professor Follows Advice "To the Letter"

To the editor:
Your latest Technograph editorial has promted me to reply. I have three items:

1. I could not avoid the comparison between Jackson and da Vinci (see below). Besides the pose, the eyes and the Mona Lisa smile, the association with the technology of advanced flight is a striking similarity.
2. Congratulations on the ECMA awards. Did they help to make the many volunteered hours seem well spent?
3. A somewhat more philosophical issue is the editorial's lament over the lack of response to Technograph on the part of readers. Obviously it bothers you or you probably would not have written about it. It bothers me too--not the lack of response to Technograph, but the general unresponsiveness of students. I don't see rallies about unemployment, Robert Parker, the Falklands, the economic suffocation of the University, girls' underwear. . . I notice the unresponsiveness in the classroom; my colleagues do too. Is no one home? Does no one care? Or is it spring fever? I hope so!

Carl J. Altstetter
Professor of Physical Metallurgy

Illinois Technograph invites letters in response to its articles and editorials, or any other item of interest to our readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.

TECHNOTES

EOH is Back...

Are you interested in promoting engineering? Showing all those queriful people what it is you do? Or how about applying your skills toward a worthwhile project? Well, this year the Engineering Open House Central Committee has chosen "Responding to Reality" as the theme for EOH '83.

Continuing with the tradition, EOH '83 will feature a central exhibit, a coordinated project, various society and departmental projects, the finals of the Engineering Society debates, and a few pleasant surprises.

And, as usual, EOH needs your help to make it the success for which it is famous. Several people are needed to help with the coordinated project. This year that project entails finishing the interior of a model space station, as well as dealing with the "social ramifications of life in space." The Central Committee also needs people to assist in planning the official opening of the open house. Your department may need you too—see your departmental head. And if you are interested in promoting EOH '83, contact Chris Balabuszko.

If you wish to speak with anyone involved, or if you have any questions or ideas, go up and see the folks in room 300 Engineering Hall, or leave a note for them in their mailboxes. They also have times and schedules for the debates there, too.

So go now and get started working for EOH '83, and respond to the reality of engineering.

Ego Boosts Galore

There have been an incredible number of awards, honors, and appointments over the summer—the succulent price paid by universities full of famous and talented faculty. Regretfully, due to this abundance, we can only mention them, instead of writing about each individually. As we all know, however, the fact that the following people received their respective awards is illustrative enough of their talents, regardless of how much we brag about them.

Theodore J. Rowland and Arthur M. Clausing, professors of Physical Metallurgy and Mechanical Engineering, respectively, were named Assistant Deans for the 1982-1983 school year. They have replaced Jane Liu and Bernard Wehring, both of whom return to teaching and research.

Mac E. Van Valkenburg has been given the distinguished honor of becoming the first Grainger Professor of Electrical Engineering, the only endowed chair in the College of Engineering at the University of Illinois. The chair exists thanks to a \$1.1 million gift to the University of Illinois Foundation by the Grainger Foundation of Skokie. Prof. Van Valkenburg is currently one of the most, if not the most, famous EE educators alive today. In addition, Peter W. Sauer was named as the first Grainger Associate.

Seichi Konzo has been awarded a 50-year member award by the American Society of Heating, Refrigerating, and Air-conditioning Engineers. Prof. Konzo is internationally known for his research, and has been honored by the Society several times before.

Bruce E. Hajek of the EE department received the American Automatic Control Council's Eckman Award for an outstanding contributor to the field of control. Last year, Hajek won an award from Xerox for best research by an assistant professor.

Daniel C. Drucker, Dean of Engineering, was made an honorary member of the Illinois Society of Professional Engineers. He is also president of both the American Society of Engineering Educators and the International Union of Theoretical and Applied Mechanics, and an elected member of the National Academy of Engineering.

Professor of Civil Engineering William C. Ackerman has received the second annual Chicago Area Sigma Xi Award. He too is a member of the National Academy of Engineering, and also has been awarded the Lincoln Medal for the advancement of human welfare. The Sigma Xi Award was given in honor of his contributions to the country, state, and Chicago area before he retired as the Illinois State Water Survey chief.

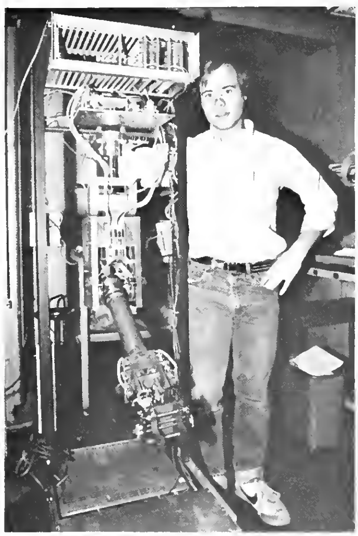
Professor Richard S. Engelbrecht has been elected for a second 2-year term as president of the International Association on Water Pollution Research. Engelbrecht is a 23 year professor of Environmental Engineering, a member of the National Academy of Engineering, and has received a number of other awards for his research.

Richard I. Masel of Chemical Engineering has been awarded the Exxon Faculty Fellowship for 1982 in solid state chemistry. The fellowship goes to the University to support Masel's research.

We Got 'em Again

There have been a lot of financial burdens to students at the University due to the troubled economy, but once more there's good news to the engineering students! The 491 engineering grads of this year who found employment still received multiple job offers—an average of 2.5 apiece. Unfortunately, this figure is down from last year's 3.7 offers. But at least the jobs are still there. In fact, out of 887 total grads in this field, by the end of July only 5.6% were "still available," according to an in-college survey. The survey also said that companies increased their interviews with University students to 20,000, an 11% increase from last year. Starting salaries were not affected by the recession, but almost twice as many engineers were "still available" this year compared to last year.

The conclusive word is that this year the economy has slowed down engineering hiring, but for good engineers the jobs still exist in reasonable abundance.



Jeff Konicek stands by his graduate thesis project, a computer controlled mechanical arm. Jeff has been working on this project since February and hopes to eventually scale it down to human proportions.(photo by Randy Stukenberg)

Chip Off the Old Block

Even though the amazing silicon chip is still looked at with wide eyes, the time has come for a new child to enter the world of fast-changing technology. It is the optoelectronic chip, and it has the capability to surpass its silicon father.

Nick Holonyak, Jr., a leader in optoelectronics research here at the University, believes that although the new chip will probably outdo the older one, it won't receive the same public acclaim. People have already been fully introduced to microelectronic circuitry, so an optoelectronic valley will probably not grow overnight.

The new chip gains its one-upness from the fact that it can process photons, which are the quanta of light. It accomplishes this through its artificial structure of superlattices, which are made of scrambled layers of aluminum arsenide and gallium arsenide. These layers make up a network of yellow and red crystals which transmit light and electrical impulses more intricately than the silicon chip. Holonyak says it may take until the turn of the century to perfect it, but the optoelectronic chip will definitely give us all kinds of new possibilities and advancements.

Not only will the optoelectronic chips process electronic impulses, but they will also use optical wave guide sections and other elements to process internal optical data. This means that in the not too distant future better lasers and light sources will be able to be built.

After watching the growth of the silicon chip, who knows where this new chip will take us in and beyond the year 2000, after it has been refined and studied in depth.

The Surface Contingent

A recent finding at the General Motors Research Laboratories has changed scientific thinking about the behavior of electrons in metal surfaces. This discovery provides a greater understanding of the fundamental physical processes involved in such surface events as adhesion, corrosion and catalysis.

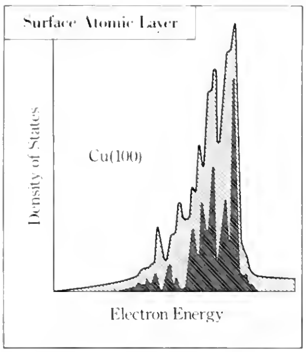
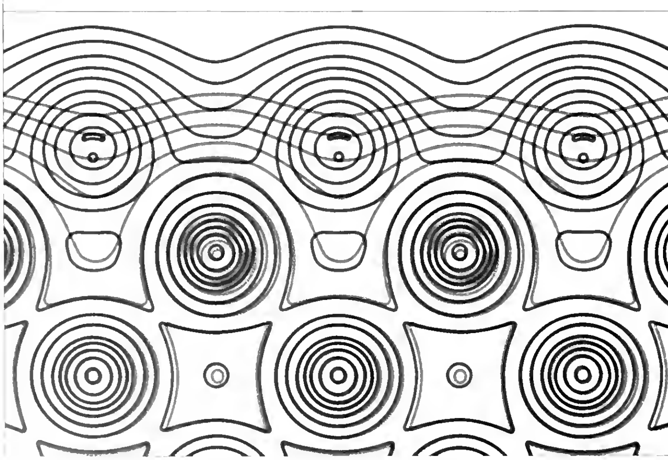


Figure 1 Energy distribution of electrons in outermost atomic layer. Shaded area indicates electrons in surface states.

Figure 2 Two electron density contour maps of the cross section of a Cu(100) surface. One map shows a clean copper surface (lt. gray); the other shows a nitrogen-covered copper surface (dk. gray).

CONVENTIONAL scientific thought treats virtually all of the valence electrons found in the surface atomic layer of a metal as if they are free to roam throughout the metal's interior. The work of three physicists at the General Motors Research Laboratories suggests otherwise. Through calculations confirmed by experimental data, the theorists have shown that more than a quarter of the valence electrons in the top atomic layer of some metals are effectively trapped in the surface. The presence of so many "surface state" electrons must be considered when analyzing physical and chemical surface phenomena, including such surface events as oxidation leading to corrosion.



Drs. John Smith, Jack Gay and Frank Arlinghaus applied their theoretical analysis to the (100) surface of five metals: copper, nickel, silver, rhodium and palladium. They made bold predictions concerning the percentage of electrons in the surface atomic layer to be found in surface states: Cu(36%), Ni(23%), Ag(23%), Rh(23%) and Pd(19%). The ratio of the shaded area to the hatched area of figure 1 gives the percentage for copper.

Electrons in surface states are not only abundant, but also highly localized on the surface. Chemisorption on a metal is also confined to the surface region. Figure 2 shows what happens in the case of nitrogen chemisorbed on copper. The two contour maps coincide except in the surface layer, where the interaction is largely exhibited. Localization of the interaction holds for the chemisorption of other gases, including oxygen in the initial stage of metal oxidation. These observations led the physicists to conclude that surface states are important in chemisorption.

One way to probe electrons in surfaces is to chemisorb atoms on a clean metal surface and look for changes in photoemission spectra. Such an experiment was performed at GM for fractional monolayers of nitrogen, oxygen and sulfur on Cu(100). The dominant change in the photoemission spectrum was the disappearance of a large peak whose shape and energy location was independent of the chemisorbed atom. It was of special interest that the shape and energy location of this peak was nearly identical to the envelope around the surface state peaks in figure 1. This suggests that surface state electrons play a major role in the chemisorption process.

THE THEORETICAL advance at the heart of the discovery is the "Self-Consistent Local Orbital (SCLO) Method" for solving the Schrödinger equation. This new mathematical method was devised by the GM theorists to handle the classic dilemma posed by the self-consistency requirement. The characterization of electron behavior used to complete the equation must be consistent with the behavior predicted by the equation. In other words, one almost needs to know the answer in order to make the calculation.

Self-consistent solution of the equation for a metal surface is made exceedingly difficult by the three-dimensional nature of the electron density distribution. The theorists dealt with this challenge successfully by dividing the electron density distribution into two parts—the first part due to overlapping atomic density distributions; the second part equaling the difference between this atomic contribution and the exact density distribution.

One of the more stringent tests of the accuracy of the SCLO method was an angular photoemission experiment conducted by Heimann et al., at the University of Munich subsequent to publication of the GM research. The German research team confirmed a prominent surface state band predicted by the three GM physicists. This was the first time a surface state band on a solid had been calculated prior to its being seen experimentally. The SCLO method makes possible something that could not be done before—accurate prediction of the actual behavior of electrons whirling around nuclei at the surface of a metal.

"The large body of surface states we found on metal surfaces," says Dr. Smith, "may be a controlling factor in many physical and chemical surface phenomena. By replacing conjecture with calculation, the new surface theoretical methods give us the means to make major steps forward in the analysis of surface and interface properties."

THE MEN BEHIND THE WORK

Drs. Smith, Gay and Arlinghaus are theorists in the Physics Department at the General Motors Research Laboratories.

John Smith (center) and Jack Gay (right) received doctorates in physics; Smith from Ohio State University and Gay from the University of Florida. Frank Arlinghaus received his Ph.D. in physical chemistry from the Massachusetts Institute of Technology.

John Smith, leader of the GM solid state physics group, did postdoctoral work at the University of California in La Jolla. He joined General Motors in 1972. Frank Arlinghaus and Jack Gay joined the corporation in 1964 and 1965, respectively.

Each member of the team brings to the project a different expertise: Smith in surface physics, Gay in solid state theory, and Arlinghaus in bulk band structure calculations.

Defending Nuclear Power

An economic analysis supports nuclear energy.

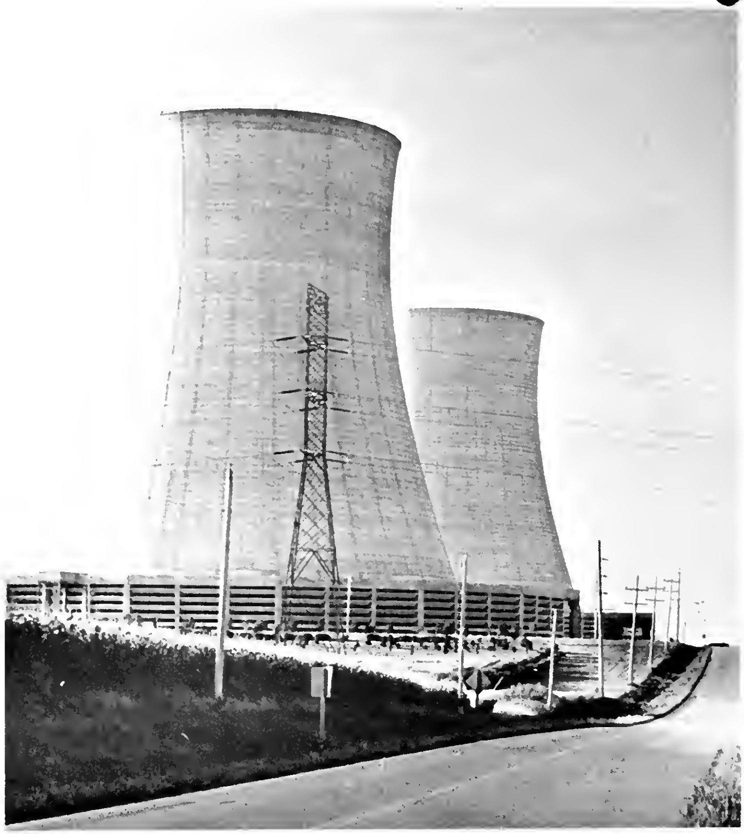
by Magdi M. H. Ragheb

Editor's note: In April of 1982, Illinois Technograph ran the article "Problems of the Nuclear Family" by Larry Mallak which discussed the financial and management problems at Illinois Power's Clinton Nuclear power plant now under construction. Technograph received this response by Professor Magdi M. H. Ragheb of the Nuclear Engineering Program. Technograph welcomes responses or comments readers wish to offer.

There has been lately a public concern about two main financial considerations occurring to electric utilities in the nation, particularly those among them using nuclear reactors for energy production.

The first consideration concerns costs overruns for construction which leads to electric bill rate hikes. For example it is reported that the construction of the Clinton Nuclear Plant by the Illinois Power Company has now a projected price of $1.8 billion, whereas its original cost was $429 million. The utility is reported hiking its rates by 19.9%. Erroneous analogies using simplistic emotional persuasion of the public are advanced regarding this issue as: "... while fixing up the house for a party, one sends a roommate out with his Visa card to get the party goods. He comes back hours later having purchased a beer-making kit, an ice machine and other extravaganza..."[1]

The second consideration is the large capital cost of nuclear facilities compared to fossil ones. The fallacious analogy given in this case is: "...the beer-loving roommate will be brewing beer using nuclear power. The taste will be the same as when fossil fuel energy was used, but the cost will be greater."[1]



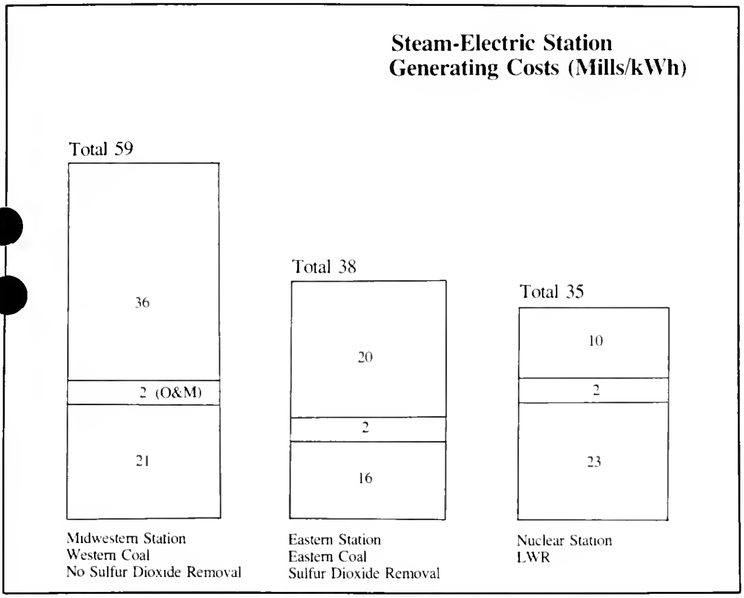


Fig. 1 Levelized costs for steam-electric stations. O&M stands for Operation and Maintenance.

Regarding the second consideration, the reader can very easily detect its half-truthed nature: in comparing different energy options, it is the cost of the energy produced (e.g. in dollars per kilowatt hours produced) that should be compared, not just the capital cost of the plant. The cost of production of electrical energy has many contributing components that should be accounted for: the cost of fuel, the cost of operating and maintaining the plant, and then of course also the capital cost. Comparing the costs of electricity produced from coal and nuclear energy in Figure 1 shows a distinct cost advantage for nuclear-produced electricity in many parts of the nation.[2]

The reason why it is unacceptable to compare energy options just on the basis of capital costs is shown in Figure 1. Whereas nuclear power stations are slightly more expensive than coal power stations in terms of capital cost, the fact is that their fuel cost is much lower, and this gives them the cost advantage over coal power stations in terms of electrical energy cost.[3,4]

This fuel cost savings is significant to the consumers in general. Let us calculate the possible energy costs of using home appliances by constructing Table 1 using the numbers from Figure 1. The table shows that nuclear electricity would offer a significant cost advantage over eastern coal: the operation of a set of home appliances using a total of 12353 kWh/yr would cost \$729 if eastern coal is used, whereas it is only \$432 if nuclear electricity is used. Environmentally, it may even be the only possibility on the East Coast, considering the possible pollution from coal burning in highly populated areas. The Tennessee Valley Authority (TVA) Browns Ferry nuclear plant produced electricity in fiscal year 1979 for 0.67 cents per kWh. Its Cumberland coal-burning plant, built at about the same time, produced electricity for 1.92 cents per kWh. This saved TVA power consumers more than \$200 million in 1979 compared to power costs from TVA's own steam plants.

TVA states that, during the 1990's, running a 1,000 MWe Nuclear plant instead of an equivalent oil-fired plant would save \$1 billion a year in fuel. This saving can also translate partly into reduction of oil import. This is important, considering that the USA spent about \$90 billion for imported oil in 1980, up 50 percent from 1979, and 1,000 percent from 1973. The combined assets of General Motors, Ford, General Electric and IBM equals \$90 billion. The net income of the entire Fortune 500 corporations is less than \$80 billion.[5]

Internationally, the same situation prevails. As of May 1980, the cost of nuclear electricity in France was 13.52 centimes per KWh compared with 24.79 for coal stations and 36.32 for oil stations.[5] In England the 1979-80 costs for three older generating plants are given as: nuclear—1.30 pence per unit of output (kWh); coal—1.56 pence; oil—1.93 pence. For newer plants: nuclear—1.35 pence per unit, and coal—1.52 pence per unit. The load factor for nuclear was 43 percent; coal 73 percent.[5]

A large capital cost is also not a matter of concern. For an individual, the cost of the Clinton plant, at \$1.8 billion [1], may be a staggering amount. But the fact is that nuclear plants pay back the energy investment made to construct and fuel them in a short period. Let us make our own estimation for the Clinton plant. The time taken to pay back the investment, if the plant power is 1,000 MWe, the availability factor is 70% and the cost of electricity is 3.5 cents/KWh, can be easily calculated. The income from the electricity produced in a year will be:

$$0.70 \times 1000\text{MWe} \times 10^3 \frac{\text{KWe}}{\text{MWe}} \times 1 \text{ year} \times 365 \frac{\text{days}}{\text{year}} \times 24 \frac{\text{hours}}{\text{day}} \times 3.5 \frac{¢}{\text{kwh}} \times \frac{\$0.01}{¢} = \$2.15 \times 10^8$$

The time taken to pay back the capital investment can now be obtained by dividing the total cost of the plant by the income from electricity produced in one year:

$$\text{Time} = \frac{\$1.80 \times 10^9}{\$2.15 \times 10^8/\text{year}} = 8.37 \text{ years}$$

Thus less than nine years will be needed to repay the total capital investment in the plant. Notice that this is less than one third of the expected plant lifetime of about 30 years.

Of course this does not justify the cost overruns, because, at its original estimated cost the plant would pay back its capital investment in just:

$$\text{Time} = \frac{\$4.29 \times 10^8}{\$2.15 \times 10^8/\text{year}} = 2 \text{ years}$$

Now we come to the issue of cost overruns. First of all, these cost overruns have been lately affecting both coal and nuclear power plants. Second, there is truly evidence of a seriously weakening and steadily deteriorating economic condition among the nation's electric power companies. But this cannot be blamed on the utilities or companies alone: this is a reflection of the naton's social, political and economical conditons. For example from 1970 to 1981:

1. The average interest rate on new long term capital debt rose from under 9 per cent to as high as 15 per cent.

2. The average rate of return on common equity authorized by state public service commissions increased only from about 12 per cent to approximately 14 per cent.

3. Due to extended regulatory proceedings and rapidly mounting inflation and/or interest rates, however, the average actual earnings on common equity decreased from about 12 per cent to approximately 11 per cent.

4. Further, an average of 45 per cent of recorded "earnings", up from 18 per cent, represented merely an accounting entry of non-cash credit—an allowance for the cost of capital used during construction rather than income available for divident payments or buiilding programs.

5. The selling price of common stock fell from more than 120 per cent of book value to less than 75 per cent (May 1982), diluting the original value of all outstanding shares.

As a result of these factors, over 60 per cent of the construction funds needed by electric utilities must be raised in the external capital and credit market. Thus, if not permitted an actual rate of return equal to the current cost of capital, any building expenditures subject the industry and its shareholders to a loss, and possible bankruptcy.

But is construction of new plants needed? The amount of electrical plant capacity needed to be committed in the Eighties to supply demand in the Nineties averages about 40,000 megawatts each year. If these construction needs are not met, economic stagnation, blackouts, and even higher energy costs will occur.

Appliance	Energy Consumption (KWh/yr)	Eastern Coal Electricity at 5.9¢/KWh ($)	Nuclear Electricity at 3.5¢/KWh ($)
Water heater	4800	283.85	168.39
Freezer (frostless 15 Ft^3)	1761	103.90	61.64
Refirgerator (frostless 12 Ft^3)	1217	71.80	42.60
Range with self-cleaning oven	1205	71.10	42.18
Clothes dryer	993	58.59	34.76
Color TV (tube type)	660	38.94	23.10
Air conditioner (room)	860	50.74	30.10
Dishwasher	363	21.42	12.71
Dehumidifier	377	22.24	13.20
Coffee Maker	106	6.25	3.71
Total	12353	$728.83	$432.39

Table 1 Cost of operating home appliances using different energy sources for electricity production.

Unfortunately, the precarious financial situation of the utilities has led to the cancellation (since 1972) of orders for 8 coal and nuclear generating units totaling more than 85,000 megawatts. Another 241 coal and nuclear power facilities amounting to over 195,000 megawatts being built or planned for service by the early 1990's have been delayed an average of 40 months. Of these 40,000 megawatts needed to be committed each year, about 8,000 megawatts only are now ordered each year.[6]

To support the needed level of power plant construction, consumer rates for electricity must thus be raised to achieve authorized levels of return adequate to attract new captial, with adjustments as costs change to ensure that actual earnings remain at permitted levels. Moreover, costs of construction work in progress must be reflected in customer charges as they are incurred rather than only after the generating unit begins operation—as long as 10 to 15 years later.

The conclusion is that more electric capacity is needed for the future, both nuclear, coal and also natural gas and oil. Any contributions from conservation, solar, wind and other forms of energy will be much needed. Considering the decade or more required to place a new coal or nuclear generating unit in service, we must realize that the future is now; without ensuring expansion of power producing capacity today, major and chronic shortages of electricity, and higher prices are inevitable in the years ahead, leading to economical turmoil and social dislocations.

References

1. L. Mallak, "Problems of the Nuclear Family," Illinois Technograph, 97, issue 5, April (1982) 8-9.

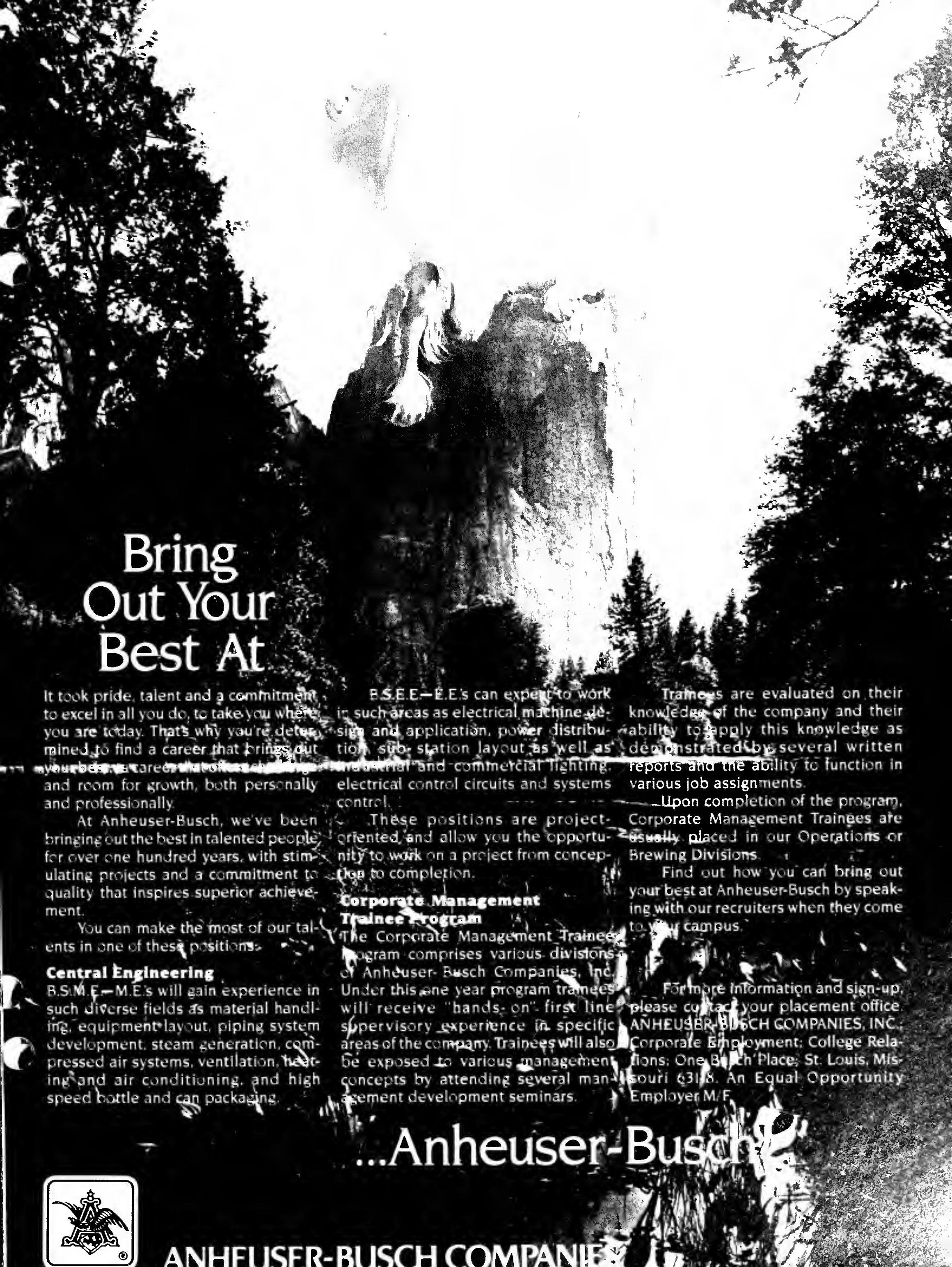
2. "Coal and Nuclear Generating Costs," EPRI, PS-455-5R (1978).

3. "Nuclear Power and the Environment," American Nuclear Society, June (1976).

4. "Nuclear Power and the Environment, Energy Alternatives," American Nuclear Society (1981).

5. "Nuclear Power Quick Reference III", General Electric, Nuclear Energy Group, San Jose, Claifornia (1982).

6. "Nuclear Power Information," Atomic Industrial Forum, Inc., May (1981).


Bring Out Your Best At
It took pride, talent and a commitment to excel in all you do, to take you where you are today. That's why you're determined to find a career that brings out your best, a career [illegible] and room for growth, both personally and professionally.
At Anheuser-Busch, we've been bringing out the best in talented people for over one hundred years, with stimulating projects and a commitment to quality that inspires superior achievement.
You can make the most of our talents in one of these positions:
Central Engineering
B.S.M.E.—M.E.'s will gain experience in such diverse fields as material handling, equipment layout, piping system development, steam generation, compressed air systems, ventilation, heating and air conditioning, and high speed bottle and can packaging.
B.S.E.E.—E.E.'s can expect to work in such areas as electrical machine design and application, power distribution, sub-station layout as well as industrial and commercial lighting, electrical control circuits and systems control.
These positions are project-oriented, and allow you the opportunity to work on a project from conception to completion.
Corporate Management Trainee Program
The Corporate Management Trainee Program comprises various divisions of Anheuser-Busch Companies, Inc. Under this one year program trainees will receive "hands-on" first line supervisory experience in specific areas of the company. Trainees will also be exposed to various management concepts by attending several management development seminars.
Trainees are evaluated on their knowledge of the company and their ability to apply this knowledge as demonstrated by several written reports and the ability to function in various job assignments.
Upon completion of the program, Corporate Management Trainees are usually placed in our Operations or Brewing Divisions.
Find out how you can bring out your best at Anheuser-Busch by speaking with our recruiters when they come to your campus.
For more information and sign-up, please contact your placement office. ANHEUSER-BUSCH COMPANIES, INC., Corporate Employment: College Relations; One Busch Place; St. Louis, Missouri 63118. An Equal Opportunity Employer M/F.
...Anheuser-Busch
ANHEUSER-BUSCH COMPANIES

Engineering Family Album

Find your place in society.

compiled by Langdon Alger

Engineering Fraternities

Triangle (112 E. Daniels, C) is about 95% engineering, and it is a social-professional-national frat. Call them at 384-9668 and ask for the rush chairman.

ΣΦΔ (302 E. Gregory, C) is not only social-professional, but also an international frat. Call the rush chairman at 337-7511.

Honor Societies

These societies are not only honorary; they get involved with their majors and are quite social.

ΑΕ is open to agricultural engineers, as long as they have a 4.0 GPA if they are juniors, or a 3.8 if seniors. Contact their adviser, Gene Shove, at 333-6762.

ΑΠΜ can be for you if you have a 4.0 and are in either of your last two years in industrial engineering. President Charles Schroeder can be written to—leave him a note in 232 Mech. Engr. Bldg.

ΑΣΜ is for metallurgical engineers. They have special requirements, so contact adviser R.W. Bohl, 206 Met. & Min., 333-0924, if you're interested.

ΧΕ's president is Everett Leasure, 344-8445, and he is the person to talk to if you have a 4.0 in civil engineering.

ΗΚΝ is open to electrical engineers who are in the upper 1/4 of their junior class, or upper 1/3 of their senior class. Talk to adviser A.W. Dipert, 333-0716, in 156 EEB.

ΓΕ is generally for general engineers. The requirements are different, so call Michael Biarnesen at 344-4963, or leave a note in 117 Transportation.

Keramos is open to ceramic engineers with a GPA between 3.5 and 4.0, depending upon their year. Julie Schoenig has a mailbox in 201 Ceramics.

ΦΚΦ has stiffer requisites, but it is open to all engineering curricula. Contact E. Copeland, 337 Administration, 333-4860.

ΦΛΥ is available to chemical engineers with a 4.5 or 4.2 for first & second semeter juniors, or a 4.0 for seniors. Raymond E. Cline, Jr. is who to contact, at box 24 in 331 Noyes Lab, or at 333-1776.

ΠΤΣ's requirements start at a GPA of 4.25, and include other items. If you're a mechanical engineer, call Chris Tadanier at 384-7628.

ΣΓΤ is open to aeronautical engineers with a 4.3 and more. Contact adviser H.H. Hilton, 101 Transportation, 333-2653 for more info.

ΤΒΠ is a household word, and it is for all engineering curricula. They have both personal and scholastic requirements, so talk to president Christopher Turner. He's got an office in 302 Engineering Hall, phone 333-3558, or call him at home, 344-9216.

Engineering Societies

Society of Women Engineers (SWE), is open to all female engineers. Contact Lynn Farley, at 344-5060 or 344-6212, or leave her a note in 300 EH.

The Engineering Council has a wide variety of activities, and you can get involved in several groups that offshoot from the Council. George Mejicano is president, and his office is in 300 EH, 333-3558.

Association of Minority Students in Engineering (AMSIE) promotes minorities in engineering through a multitude of activities. Contact Wadell Brooks Jr., 302 Eng. Hall, 333-3558.

The Illinois Technograph is UIUC's only engineering magazine, and the opportunities include more than just writing. Contact editor Kevin Wenzel, 302 EH, 333-3558.

All the following societies have membership in Engineering Council. Their purposes are explained in the names, and they all include social as well as scholastic and employment activities. Feel free to contact the representatives of the ones that interest you.

American Academy of Mechanics (AAM), Kathryn Wilson (367-6148), office at 121 Talbot (333-3197).

American Ceramic Society (ACS), Lynne Gignac (384-1381), office at 204 Ceramics.

American Foundrymen's Society (AFS), J.L. Leach (333-1779).

American Institute of Aeronautics & Astronautics (AIAA), Mark Lemak (359-4592).

American Institute of Chemical Engineers (AIChE), Kirk Nass (344-6002). AIChE has a mailbox in RAL.

American Institute of Industrial Engineers (AIIE), Connie Kus (384-1678), office 221 MEB.

American Nuclear Society (ANS), Mindy Krause (356-1412) for undergrads, Tim Polich (328-4213 333-6686, 214 Nuc. E. Lab) for grads. Office in 419 Ceramics.

American Society of Agricultural Engineers (ASAE), Tom Kreher (867-8640), off. 202 Ag. E.

American Society of Civil Engineers (ASCE), Don Tappendorf (367-6861), off. 308 Engr. Hall.

American Society of Mechanical Engineers (ASME), Nancy Sprick (344-1295), mailbox in the ME lounge.

Association for Computing Machinery (ACM), Andy Wisniewski (328-4422), mailbox in 222 DCL.

Associated General Contractors (AGC), Wayne Aldrich (344-0078), off. 308 EH.

Bioengineering Society (BS), Tony Schrock (337-5000).

Illinois Society of General Engineers (ISGE), Andy Karas (384-5343).

Institute of Electrical and Electronic Engineers (IEEE), Luis-Blas Gonzalez-Alvarez (367-3042), office 247 EEB (333-7401).

Institute of Transportation Engineers (ITE), Trudy Boehme (344-9187).

Physics Society (PS), John Sloan, office 239 Loomis (333-7031).

Society of Automotive Engineers (SAE), Mike Truex (332-3876), off. 144 ME.

Society of Cooperative Engineers (SCE), Mike Marinos, off. 109 EH.

SYNTON (Ham radio), Tom Ask. Adviser C.A. Cain, 308 EE Annex (333-7288).

University of Illinois Metallurgical Society (UIMS), David Kleine, 201 Met. & Min. (333-6584). T

Biological Effects of Smoking

Tar and nicotine spell only trouble.

by Yuki Spellman

"And a woman is only a woman, but a good cigar is a smoke." Thus Rudyard Kipling expressed himself on smoking. He may have been the most famous person to endorse the habit, but he certainly wasn't alone. Today tobacco companies echo Kipling with a more prosaic push to consumers. Last summer saw Kool Jazz Festivals, the Merit Report and the Camel Sports Scoreboard, not to mention a deluge of ads telling people that they've found it—True. Or to come over to macho Marlboro country. Or that you've come a long way, baby.

The Tobacco Institute takes the podium against anyone who would protest with their series of ads: "Answers to most asked questions about cigarettes." The ads advise anyone concerned about the effects of smoking to take into consideration the views of the tobacco companies.

Promotion of cigarettes had the intended effect on over 53 million Americans who continue to spend more than $19 billion on cigarettes each year, in spite of morning cough, stained fingers, and smoke-scented clothes. And that's just the obvious effects. The Surgeon General's report issued last March links cigarettes more strongly than ever before with serious health damage. Surgeon General C. Everett Koop states, "Cigarette smoking is clearly identified as the chief preventable cause of death in our society and the most important public health issue of our time."

Then why do people continue to smoke? Psychologists explain smokers' need for oral gratification, and the excuse to keep hands occupied in social situations. However, there is also a biological dependence. Cigarettes contain nicotine, a chemical which, when it makes contact with the brain, releases a variety of nerve stimulants.

The most significant biological change effected by nicotine is the release of epinephrine from the adrenal glands. Epinephrine is more commonly known as adrenaline. The result is a faster heart beat and the constriction of blood vessels, preparing the body for stress as in a fight or flight reaction. This nerve stimulation improves mental alertness and in time the smoker depends on it, becoming irritable when it's withdrawn.

The effect on the body is less tonic. Nicotine puts stress on the heart, increasing its demand for oxygen. Past Surgeon General's reports have shown that when cigarette smoke enters the body, the heart muscle works harder, blood pressure rises and heart rhythms become irregular. Such conditions can only exacerbate heart disease, if not cause it. Statistics show that the risk of heart disease is twice as high among people who smoke a pack a day than for nonsmokers.

Besides increasing the heart rate and demand for oxygen, smoking apparently reduces the amount of high density lipoproteins (HDL) in the body. Lipoproteins wrap cholesterol so it can be transported in the bloodstream. High density lipoproteins carry cholesterol away from the arteries, while low density lipoproteins tend to deposit it on the arterial walls. The level of HDL in smokers is 11 percent lower than levels in nonsmokers. This was reported by Dr. Michael Criqui, an epidemiologist, at a 1979 meeting of the American Heart Association. Lower levels of HDL would encourage the buildup of cholesterol deposits in arteries, which is the major cause of heart attacks.

Smoking also poses a threat to the lungs. The Surgeon General's report states that 111,000 people are expected to die this year from lung cancer. But 85 percent of lung cancer deaths might be prevented by people giving up cigarettes. Cigarette smoke traps tobacco products in the lungs. Several of these products have caused cancer in laboratory animals. On the whole, smokers are twice as likely as nonsmokers to die of cancer. The chances of death due to oral cancer, cancer of the esophagus, and cancer of the pancreas, are significantly increased by smoking cigarettes.

Women on the pill are especially vulnerable to health damage from smoking. A study by the Boston Collaborative Surveillance Program found that of the pill users who have suffered heart attacks, 92 percent are smokers. Doctors believe there is a link between blood clots and smoking among those who use the pill.

Women who smoke can also endanger the health of their unborn children. Smoking mothers give birth to underweight babies more often than nonsmoking mothers. This is probably the result of the reduced amount of oxygen available to the fetus. Smoking is also a major cause of placental infarcts--areas of dead tissue which result when the blood supply is blocked. Premature detachment of the placenta is related directly to the amount smoked during pregnancy. A past Surgeon's Report stated that the risk of spontaneous abortion among women who smoke during pregnancy is 35 percent higher than among nonsmokers.

Smokers can even damage the health of nonsmokers who stay near them long enough. The exhaled, or "sidestream," smoke can contain carcinogens in higher concentrations than the smoke inhaled. Nitrosamines, known carcinogens, can be found in concentrations fifty times that found in mainstream smoke, and it has been found that the nicotine levels in nonsmokers regularly exposed to smokers are up to 20 percent of the levels found in smokers.

Marijuana creates many of the health problems associated with tobacco smoking, with a few additional risks. Physical effects, as detailed last March in a comprehensive report by the Academy of Science's Institute of Medicine, include precancerous changes in the linings of the bronchial tubes and also increased heart rate and blood pressure.

The active ingredient in marijuana is delta-9-tetrahydrocannabinol (THC). Like alcohol, it impairs coordination and judgement, and also impairs short term memory and the ability to learn. In the body, the formation of protein cells is impaired. For instance, white blood cells divide more slowly than normal, making it harder for the body to combat disease.

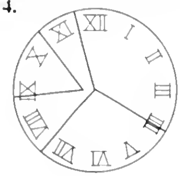
Currently, the legal cigarettes carry a familiar warning label stating, "The Surgeon General has determined that cigarette smoking is dangerous to your health." Some health organizations worry that it has become too familiar, and legislation is pending that would put a rotating series of stronger warnings on cigarette packages and advertisements. These warnings would tell consumers that smoking can cause lung cancer, heart disease and birth defects. This legislation is supported by organizations such as the American Cancer Society, the American Heart Association and the American Lung Association.

If you're already smoking, it's not too late to start paying attention to warnings. According to the Surgeon General's Report, 95 percent of the people who quit smoking do so on their own, without organized programs. The report also noted that quitting cold turkey seems to be more effective than gradually cutting down. The person trying to quit shouldn't be alarmed by slight weight gain. The slowed metabolic rate caused by reduction of nicotine intake explains the tendency to put on an extra pound or two.

In their book, Learning to Live Without Cigarettes(Dolphin Books, 1968), authors Allen, Angumann and Fackler tell the person giving up smoking to avoid situations that usually involve smoking, such as social gatherings, coffee breaks, etc., and to think of things that are pleasant (like the amount of money saved by not buying cigarettes) whenever the urge to light up a cigarette occurs. Perhaps the best thing to keep in mind is that there's simply no such thing as a "good cigar." **T**

Tech Teasers Answers

1. Janet entered the store with $99.98.
2. The number is 13452, because 13x452, and 1,2,3,4,5 are all successive digits.
3. The customer ordered one and one-ninth pounds of cookies. Thus, after the baker munched his fee, the customer had 1 pound left.
4.



Statement of Ownership
Illinois Technograph

Editor in Chief of the Illinois Technograph is Kevin Wenzel, 620 E. John St., Champaign, IL, 61820. General manager of the Illini Publishing Company is E. Mayer Maloney, Jr., 704 Harmon, Urbana, IL, 61801. Business Manager of the Illinois Technograph is Jim Lee, 620 E. John St., Champaign, IL, 61820.

The Illini Publishing Company is a not-for-profit organization established in the State of Illinois in 1911.

Average number of copies of each issue during the preceding 12 months: 4,100. Annual subscription rate: $4.00. Paid circulation through dealers and carriers: none. Average mail subscriptions preceding 12 months: 1,201. Free distribution preceding 12 months: 2,799. No copies distributed to news agents. Total distribution preceding 12 months: 4,000. Office copies preceding 12 months: 100. Total average distribution: 4,100. No paid circulation through dealers or carriers. Actual April mail subscription: 1,094. Free distribution at the Engineering campus of the University of Illinois nearest to filing date: 2,906. Total distribution nearest filing date: 4,100. Actual number of office copies nearest to filing date: 100. I certify that the statements made above by me are correct and complete: E. Mayer Maloney, Jr., Publisher.

Illini Publishing Company

Leo Pigage

by Larry Mallak

To his students, Professor Leo C. Pigage is the spinner of Industrial Engineering yarns which span his 45 years associated with the profession. Professor Pigage completed both his undergraduate and graduate work at Cornell University. At the time of his studies, IE was not a distinct department, but an option in IE was offered.

After leaving Cornell, Pigage spent 3 years at Duke, followed by a 7-year stay at Purdue. He came to the University in 1947 for a joint appointment of the Institute of Labor and Industrial Relations and Department of Mechanical Engineering. At that time, an IE department did not exist at the University, but in the late 50's IE emerged as a discipline on its own.

Pigage is quite active with his students, as advisor for the student chapter of the American Institute of Industrial Engineers (AIIE) for 25 years, and as advisor for AIIM, the IE honor society.

Pigage teaches IE 232 and IE 332, both of which deal with methods-time measurement; in addition, he teaches IE 287--Wage Incentive Systems and IE 393--Plant Layout. As an extracurricular activity, he has been involved in consulting and currently consults the E. Colson Co., a printing company in Paris, Illinois, which profited from more than 30 years of Pigage's service.

Next year will be Pigage's last year of teaching, as he will be retiring, however he did state that he may be back to teach a few courses.

Jane Liu

text and photo by Jim Lee

Emigrating from mainland China in 1957, Dr. Jane Win-Shih Liu attended Cleveland State University for a B.S.E.E. and the Massachusetts Institute of Technology for her master's and doctoral degrees. Recently promoted to the rank of full professor in the Department of Computer Science, Liu has had extensive background in both industry and academics. Her areas of expertise encompass computer networks, database management systems, and distributed systems. Her past industry experience include RCA, the Department of Transportation, and the Mitre Corporation.

Coming to the University of Illinois in 1973, Liu was a Research Assistant Professor doing work in computer networks and architectures, scheduling algorithms, and database management. Ongoing research projects include operations research, computer networks, and database integration for sponsors such as the U.S. Army, R.R. Donnelly, and U.S. Naval Research. Under Dr. Liu, four students have received their doctorates and 10 have their master's degrees. Currently, she has seven students pursuing advanced degrees.

"Teaching the graduate students is the most exciting aspect of being a professor. You are directly involved in the process of helping them mature in their professional careers and the psychological reward is more meaningful. Industry's rewards are realized more quickly than in academics, but it soon gets to be frustrating. In academics, there is never a dull moment in that every year brings new students and ideas."

Mike Binder

text and photo by Kevin Wenzel

Mike Binder began his career in engineering at the University of Arizona at Tuscon. He received his Bachelor's degree in Aeronautical Engineering in 1970, and continued his work to receive his Master's in the same field in the same year. Binder then switched his emphasis to Mechanical Engineeing, in which he received his Ph.D. in 1976. After spending a year as a visitng professor at the University of Arizona, he moved here to join the faculty of the Mechanical Engineering Department.

Binder teaches ME 205 and ME 304 (thermodynamics), and he has taught both 211 and 210. Binder teaches 304 from the applications point of view, because he enjoys showing how thermodynamics is used in power plants and industry.

Binder has been doing research for the EPA Advanced Environmental Control Technology Research Center. They have been looking at looking at the thermal destruction of industrial wastes for the past two years. Their main efforts are directed towards setting priorities for the use of research money.

Besides teaching and doing research, Binder keeps himself busy with other activities. He enjoys fishing, and frequents several area lakes on the weekends. Binder's main indoor activity is playing darts. He is the vice-captain and the recording secretary for the Champaign Urbana Darts Association. The club meets at Trito's in Urbana on Tuesday nights, and Binder encourages students to stop by and throw some darts.

Binder's external activities aren't all for fun, though. He is a member of AIAA, ASME, ASEE, and ΣΧ, a research honorary.

by Langdon Alger

The Space Tablet allows the user to easily record coordinates by interfacing with an IBM or Apple computer.

This Isn't a Plane Product

The time has arrived for the computer digitizer to rise up out of its two dimensionality. Micro Control Systems, Inc., has developed The Space Tablet™, which is capable of easily recording the X, Y, and Z coordinates of any three-dimensional object.

The product comes with all the equipment necessary to pull points and lines, and store them for whatever use desired. All the user has to supply is an Apple II or IBM Personal Computer, and a single floppy disk drive. The provided hardware consists of a 13.5 by 16 inch clear lucite tablet, and an aluminum/delrin arm. The regular model gives three degrees of freedom, while the professional package adds one more. Software is provided as a 3-D graphics package, and Micro Controls representative Michael Shaw says that in about a month there will be a choice of two of these packages available for the Apple users.

High quality potentiometers in the mechanical arm convert the angles the joints stand at into cartesian coordinate points, and then the computer displays them on its CRT. The operator can store all the points, call them back, move them, replace them, or perform any necessary processing. To build lines, the computer simply connects points. That means if you have a curve that has to be traced, the more points you digitize gives a more exact representation. This is not a problem, however, because the process is so simple.

The system is actually a small CAD system that offers many features only larger ones have. This is one of the reasons it is so popular with the public, and with a price under $600, it is no wonder it is selling well all over the world. Just a sampling of the applications it makes available are in the areas of education, architecture, engineering, design, science, and medicine.

Board of Resumes?

It is a sign of the times, and it is catching on quickly. The Electronics Worksite Training Project started it, at the College of San Mateo, in Silicon Valley (where else?). Heathkit/Zenith Educational Systems provides the project with 90% of the course material, as well as all of the hardware. So what is it?

The "electronic resume," that's what, and it is a visual, working representation of a student's technical skills. A student can enroll in any of about 43 different courses, according to Heathkit/Zenith representative Myron Kukla, and their resume is the final project of their course. The classes teach just about everything needed to know from digital techniques to electronic test equipment, from AC to DC electronics, and from circuits to semiconductor devices.

Evidently, the idea was initiated in response to a difficulty that electronics companies have been suffering from—a lack of competent and qualified personnel. Even in these days of unemployment, it is difficult to find technically capable employees. Thanks to this program, when a student goes in for an interview, the interviewer doesn't have to rely solely upon the grades, experience, and personality that the student provides on paper. The student hands his hopefully-future boss his circuit board, and if it works when it is turned on, the interviewer knows for sure that the person knows his stuff. This also makes the interview process easier, as it cuts down on paperwork and time.

Kukla added that this system is being copied all around the country now, and every time a new program pops up it is like reinventing the wheel. There are other aspects of importance in these systems, however, that go beyond the technical aspects. They illustrate how government, industry, and schools can all work together to give people the chances they need to learn skills and find jobs, thus reducing unemployment.

What's Your Favorite Brand?

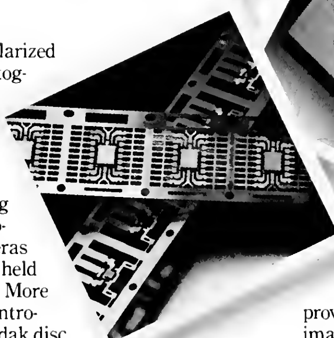
If diamonds are a girl's best friend, General Electric researchers have found a way to ward off women's loneliness. In fact, jewelers, law-enforcement officials, and anyone who owns diamonds may rest easier; now they can brand their precious gems with a personal motif.

GE found a way to brand diamonds with an ion implanter, the key instrument used in manufacturing integrated circuits. Normally, the ion implanter is used to make areas of varying electrical charges on a silicon chip. This comes about because the spots on the silicon where the beam is aimed become electrically altered just below the surface of the material.

To brand the diamond, GE researchers place a custom-made stencil over an area of the diamond. The stencil could be an initial, a number, symbol, or just about anything the diamond owner wants. Then the diamond is bombarded with the ion-implanting beam, and the ions penetrate the gem, creating a "modified region" just beneath the surface of the uncovered area. The stencil is removed, and the diamond owns its own code.

To reveal the secret identity of the stone, a piece of cotton or silk can be rubbed over the surface of the diamond. Then a special powder is sprinkled over it, which only sticks to the charged regions. Once the rock has been identified, the powder and the pattern are wiped away with a cloth. The pattern can be revealed again by re-charging and re-dusting the crystal. Thanks to this anti-theft invention, diamonds are now really forever.T

Electronics at Kodak. Putting good things in small packages is one of our specialties.



Kodak popularized amateur photography when we mass-produced photographic dry plates, leading to the development of cameras that could be held in your hand. More recently, we introduced the Kodak disc camera—a camera in which integrated circuits make the decisions, automatically, at the touch of the shutter release.

Today, integrated electronic components designed and fabricated at Kodak are built into a wide variety of our cameras. But it takes more than the electronics in our cameras to place us among the nation's top companies in sales of electronics-related equipment.

It takes innovative engineers working on projects that use a microcomputer-based software development system to debug application programs for Kodak Ektaprint copier-duplicators. And the development of ongoing product improvements in the Kodak Komstar 300 micro-image processor, a computer peripheral which uses pulsed laser beams to convert digital data to alphanumeric images on microfilm, at speeds up to 20 times faster than many ink-jet paper printers.

If you're ready for the challenges in electronics you'll find at Kodak, see a Kodak recruiter on your campus.

Or send your resume to:
Personnel Resources,
Eastman Kodak Company,
Rochester, N.Y. 14650.

Kodak

Kodak. The right place. The right time.

An equal opportunity employer manufacturing photographic products, fibers, plastics, chemicals, and electronic equipment. Plants in Rochester, N.Y.; Kingsport, Tenn.; Windsor, Colo.; Longview, Tex.; Columbia, S.C.; Batesville, Ark.; and a sales force all over the U.S.

Expand the mind of the microchip.

Remember when electronic calculators were considered a luxury? Well, consider this sign seen recently outside a gasoline station in Schenectady, New York: "Free calculator with an oil change."

That's just one sign of the enormous impact microchips have had on the way we do everything from banking to game-playing.

But how will we use microchips that are smarter, faster, more reliable, and less expensive to design? How will these new microchips be used to improve systems, products, and processes? As one GE engineer puts it, "The sky's the limit!"

That sky is replete with a number of integrated circuit concepts that GE is applying right now.

There's the custom IC, a chip that performs highly specialized functions. Traditionally, creating this chip has been an expensive, time-consuming job. So we're working on ways to cut design time and cost.

We're using computer-aided design (CAD) to design and simulate chips right on computer screens. We're also developing gate arrays, a system that allows you to build inexpensive prototype chips that can be "played" in systems before the final design is fixed.

Another area that GE is developing is VLSI (Very Large Scale Integrated) circuits. These ICs will eventually squeeze one million transistors onto a single chip.

Where will all this super electronic power be applied? GE engineering manager Don Paterson sees it this way:

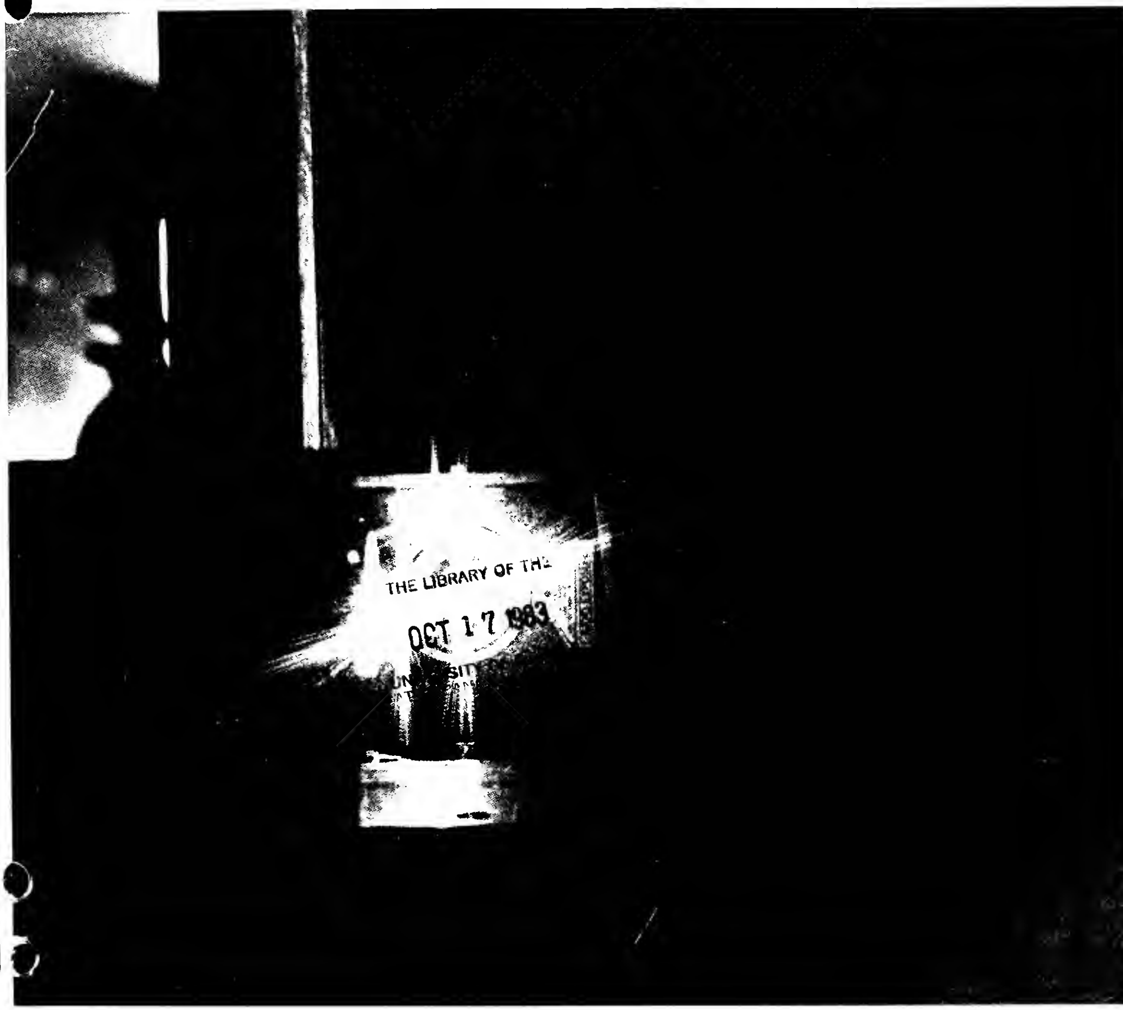
"At GE you can innovate from the system down to the chip to create whatever ignites your imagination."

In other words, you can dream it and do it.

WE BRING GOOD THINGS TO LIFE

An equal opportunity employer

ILLINOIS TECHNOGRAPH



November 1982 Volume 98 Issue [illegible]
Newsstand $1.25

The growing use of lasers shines new light on materials research.

I L L I N O I S
TECHNOGRAPH

November 1982 Volume 98 issue 2 © 1982 Illini Publishing Company

4 SAE Formula Car

Steve Yencho describes firsthand the metamorphosis of a garage-built formula car.

6 Laser Processing: Hot Stuff

Materials processing is now making use of the laser. Tushar Chande explains.

10 Components of Audio Care

Advice on efficient cleaning of audio equipment is offered by Eric Guarin.

14 Signals From Space

Mary Kay Flick dishes out the latest in video.

18 Enabling the Disabled

Robert Ekblaw tells how wheelchair lifts and ramps are helping the handicapped enter the world.

Departments

Tech Teasers 2, Forum 3, Technovisions 12, Technotes 16, Tech Profiles 21, Technovations 23

On the cover: One of the many lasers used to study the interactions between laser energy and materials.(photo by Randy Stukenberg)

People Need Ideas, Not Labels

I have a label. I don't particularly want it, but it was given to me by somebody, so there it is. Most people face this same problem.

I got my label recently when I told a man that I was a nuclear engineering student. His reply was, "Oh, sometimes I could just pick up a gun and shoot those anti-nukes." He was sincere; he had just assumed that I was a super-conservative, anti-environment pro-nuclear fanatic.

I'm sorry, but I just cannot wear those shoes; they don't fit. I am studying nuclear engineering because I hope to help solve some of the energy problems we face, not because I support everything the nuclear industry does. I support solar, hydroelectric, wind, and geothermal energy research, many of the things my supposed "environmental enemies" stand for.

It seems that all of us with unsolicited labels are in similar situations. We are accused of supporting things more adamantly than we actually do. This does more than limit the recipient of the label, it also limits the labeler and demonstrates his ignorance.

Look at how a label can affect a person today. Once one is given the title "Democrat" or "Republican", he is expected by his peers to support the same side of an issue as his party. People don't understand when a person casts a vote based on the merits of an issue. He is practically considered a traitor if his vote goes against party lines. Taking a stance on an issue is good, but limiting yourself to the stance your stereotype dictates is very bad. Opinions should be the threshold to discussion, not the corner you are pushed into through argument.

Historically, labels have caused a majority of the problems in the world today. Look at what happened in Germany when Hitler labeled Jews as enemies of the master Aryan race. Millions of people were killed, families were torn apart, and many people still live in fear of anti-Semitism. Closer to home, one of the most militant struggles for human freedom occurred because arrogant whites labeled blacks as inferior. A similar struggle began because women also had an inaccurate label of inferiority.

Reasonable discussion is almost forbidden by labels. They create a greater rift between people than would otherwise exist. The black situation demonstrates this. Since blacks had a label, whites refused to hold sensible discussions with them about their problems. This led to a more violent fight to break the black mold than was necessary. When people label one another, they may never peaceably settle disagreements.

So how does one avoid labeling others? First, you must carefully examine your views on major issues. Are they sound? Are they too harsh on other people? Do your views have any room for dissenting opinions? Don't necessarily relax your standards, but be prepared to allow people a different view. Realize that if everyone thought the same way we might have ended up living under a Hitler forever, or we might still be living in a slave state. Differences are what allow us to live freely today.

Next time you meet somebody, be prepared to make some concessions if you find you have differences. From there, you may be able to reach some common ground. If not, that's okay, at least you didn't label someone unjustly.

Kevin W. Wenzel

TECH TEASERS

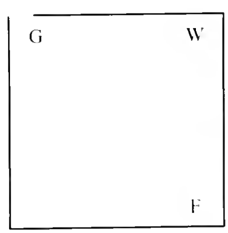
1. A miner had 20 kilograms of gold, and four children to whom he wished to give equal shares of his loot. He kept none for himself. However, his pan balance had only the 3 and 7 kg weights; all the others were lost. How many weighings did it take for him to divide out the four 5 kg portions, and how did he do it?

2. When does $16 \times 10 \div 11 \times 32 = 211$?

3. Find a number that starts with 2, so that when it is divided by 2 the quotient (no remainders, please) is the same number you would get if you moved the leading 2 to the end of the number. An example is, using 8 instead of 2: 8,101,265,822,784 divided by 8 is 1,012,658,227,848.

4. Given that $.3'$ is the same as .33333. . .(or .3 repeating), can you use the characters .0.1.2.3.4.5.6.7.8.9. and any other arithmetic operators to create an exression that equals 6? (You must use all the digits 0-9 only once, and you must use every one of the 11 decimal points)

5. This is Felicia Farmer's field. It is 100 meters long on every side. If her pet wombat starts at position W and runs towards G, and Felicia starts at position F and runs towards the wombat, will she catch him? How far will both of them run? Assume Felicia is silly, and instead of running directly to the gate, she always runs towards the 'bat, thus running in a curved path. By the way, Felicia can run twice as fast as the wombat.



Answers on page 20

FORUM

Indecisive Engineers' Guidebook

by Larry Mallak

The suffering economy has finally hit the engineer. Time has come for the student to seriously consider whether engineering is actually the career of preference, and should take a moment to analyze his goals in a scientific manner.

Step 1: Elimination. Maybe engineering isn't for you, so why clutter the scenery when the rest of us can have a chance at your job? If this is the case, sell back your books, smash your calculator, break all your Pentel pencil leads and. . .

Step 2: Read the want ads. Have you recently applied for a job through the want ads? If so, you probably noticed a mad rush of job seekers similar to engineering signups, only lower on the social scale. Local employers have been innundated with overqualified unemployed applicants, which leaves little hope for the justly qualified unemployed applicant. All this futile filing of applications, right into the eternal file leads you to. . .

Step 3: Join a rock band and go on tour. This is the classic way out of anything between ages 12 and 29. A tour gets you into the bars for free and spurs fans to clamor at your feet, all the while offering the excitement of peering out of a one-mile radius imposed by campus life. Drawbacks abound, and most would-be rock stars fail to produce a major record contract and turn to recreational drugs to escape tour blues. Escaping from an escape mechanism will probably require another escape, so why not try. . .

Step 4: Become a bum. Moneysworth magazine reported a few years ago on the earnings of beggars in large cities. The results: many of these poor, decrepit souls turned over $5 per hour for their wide-eyed pleas. Just look at the advantages: flextime—you work when you want to, no boss to report to, no income tax (unless someone slips a check in your cup), the pleasures of city living, no commuting—just sleep in the park, and a modest initial investment of one beggar's cup and one set of soiled, tattered, wrinkly, smelly clothing. If this doesn't appeal to you, there's always. . .

Step 5: Go into politics. It's one step above begging, but very similar. Instead of holding a cup and begging for money, you hold a view and beg for money. Once again, you enjoy the pleasures of city life, work when you want to, and hopefully pay no income tax. Should political hypocrisy not appeal to you, step up to. . .

Step 6: Accept an engineering job. Take your pick among the 2.7 job offers the average engineer received. Be flown on a plant trip to be wined and dined and shown an empty desk flanked by secretaries. Make thousands of dollars more per year than your LAS friends. Use your mind to solve the world's complex problems. Conform to the corporate image. Be promoted. Get a raise. Move to the California plant. This very often leads to step 5, which leads to step 4, which leads to step 3, which leads to step 2, which leads to step 1, which leads you nowhere.

Forum is intended as an open exchange of views and ideas on areas of interest to the Engineering campus. All University students and faculty members are invited to contribute articles for Forum. Articles may be editorial in nature, and must be signed.

Illinois Technograph invites letters in response to its articles and editorials, or any other item of interest to our readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.

STAFF

Editor	**Kevin Wenzel**
Production Editor	**Larry Mallak**
Business Manager	**Jim Lee**
Copy Editor	**Charley Kline**
Asst. Copy Editor	**Raymond Hightower**
Photo Editor	**Randy Stukenberg**
Features Editor	**Langdon Alger**
Design	**Nancy Grunthaner**
Assistant Design	**Beth Beauvais**

Publisher	**E. Mayer Maloney, J**
Production Manager	**Geoff Bant**
Adviser	**Ed Mast**

Editorial Staff

Steve Alexander	Eric Guarin
Rob Busse	Chris Konitzer
Doug Campoli	Laura Kosper
Tushar Chande	James O'Hagan
Joe Culkar	Bill Proctor
Tad Dierkes	John Przybysz
James Ehrhart	Thom Roe
Robert Ekblaw	Doug Shaw
Jane Fiala	Andrew Saporoschenko
Elayne Fletcher	Yuki Spellman
Mary Kay Flick	Robert Strahanowski

Business Staff
Brian Carlson
Jeff Lee
Donna Obermaier

Illinois Technograph
(USPS 258-760)
Vol 98 No 2 November 1982

Illinois Technograph is published five times during the academic year at the University of Illinois at Urbana-Champaign.

Published by Illini Publishing Co., 620 East John St., Champaign, Illinois, 61820. Editorial and Business offices of the Illinois Technograph Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3730.

Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001, 221 N. LaSalle Street, Chicago, IL., 60601

Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879.

Illinois Technograph is a member of Engineering College Magazines Associated

SAE Formula Car

Engineering students kick up some dust in Texas.

by Steve Yencho

This year's Formula SAE competition in Austin Texas was a challenge for a group of University of Illinois students to overcome a wide variety of obstacles and nevertheless return home with a trophy. The competition, sponsored by the University of Texas at Austin's Society of Automotive Engineers, involved designing and building a small scale Indianapolis 500-type vehicle and racing it against others in its class. Four student members of the Society of Automotive Engineers (SAE) competed for Illinois: Steve Yencho, Mike Truex, Trace Nelson, and Mat Klemp. Teresa and Chris McCarthy also took an active part in the designing and building of the vehicle.

The University of Illinois SAE had competed in the event two years ago. The 1980 vehicle was improved for the event in 1981, but the society depleted its funds and could not participate. The car at that time was powered by an eight horsepower Briggs and Stratton engine. It resembled a go-cart since it did not have a suspension system and used go-cart components. However, the rules for this year required larger nine to thirteen inch diameter wheels, a full four wheel suspension, and four point supported roll bar.

The team had planned to use the existing frame and modify it to meet the new rules. A larger engine was also planned because the new rules allowed any engine size as long as the engine could run with a one inch diameter restriction in the intake manifold. One major problem existed—lack of funds. To cut costs, the team started with an engine which came in pieces from a flat track motorcycle racer. This Honda 350 Enduro engine had to be completely rebuilt, since it had been stored outdoors for years and most of the critical surfaces were pitted with rust. A carburetor from a 175 Honda engine and an ignition system from a Buick Opel were added, and a variety of used automobile parts were installed.

For the frame, the team sought and received sponsorship from the Marvel-Schebler Tillotson Division of Borg-Warner, located in Decatur. Borg-Warner had agreed to supply five employees to weld for six hours to complete the frame. After a night of hurried preparation, the frame was taken to Decatur and welded. The newly designed front and rear suspensions were set up and the necessary frame reinforcements were added. Borg-Warner also machined the rear axle and front wheel spindles for the project. The front spindles and wheel hubs were designed for boat trailers and were donated by Central Illinois Marine in St. Joseph, Illinois. The wheels for the car were obtained from a Yamaha golf cart. Tires were located by Ron Schneider, another society member and former country club employee.

After the components of the car were completed, other problems began to surface. All the linkages including the clutch, throttle, gear shift and battery circuit were connected after the engine was wrestled into the frame. The car was still missing an exhaust system, intake manifold with the required one inch restriction, and a braking system. Delton's Cycle Machine Shop in Champaign built a tuned exhaust pipe and sold the team a hydraulic motorcycle racing brake set-up. After many attempts, the engine came to life in a parking lot north of I-74.

Then it was noticed that the steering system was too flexible for the forces encountered by the fast and powerful car. Sway restraints were added to the front swing arms to combat this problem. The rear of the car kept squatting down under full acceleration, so rear suspension limiters were added as well. After final exams were completed, the body was created from aluminum in a marathon all-night work session. The team painted the car and made final adjustments to prepare for the competition in Texas.

For the trip to Texas, the University provided a Chevrolet Suburban, and Professor Truex of Illinois State University lent a trailer in which to haul the car. After 23 hours of driving, the team arrived in Austin. The competing universities' entries were immaculate, having four wheel disc brakes, production racing tires, and independent rear suspensions. The University of Texas car was powered by a Wankel engine, but was heavier and slower than the Illinois car. The University of Houston entered a flawless vehicle sponsored by Exxon, powered by a Honda 450 twin cylinder engine. Nichols State University of Louisiana entered the last car in the class, powered by a 250cc engine donated by Kawasaki. This car became permanently engaged in second gear and did not compete.

On the first day of the event, the Friday before Memorial Day, the drag race and fuel economy events took place. That morning, warming up for the drag race, the chain on the Illinois car jumped from the engine output sprocket and destroyed the left crankcase cover. Miraculously, the local Honda dealer had a replacement for this usual order part. With the help of a short rainstorm, the event was extended until the track dried, providing time to repair the car. Illinois made only one run in the drag race due to lack of time, and took second place because the engine was still cold. The University of Texas placed first. That

Society of Automotive Engineers members Mike Truex (sitting) and Steve Yencho show the car that won second place in competition at the University of Texas at Austin.(photo by Steve Alexander)

afternoon, Illinois won the fuel economy event with a fuel consumption of forty miles per gallon. Minor changes were made to the car that night, and it was ready for the 50 mile endurance race on Saturday.

At the start of the endurance event, Illinois led the pack, with Houston close behind. Austin had a steering failure on the first lap and their car was temporarily out of the race. The race continued to be close, as Illinois would increase the lead in the straights and Houston would catch up in the corners of the circuit, due to their highly refined suspension system. At last, on the eighth lap, Houston passed Illinois just as the Illinois car lost power. The team quickly pulled it into the pits, and tore the engine apart to discover what caused the failure.

One of the four valves had broken off at the stem, destroying the engine, and putting the Illinois team out of the race. In the second quarter of the race, after a mandatory driver change, Houston led the race. Austin had repaired their car and were back in the race, making up for lost time. After 78 of the 100 laps, the Houston car failed due to a cam problem, dropping them out of the race. The University of Texas won by completing the race.

That night, at the awards banquet, the University of Texas received the first place trophy for overall performance based on design and racing. The University of Illinois received a trophy for second place, and the University of Houston received third place.

The society is planning to rebuild the car this year and return to Austin in the spring with the hope of winning the event. Numerous changes are planned from the group's experience. Hopefully, the SAE will be able to gain enough support to undertake this massive project again.T

Laser Processing: Hot Stuff

Laser technology burns new holes in research.

by Tushar Chande

This is the first of a two part series looking at the various uses of lasers in research and industry. The second part will appear in the February, 1983 issue.

We are in the midst of a beam boom. Troubled times for the economy or not, the laser industry has maintained an impressive growth rate in excess of 20 percent for the last few years. Net sales approaced the $1.3 billion mark in 1981 (see 'Laser Focus,' Feb. 1982, p. 69), after doubling in three years. That's less than the total sales of some corporations, but the industry is still expanding with no end in sight.

Laser materials processing is a bright spot even in this growth area. Sales of new lasers for materials processing were up a handsome 29 percent last year, to $90 million. An additional attractive feature of this high technology area is the shortage the industry faces of trained personnel. Those University students who would like to specialize in something interesting are in the right place at the right time. For here on campus we have many laser related research programs which are currently underway.

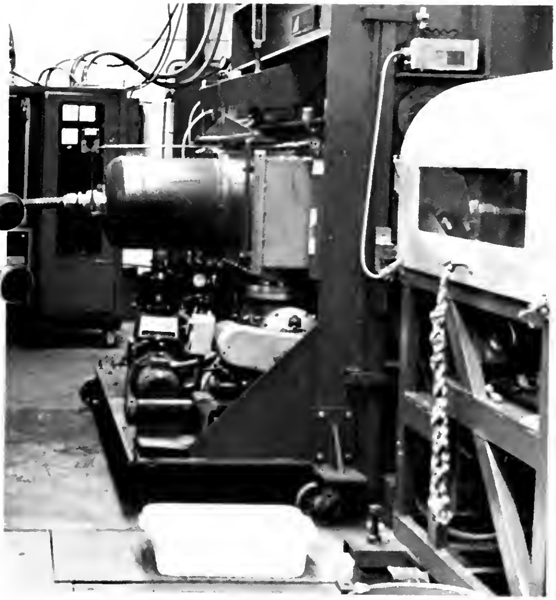
First, one must take a look at what a laser actually is. LASER is an acronym for Light Amplification by Stimulated Emission of Radiation, apparently coined by Gordon Gould, a somewhat controversial figure in the early development of lasers. In 1916, Albert Einstein predicted that the electrons of an atom could be stimulated to emit light of a particular wavelength. Amplification of the stimulated radiation was considered in the early 1950's, and the first practical ruby laser was actually made by Theodore Maiman in July 1960. The development of gas and other lasers followed, and in 1964 the Nobel Physics Prize was shared by Charles Townes, Nikolai Basov and Aleksander Prokhorov for their studies leading to the invention of the laser[1].

Mr. Don Casale controls the laser from an adjacent room in Talbot Lab. The laser operates at up to ten kilowatts of power.(photo by Randy Stukenberg)

The laser is a device that produces light by stimulating a lasing medium, which may be a solid or a fluid. The stimulation can be accomplished by exciting the atoms of the lasing medium to a higher energy level than their usual low or ground state. This is called creating a population inversion.

In their excited states, the atoms are unstable, and have a tendency to return to the ground state. They do so in steps, releasing energy in the form of electromagnetic radiation in the process. This electromagnetic radiation is coherent. It does not spread out like ordinary light, it is intense, and it is monochromatic. It is laser light. It has been generated using crystals, semi-conductors, liquids, and gases as a lasing medium.

In the early days, the laser was called "a solution looking for a problem"[1]. Today it has found an astonishing range of applications. Lasers are used in supermarkets to ring up purchases, in hospitals to aid in surgical procedures, in communications to allow very high signal densities, and in sophisticated weapons systems for guidance and targeting. In 1978, the Navy used a moderate power chemical laser to destroy a TOW anti-tank missile in flight. Home entertainment and art have been touched by lasers. Then there is Shiva, the most powerful laser in the world, used for fusion studies at the Lawrence Livermore Laboratory in California.



Left. A beam of infra—red light is generated from this unit which is approximately half the size of a dorm room. When warming up the unit the beam is dumped into the tray of water on the floor, instantly bringing it to boil.
Below. The beam is concentrated on a piece of metal on a moving table. In this experiment the laser is drawn across a metal bar to anodize a coating to the surface.(photos by Randy Stukenberg)

Let us now examine more closely an area of growing engineering interest, laser materials processing. Laser materials processing is possible due to the heating effect produced in metals upon laser irradiation. Processing then involves heating and cooling steps, to alter some physical characteristic of the metal on a macroscopic or microscopic scale.

The laser is the special heat source in materials processing. It is intense, chemically clean, and inertialess. It can also be transmitted over long distances in air, precisely maneuvered, and finely focused to produce high energy densities. The laser beam can simply be moved over the material being processed. The heating effect it produces is rapid and localized, thus metals are easily vaporized.

The cooling rates after laser irradiation are high, sometimes over a million degrees per second. This enables unusual materials like amorphous or glassy metals to be produced. One can thus create materials with unusual properties. Even somewhat slower cooling rates produce refined structures with superior properties. The high heating rates also make rapid processing rates achievable, making cost reductions possible. Precise control over the motion of the beam makes it attractive in automated manufacturing.

Lasers are commonly used in the semi-conductor industry, both in the production of wafers and in the fabrication of devices. In metalworking industries they are used for cutting, welding, drilling, surface heat treating and surface alloying.

If a process is to be used in industry, not only must it provide cost reductions and other economic benefits; it must also be flexible and controllable. Often, the exact mechanism is not fully known, even though the process is in service. This inhibits further exploitation of the process.

The key to widespread use of lasers in industry is a better understanding of how lasers work in materials processing. This is where university research comes into the picture. In a field where the potential of its primary tool has yet to be fully realized, research has much to contribute, for at a university one can use a wide variety of skills and techniques to improve his understanding of a process.

The University of Illinois is one of the few schools nationwide, actively engaged in laser materials processing research. Of the 213 schools responding to a nationwide survey of engineering research and graduate study published by "Engineering Education" in March, 1982, only 24 schools listed laser related research, not all of which were researching laser materials processing.

The College of Engineering lists 56 faculty members engaged in materials engineering or mechanical property research, spread over 12 engineering or engineering-related departments. Of these, 6 use lasers in some way, while 3 list laser processing as their principal activity. Laser processing programs are to be found in the departments of Ceramic, Civil, Electrical, and Mechanical Engineering, as well as Metallurgy and Mining. A Materials Processing Consortium is currently being set up, and this is to include laser processing too. The University's present committment to laser materials processing research is noteworthy, and slated to rise in the future.

According to the "Summary of Engineering Research,1982", provided by the College of Engineering, a maximum of seven laser processing projects are at hand in the Materials Engineering and Materials Processing Division of the ME department, under the direction of Prof. J. Mazumder. These are in the areas of laser welding, control of plasma during laser materials processing, surface alloying, surface tension effects on fluid flow during laser processing, laser heat treating, and laser chemical vapor deposition.

Laser processing for production of erosion resistant materials is being studied by Professors Altstetter and Rigsbee of the Metallurgy department. Laser surface melting is being used in rapid solidification studies by Prof. H. L. Fraser in the same department. Powder production by laser spin atomization is also being studied by his group. An unusual study of laser-driven crystallization is being conducted by Prof. S. H. Risbud at the Materials Research Laboratory. Thin gauge metal sheets of three different metals have been studied under approximately 400 different conditions in an exhaustive study by Prof. F. V. Lawrence and J. Culton.

Laser heat treatment is being looked into because this process, now actively used in manufacturing, offers a precise technique for microstructural modification with minimum distortion. Wear resistance of a material can be significantly enhanced by depositing a hard layer on the surface. Laser chemical vapor deposition of titanium carbide is of interest in producing hard surface layers because it is a hundred to a thousand times faster than conventional deposition processes.

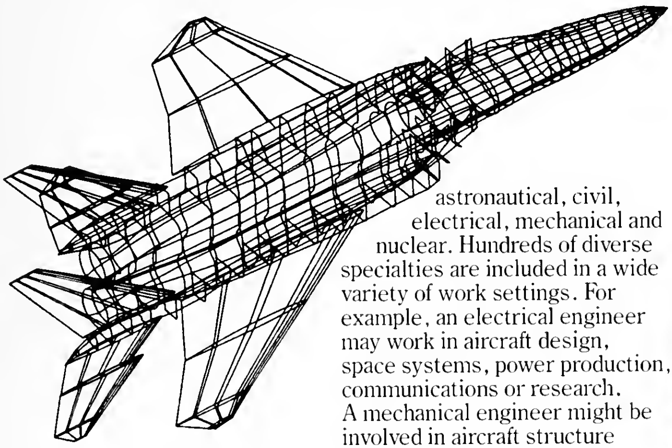
Laser surface alloying provides a convenient yet powerful tool to generate corrosion resistant coatings on inexpensive substrates with a minimum amount of alloy element. This will save expensive materials such as chromium while providing desired surface properties. Laser spin atomization can be used to produce powders of high melting point metals under very clean conditions. These are then compacted into useful forms. Novel materials can be produced from chalcopyrite and amorphous materials by using the laser to drive crystallization.

This points to the variety of areas being explored at present. Each is addressed to a specific application in the industry. Prof. Mazumder of M&IE aims at understanding these processes in the widest sense. Planned experiments are used to obtain process information of fundamental interest. This is related to other process effects, such as the microstructure of the processed material and its subsequent mechanical and metallurgical properties such as tensile strength and corrosion resistance. This is accompanied by a theoretical transport phenomena analysis, involving heat, momentum and mass transfer, which yields additional insights into the mechanisms involved.

Ultimately, the aim is to have a model of the process and a reasonable predictive capability. Thus, answers to a wide range of questions about the process are sought, and the student can develop a number of useful skills, from numerical analysis to electron microscopy. Far from being a specialist, one ends up being a respectable generalist. And this is why University graduates in Laser Processing will be very much in demand in industry. T

References
1. Jeff Hechd and Dick Teresi, LASER Super Tool of the 1980's, Chap. 4, Ticknor and Fields, New York (1982).

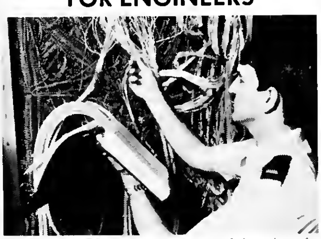
ENGINEERING TAKES ON EXCITING NEW DIMENSIONS IN THE AIR FORCE.



Computer-generated design for investigating structural strengths and weaknesses.

Developing and managing Air Force engineering projects could be the most important, exciting challenge of your life. The projects extend to virtually every engineering frontier.

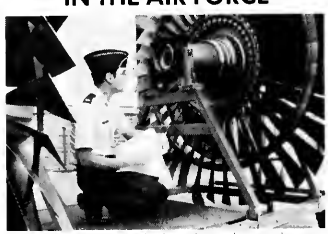
8 CAREER FIELDS FOR ENGINEERS



Air Force electrical engineer studying aircraft electrical power supply system.

Engineering opportunities in the Air Force include these eight career areas: aeronautical, aerospace, architectural, astronautical, civil, electrical, mechanical and nuclear. Hundreds of diverse specialties are included in a wide variety of work settings. For example, an electrical engineer may work in aircraft design, space systems, power production, communications or research. A mechanical engineer might be involved in aircraft structure design, space vehicle launch pad construction, or research.

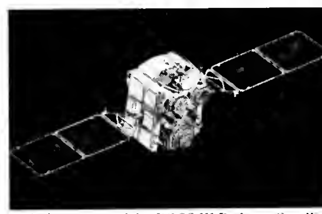
PROJECT RESPONSIBILITY COMES EARLY IN THE AIR FORCE



Air Force mechanical engineer inspecting aircraft jet engine turbine.

Most Air Force engineers have complete project responsibility early in their careers. For example, a first lieutenant directed work on a new airborne electronic system to pinpoint radiating targets. Another engineer tested the jet engines for advanced tanker and cargo aircraft.

OPPORTUNITIES IN THE NEW USAF SPACE COMMAND



Artist's concept of the DSCS III Defense Satellite Communications System satellite. (USAF photo.)

Recently, the Air Force formed a new Space Command. Its role is to pull together space operations and research and development efforts, focusing on the unique technological needs of space systems. This can be your opportunity to join the team that develops superior space systems as the Air Force moves into the twenty-first century.

To learn more about how you can be part of the team, see your Air Force recruiter or call our Engineer Hotline toll free 1-800-531-5826 (in Texas call 1-800-292-5366). There's no obligation.

**AIM HIGH
AIR FORCE**

Components of Audio Care

Snap, crackle, and pop tend to zero if we apply these guidelines.

by Eric Guarin

Stereo maintenance? Who worries about stereo maintenance? Many people don't—or do so improperly—and in so doing not only deprive themselves of the best possible sound but actually damage their system slowly but surely. Maintenance is important to any system, and this is just as true in the audio field as in any other field. To keep an audio system in good working condition, one must care for it properly.

To begin with, there are currently three major sources of canned music: disk, tape, and radio. Sound sources are then played with the use of three main components: turntable, tape deck, and amplifier (or receiver), plus system accessories. Each needs a certain type of care, which hopefully can be provided without too much financial strain.

Tape, from the 8-track to professional multitrack reel-to-reel setups, works on one basic principle: electronic signals are converted into magnetic energy and impressed on the tape by the recording head. Then, on playback, the magnetic areas on the tape are reconverted into electronic signals by the playback head. Several things can go wrong along the way—stray magnetism, worn parts, and dirt; tape maintenance should prevent this.

Stray magnetism buildup is usually the most easily controlled problem. If enough residual magnetism builds up on the heads, it can interfere with, and even obliterate, the signal on the tape, so it pays to demagnetize tape heads. Demagnetizers cost $3 and up, and are definitely worth it. Depending on individual models, waving the end of the probe past the heads and metal parts induces magnetic action which removes stray magnetism.

Worn parts are another problem. Just like anything else, deck parts get worn, old, and tired, and eventually need replacing. Strange motor noises can mean trouble and should be checked by a knowledgeable individual; cracked rubber parts need replacing. As a side note, compounds which tighten loose belts are available but cannot work miracles. Common sense is probably the best maintenance for these sort of problems.

Dirt, in addition to increasing wear, may interfere in the recording process. Important parts to keep clean are tape heads (1) and transport (capstan (2) and roller (3)). Tape rollers are usually made of vinyl or rubber compounds and should not be cleaned with alchohol based cleaners, which will cause cracking. Special roller cleaning fluid on plain cotton swabs should be used. Heads and transports need fluids designed for cleaning them, such as isopropyl alchohol; other solvents such as acetone may damage these parts. To clean properly, apply fluid to swabs, and rub gently over heads and transport. Cleaning with dirty swabs, of course, defeats the purpose.

A final item in connection with tape care is the availability of cleaning cassettes, demagnetizing cassettes, and all-in-one units which do the work of both. These are usually up to par with other cleaning methods, and are especially handy for cars, but often don't clean the entire head surface as well as a swab. Prices for these cassettes start at $5, and may be an infinitely more desirable option for auto use as well as convenient home use.

Records are a second main source of music. Playing a record is more complex than playing a tape; care of a record system is consequently more complex. Before attempting to provide proper care for the system, the user must first know how the system works.

When a disk plays on a turntable, the needle rides in the record groove and moves according to the shape of the groove as it spirals inward. Within the cartridge, the needle's mechanical motion is changed into electrical energy; actual mechanisms used to accomplish the conversion vary from cartridge to cartridge. Electrical energy thus generated flows into the amplifier via wires in the tonearm. Since a great many mishaps may occur to the signal along the way, record system care should, if possible, prevent each nasty possibility from occurring.

A good approach to disk system care involves a step-by-step analysis of what can go sour as the electric signal goes from the needle to the amplifier. Actually, the playback chain begins before the needle, with the record itself and the turntable it rests on.

Records are really what a disk system is all about; keeping records clean therefore makes good maintenance sense. Care of records and associated hardware is not as simple as the manufacturers of many record care products would have us believe; more realistically, it is a fairly simple process which has several steps involved.

Step one is to minimize dust, which clogs parts and gets shoved along the record groove by the needle. This is bad for both needle and record. The first and simplest step in record care is to keep the dust cover down when records are not being changed. This reduces air circulation past the record and the turntable platter it rests on, and thus overall cleanliness is improved.

Step two involves getting rid of dust on the surface of the record, a process which incidentally can be aided by reducing static electricity. There are several approaches to disk cleaning: a $1000 record washer, cleaning pads, or fiber brushes. It takes some shopping around to determine which approach works best for a particular sound system and budget.

Each approach has advantages and disadvantages: the $1000 record washer provides the ultimate in spic-and-span records but is obviously hard on the pocketbook. Cleaning pads and fiber

Shown above are the insides of the tape deck: heads (1), capstan (2), and roller (3). (photo by Randy Stukenberg)

brushes are the two best cleaning methods available along the low-budget lines. Cleaning pads, if chosen well, are reputed to do a somewhat better job overall than fiber brushes. Good ones cost between $5 to $15 depending on type, accessory gadgets, and whether or not fluid is supplied.

Cleaning pads resemble 6 inch dowel rods or wooden blocks, and have a velvety covering on the cleaning surface. Various fluids designed specifically for record cleaning are available (use of other fluids can harm disks) and may be sprayed or dripped onto the cleaning surface.

Fiber brushes, on the other hand, incorporate many thin soft bristles which fit deep into the grooves of the record. These usually cost about $10. Whether they outperform the better brand cleaning pads is a topic hotly debated by companies and dealers, but most neutral parties favor the pads. Two other gadgets may be worthwhile purchases: a static gun, which reduces static electricity and makes dust both easier to remove and less likely to adhere in the first place; and cartridge-mounted dust brushes, which sweep the groove in front of the needle pushing dust gently out of the way. This may not mount on all cartridges, and has other effects, but may be useful in cases where a pad or brush doesn't quite get all the dust.

Step three deals with what the record sits on: the turntable and platter. Vibrations in the air or in the cabinet the turntable rests on may be transmitted through the needle into the amp, a condition known as feedback. Placing the turntable a sufficient distance from the speakers reduces air feedback; by mounting the turntable on rubber feet or by hanging it from the ceiling cabinet feedback can be reduced. Turntable platter mats can help alleviate either problem and can also reduce static buildup; mats vary in price, purpose and design.

Finally, the last links of the chain transmit the signal from needle to cartridge and should be set up correctly. Connections need to be good, and needles and cartridges should be properly aligned and mounted. After these steps, the signal goes into the amplifier, the next object of concern.

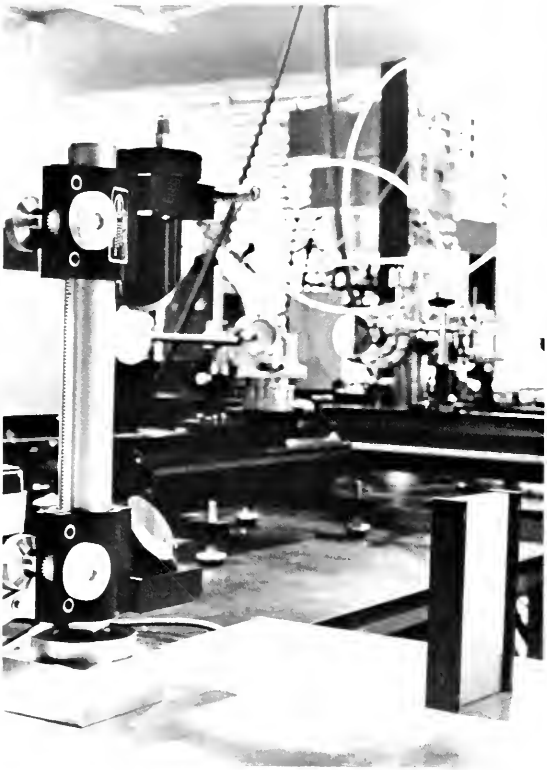
As most other components are varied in use and purpose, their needs are varied also. In this miscellaneous category, though, the item which probably requires the most attention is the amplifier, which when combined with a radio tuner is called a receiver.

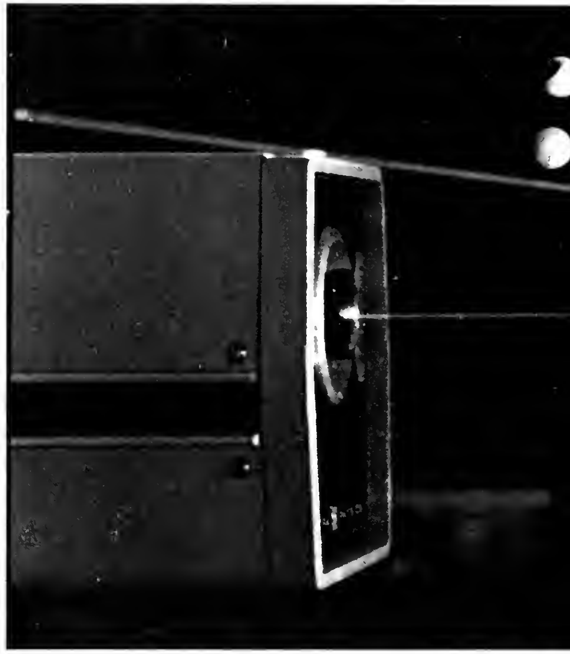
Basically, an amp turns power from a wall socket into power speakers can use. Of course, there is a hitch in this process: it is not 100% efficient. In other words, an amplifier puts out speaker power plus waste heat. To get rid of this heat, amps should be properly cooled. Most importantly, amps need space around them so airflow can cool hot surfaces. If space is not available, or if the amp gets hot even so, muffin fans (4 to 5" across, $10 to 15) will probably work well. Some sort of airflow is a must, even though a particular amp may not get very hot except at high output. Remember, heat kills, so let your amplifier breathe.

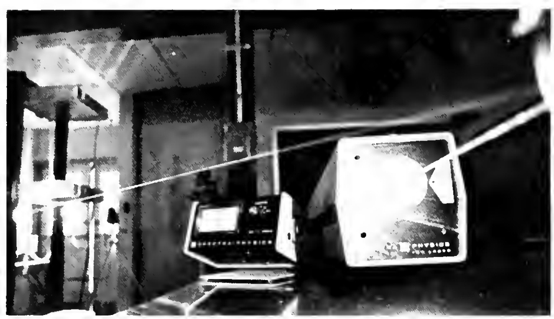
Other components may or may not generate much heat, depending on their function. Try each component in the most convenient place for it, run the system for an extended while, and test it for hot surfaces—if there are any, relocate the component to eliminate the problem. A good idea is running the entire audio system at high output for a fairly long period, then making sure everything's cool.

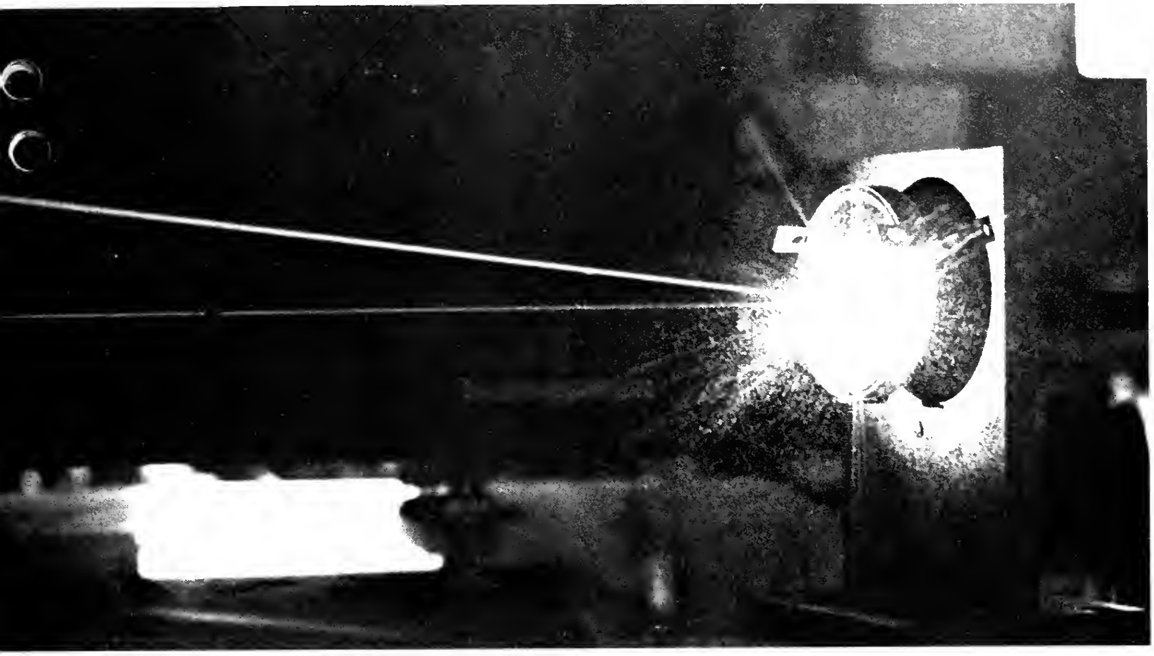
This guide to proper stereo system maintenance is not very time-consuming; nor is it very complicated. However, following the steps outlined here will help to make everyone's system sound better, whether or not he is a connoisseur of fine sound. **T**

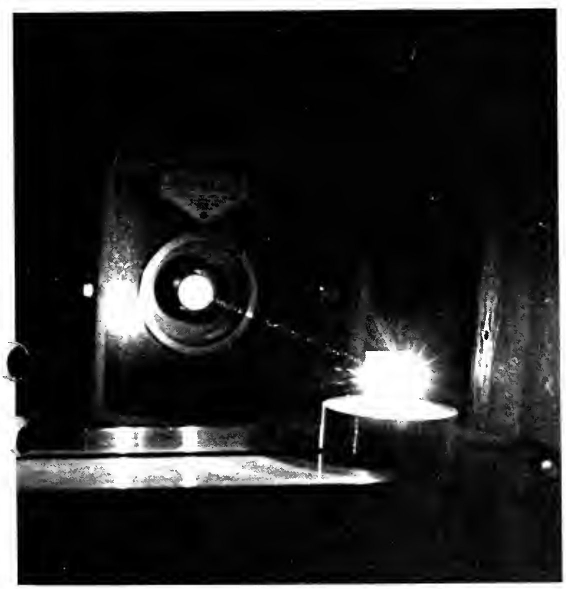
text and photos by Randy Stukenberg











Laser lights

The days of Buck Rogers are fast approaching. Already lasers are being used to destroy satellites as well as repair delicate parts of the human eye. Associate Professor Jim Eden and several graduate students are researching lasers in the Gaseous Electronics Research Laboratory, 607 E. Healy Street, Champaign, using rare inert gases to produce a strong beam of light. The laser on this page is one of the self sustaining lasers in the laboratory. At only ten watts of power it is capable of burning a hole thru a wooden door. Usually it is directed thru mirror arrangements into gas chambers or other experimental projects. However there is no danger that the laser will be used on unruly engineering students since it requires a very large power source.

Signals from Space

Television satellites provide greater programming choices for viewers.

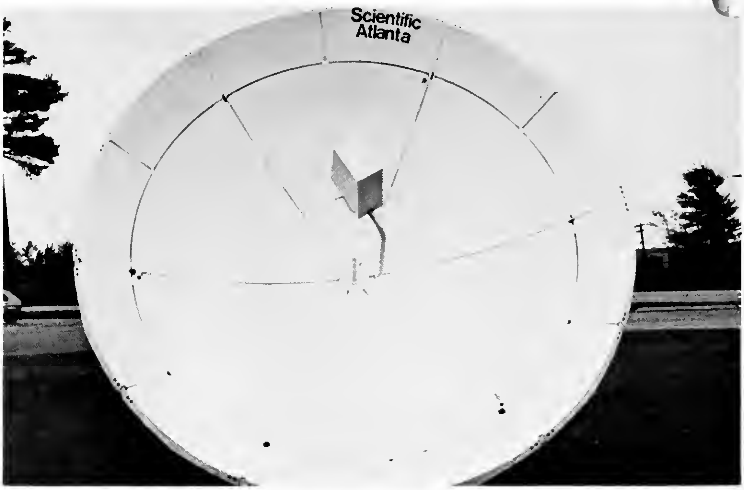
by Mary Kay Flick

Television has changed dramatically since its beginning. First, there was black and white with extremely limited programming. Then came color and more programs, but there was still a limit to what the good old rooftop antenna could pick up. Then came cable television, and the variety of programs available increased greatly for those within the reach of the cable. The latest alternative for TV programs is the backyard receive-only satellite dish (TVRO) which makes a larger variety of programming available to more people.

TVRO's are becoming a more common sight as television watchers aim for a larger scope of program options. Yet, these dishes seem like something amusing, alien, or perhaps even extravagant to an observer who really does not understand them. As the use of these dishes increases, people must become aware of their influence on society.

The concept of the TVRO is relatively simple. The broadcaster sends a microwave signal through an uplink antenna (sometimes as large as 60 feet in diameter) addressed to a specific channel, or transponder, aboard a geostationary satellite. The signal is then beamed downward toward the earth where it is picked up by a TVRO, commercial or private. A TVRO setup consists of several parts including a parabolic dish, a low noise amplifier (LNA), a microwave converter, and the user's television.

The parabolic dish consists of a metal wire mesh, or a special fiberglass resin, embedded with finely ground metallic particles and then covered with aluminum or fiberglass. It has a diameter of nine to fifteen feet. Protruding from the focal point of the dish is the feed horn which picks up the signal directed towards the satellite. This dish can be mounted on a moving base to facilitate convenient change to a different satellite.



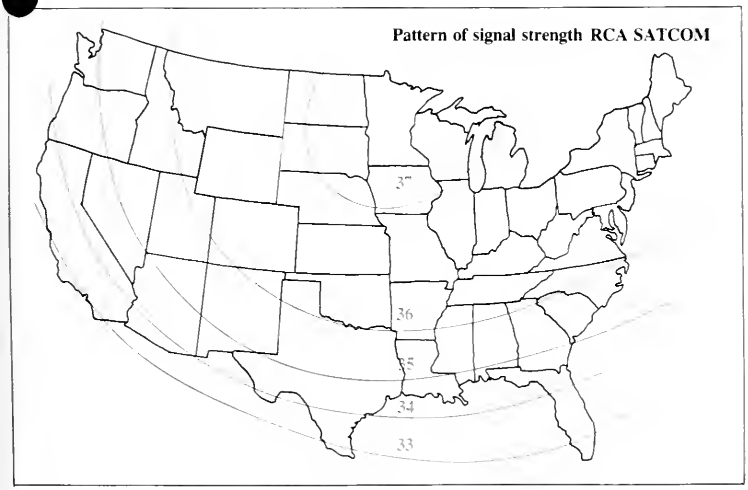
Satellite dishes like this receive signals from all over the world via orbiting space satellites. (photo by Mark Matheny)

The LNA, usually mounted on the feed horn, has a special gallium arsenide field-effect transistor. This part of the system clears up and strengthens the signal. It is then hooked up to the receiver in the user's living room (via coaxial cable) which allows him to tune into one of various channels per each satellite. To be able to tune in to more than one satellite, it is necessary to have a "polar mount" which aims the antenna at different satellites. The antenna may be pushed into a new position for a different satellite manually, or automatic satellite changers are available. The antenna itself sits on a solid concrete base.

Currently, it is possible to receive up to eighty channels broadcast through satellites. However, the number of channels received depends on the location of the dish. One must be able to "see" the satellite in order to receive its signal. Depending on where they reach the earth's surface, signals vary in strength, forming concentric "footprints" on the surface of the earth. These "footprints" of signal strength also influence the number of channels received and the quality of the reception.

Currently, the RCA Satcom gives the most programs; but most people wish to be able to tune into more than one satellite. It is possible to receive channels broadcasting programs such as HBO, Cinemax, Showtime, Spotlight, CNN, MTV, ESPN, USA Network, PBS, WTBS, plus all the major networks and many independent stations.

The only major drawback to the TVRO is the cost; however, prices are continually decreasing. Fiberglass dish



The strength of signals varies over the country. The numbers represent millidecibel levels. (from Popular Mechanics, Sept. 1980)

prices now start as low as $2500. Through the use of do-it-yourself kits, these costs can be reduced. The kits are available for everything (antennae, receiver modules, etc.) which will bring the cost down to as little as $500. An automatic satellite channel changer or additional receiving units will increase the cost of a dish, but after this initial purchase the dish is relatively inexpensive and maintenance free.

Thus, the backyard TVRO is becoming more affordable than even a new recreational vehicle or camper. Because more people are now able to buy the satellite dishes, companies are springing up overnight to make them. It is impossible to say just how many firms are manufacturing the dishes because many are being made by private individuals in basements and garages.

Most buyers of dishes are people living outside the reaches of cable television. Because of this, cable companies are not extremely concerned about a loss of business. They feel that in the long run pay cable TV will be cheaper and have better picture quality than a satellite dish. Both claim to be maintenance free. However, prices for dishes will decrease even more as satellite companies make plans to launch even more powerful satellites. A more powerful satellite can be picked up by a smaller diameter TVRO, which means a lower cost for the user.

There has been much controversy as to the legality of celestial evesdropping. As of October 1979, it has no longer been necessary to obtain a federal license to operate a TVRO. However, some areas have zoning laws governing the placement of TVRO's because many consider a satellite dish an unattractive addition to the landscape. Before installing a dish, most satellite dish retailers conduct a frequency search and sight survey. Not only do the surveys control what equipment to install but also if it would be worthwhile for a prospective owner to even buy a dish.

Some program suppliers charge a "lifetime" fee or install signal scramblers to prevent unauthorized use by private individuals. Yet, many people feel the celestial highways are free to everyone's use and everyone has a right to receive the signals that come in contact with their property.

So far, the future looks good for the TVRO. Costs are continually decreasing and improvements are constantly being made. For example, Automaton Techniques, Inc. in Tulsa Oklahoma has developed a new dish called Toysat™ which makes use of a "Dish-Stretcher". The Dish-Stretcher allows the use of a much smaller dish to receive the same number and picture quality of programs. It also clears reception and reduces snow. Manufacturers of this dish are also experimenting with a folding umbrella type wire metal dish for use on vans, campers, and other recreational vehicles.

More and more satellites are being launched into space. Current projections show that between 37 and 42 satellites will be orbiting earth by 1988. This will permit the reception of even more programs by those who think TV is the best entertainment available.

Obviously, the backyard satellite dish industry is here to stay. Although there may be controversy as to the legality and ethics of such eavesdropping, people are still buying the dishes. A person does not need an intricate knowledge of microwave theory and electronics to enjoy the use of TVRO. No longer are the geostationary satellites being used only for scientific or business communications. No longer are satellite dishes weird and alien objects dotting the landscape. No longer are they fascinating yet incomprehensible objects to the average home owner. Since Americans insist that television is their favorite pastime, the available technology might as well used to its full benefit. **T**

by Langdon Alger

Good Knight!

There is still plenty of time to nominate your favorite engineer for the Knights of Saint Pat awards. Formally, the award is given to recognize outstanding juniors and seniors who exhibit exceptional leadership qualities while still keeping a minimum grade point average. However, it takes more than that to be accepted as a Knight.

The process is basically simple. Every engineering society nominates two of its members to be considered for the awards. The two nominees must then fill out their share of the paperwork. They must write a few essays, and turn them into the Engineering Council. Once there, the Council will make an initial decision, cutting down the list of potential award winners. Nominees making the first cut must appear before the council for a personal interview.

Through the interview and the essays, the Council finds out what kind of person the nominee actually is. It is at this point that the truly exceptional people are filtered out. All the nominees may start out with a leadership position and a high GPA, but only the ones that are true leaders and humanitarians will make it through the entire process.

The nominations will be accepted until December 3, so turn them in soon. It can take a while to compose a good essay. Who knows, maybe you or someone in your organization is a future Knight.

Bowl 'em over

November thirteenth is the date for the annual Engineering Council bowling tournament. The cost is thirteen dollars per team, and each team must have at least one faculty, one female, and one male player who are affiliated with the society. The awards are in keeping with tradition, as the winning teams will be given trophies for their efforts. The entry fees are used to offset the cost of the awards, and to raise money for the Council.

Clean Coal

A couple of months ago, the Illinois Center for Research on Sulfur in Coal (CRSC) was established. This center calls upon the State Geological Survey, University of Illinois at Urbana-Champaign, and Southern Illinois University at Carbondale to work together towards solving the problem of the high sulfur content in our state coal. The CRSC was able to come into existence through a $850,000 investment by the Illinois Coal Research Board.

Neal F. Shimp was appointed acting director of the CRSC, which will act from the survey here on campus. Shimp is also head of the survey's chemical group, and he will now be responsible to the institutional advisory board, which includes Theodore L. Brown, UIUC Graduate College dean, and Clark W. Bullard, director of UIUC's Office of Energy Research, as members. Part of the advantage to this set up is that the center can use staff members and facilities from all three institutions.

The CRSC will be researching sulfur in coal heavily, because that is the main reason coal is not used as much as it could be in Illinois. Currently, industry is working on removing sulfur from the products of coal burning, whereas the center wants to focus on removing the sulfur before the combustion is executed. There are basically two methods of doing this. One is called supercritical extraction, where coal and ethanol are mixed at high pressures and temperatures. The solid products from this process have about two-fifths less sulfur in them, and just as much coal. The other method is low-temperature charring, where the samples of coal are heated to drive out some of the sulfur, and most of the remaining sulfur is removed chemically and physically. The center will also act as an information center for other coal research, and sponsor conferences and informative sessions throughout the nation.

In the long run, the hopes are that the CRSC will help Illinois, as well as the rest of the country, learn about their coal so that it may be used as an efficient and clean fuel.

Will the Real Everitt and Pierce Please Stand?

Every year two special awards are endowed upon three engineering professors and one engineering student. Two of these professors win Everitt Awards, which are given in response to outstanding teaching. The award is monetary as well as honorary, the former being the sum of $500. The other award is the Pierce Award, which is awarded "for encouraging empathetic student/faculty relations." The recipients receive $200 and an engraved silver bowl.

Unfortunately, these awards do not usually attract very many nominations. This could be due to the scarcity of people who fit the categories, or just to a lack of knowledge about the awards. Nominations are due by the middle of this month.

The 1982 recipients of the Stanley H. Pierce Awards were Nancy Schumaker, Industrial Engineering student, and Daniel Hang, Nuclear and Electrical Engineering professor. The professors who won the Everitt Awards last year were Vernon Snoeyink, Civil Engineering, and Richard Schaltz, Electrical Engineering. We offer congratulations to them, and hope that there are a record number of nominations for this year's honors.

Pat Our Backs Again, and Again

Professor of Theoretical and Applied Mechanics Su Su Wang and Chemical Engineering professor Mark A. Stadtherr have received the 1982 Xerox awards for U. of I. outstanding faculty research. Wang won $2000 for his work from the past five years, and Stadtherr won $1000 for his work during last year.

John Bardeen, winner of two Nobel Prizes in physics, has been chosen as a foreign member of the Academy of Sciences of the U.S.S.R. Bardeen, electrical engineering, physics, and Center for Advanced Study professor here at UIUC, was the first person to win two Nobel Prizes in the same field. He was also on the Bell Labs staff when the transistor was developed. The Soviet honor was given to him in reflection of his overall scientific work.

Agricultural Engineering professors Loren E. Bode, B.J. Butler, and Arthur J. Muehling, plus extension assistants Stephen L. Pearson and C.L. Rahn were all honored by the American Society of Agriculture Engineers. The former three profs were cited for "outstanding effort and achievement in the development of noteworthy educational aids" because of their publications on the calibration of flotation sprayers and granular applicators. The latter two won blue ribbons for a videotape they made on "Solar Heating for Livestock Buildings." Also honored by the Society was S.I. Ahman, research assistant, who, along with Bode and Butler, won an honorable mention for their paper "A Variable-Rate Pesticide Spraying System."

Dean Daniel C. Drucker makes the press again this month for becoming an honorary member of the American Society of Mechanical Engineers. He was honored for his leadership in engineering education and the profession.

More Coal

Have you ever heard of an instance where pollution control is beneficial to the economy? Well, there is one, and it was studied here on campus. The problem is the loss of millions of pounds of coal from "fugitive emission," or when the wind blows small particles off and away from piled coal. The study was conducted by Mechanical Engineering professor Shao Lee Soo.

Coal is normally stored in piles next to power plants, steel mills, and other coal—burning or coal—storage areas. The problem is that small particles are loosened in the pile during stacking, moving, and other activities. These particles are picked up by the wind and blown away. Hence there is a contribution to air pollution—in fact, it makes up 10% of the suspended particles smaller than 30 microns in the air. The wind erosion comes about in varying degrees, depending upon moisture content of the coal, wind velocities, rainfall, age of the pile, compaction and design of the pile, and the number and size of the dust particles. Usually, the industries try to pack down the coal piles, which actually creates more of the tiny particles. Sometimes they try using chemicals to hold down the erosion, but this method is costly and brings about more problems than it's worth.

Soo used a computer to imitate the conditions of coal piles, and then a wind tunnel to check a physical scaled-down model of the situation. Soo and his colleagues modelled the wind tunnel piles with haydite particles, which simulated three-inch coal lumps, and piped in smoke from kerosene-soaked cigars to view the wind dispersion. They concluded that if a snow-fence is placed about three pile heights away from the pile, the fence being about one-half the pile height, and if the pile is put lengthwise to the strongest wind, the fugitive emmision will be cut by 70%. This means that the air pollution will be less than 5% coal particles—a significant cut.

If this is the case, not only is the air cleaned up, but industry saves a lot of coal and money it would have otherwise lost. Hence the value of Soo's five year research work is realized. His work was funded by both the U.S. EPA and the American Iron and Steel Institute, two organizations which normally oppose each other in views and actions.

Your Chair, MacArthur

A year ago, the University was given a $1.2 million grant from the John D. and Catherine T. MacArthur Foundation to endow and support the MacArthur chair. Well, Anthony J. Legget has been selected as the first person to fill that chair. Legget is known for his international leadership in low-temperature physics. Legget, professor of mathematical and physical sciences at the University of Sussex, England, has already had the rare honor of being awarded the Fritz London Memorial Award as well as the Simon Memorial Prize of the British Institute of Physics. He is also a fellow of the Royal Society, winner of the Maxwell Medal, and winner of the Prize of the British Institute of Physics. He was a postdoctoral fellow here twice, and is returning back to this campus. It took 13 months for this appointment to be finalized, and Legget's presence here at the University is looked favorably towards by all.

Correction

In the October issue of Technograph Engineering Family Album we failed to include a relatively new honor society. ΑΝΣ is an honor society for nuclear engineering students. Juniors need to have a 4.63 grade point average, while seniors can enter with a 4.25. Graduate students can also be elected with a grade point of 4.75 after completing 4.5 units. Interested people should contact Professor James Stubbins at 333-6474, or stop by 214 Nuclear Engineering Laboratory. Illinois Technograph regrets the error.

Enabling the Disabled

Handicapped students are rolling with the changes.

by Robert Ekblaw

This is the first part of a two part series on facilities available for handicapped people on campus. The second part will appear in the December, 1982 issue.

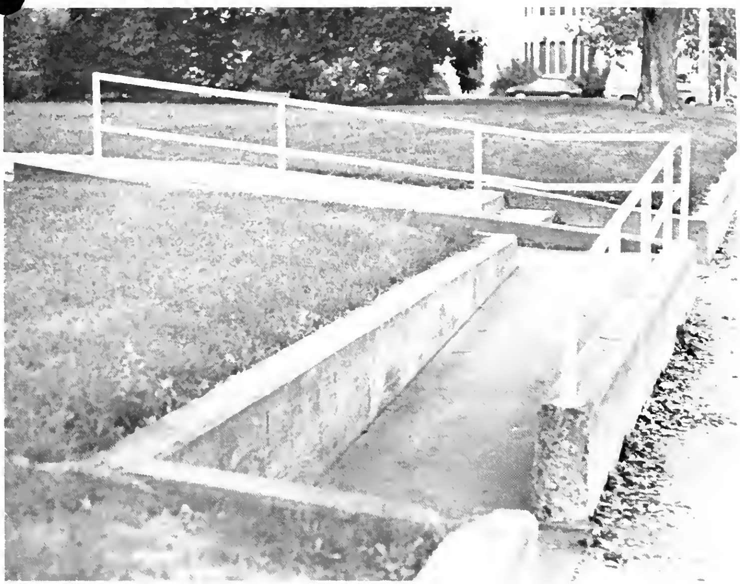
Many students have undoubtedly encountered at least one strange-looking sloping cement construction. For those who do not know what they are by now, they are ramps for use by those students who are confined to a wheelchair. There are several of these structures throughout campus, as well as other aides to assist in the movement of the handicapped around campus. Perhaps one of the most noticable of the ramps is located at the southeast end of the Illini Union.

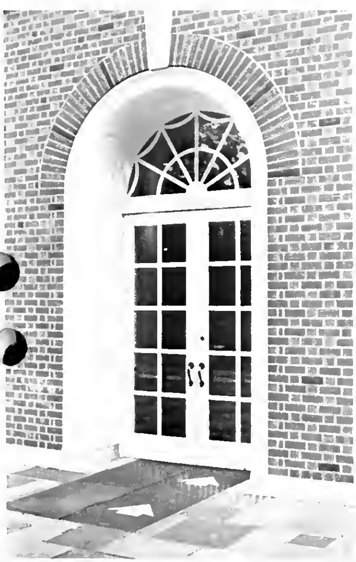
When the construction of the south wing of the Illini union was planned in 1963, the architects also planned accessibility for paraplegics and other people who must travel using wheelchairs. Along with the ramp, they installed an automatic door which opens by pressure, similar to those found at the entrances of supermarkets.

Within the wing itself, they supplied the handicapped with elevators in order that they might have access to the other floors of the building. The rest rooms were designed with special facilities for those confined to wheelchairs. Many features like these were built in favor of allowing accessiblity to paraplegics. When these additional features were built, the contractors reconditioned other sections of the Union, in order to facilitate the handicapped students and guests. In later years, they added even more services aimed at the physically disabled, including a new wooden ramp at the west end of the Union.

Despite the fact that private contractors built all of the aides in and around the south wing of the Union, most of the reconstruction work on the campus buildings was done by the Space Utilizations Office of the Physical Plant here on the University grounds. Actually, the whole job is divided

Above: The University provides buses equipped with elevators designed for wheelchairs.
Top Right: Ramps provide access to most buildings on campus.
Right: An automatically opening door provides easy access to the Illini Union from the South Porch.(photos by Thom Roe)





between two departments. It is the responsibility of the Facilities Planning Commission to review remodeling designs. After the Commission approves the project, it is turned over to the Space Utilizations Committee to determine the best procedure for construction and to gather the best group to handle the actual construction.

William Stalman, the gentleman from the Space Utilizations Committee who is in charge of this procedure, stated that most buildings constructed after 1955 and all those built after 1959 have complete accessibility both inside and out. In addition, whenever major renovating is done on a building not completely accessible to the handicapped, the neccessary features are incorporated into the construction. By this means, his department has been able to provide access to most of the major buildings and nearly half of the classrooms and lecture halls on campus.

In order to ensure the accessibility of the buildings, a survey was taken in 1978. This survey was conducted by the Space Utilizations Committee and Alpha Phi Omega. The survey involved inspecting every class building, every residence hall, and all other college and University buildings. They examined routes to every room in every hall, determined if they were accessible and if so, how one would get there. The results of the survey were compiled into a book, which is found in every office of the Space Utilizations Committee. By referring to the book, the committee is able to find the important rennovations that have yet to be done. Some buildings require elevators while others lack the proper rest room facilities. Still others have had no work at all done to increase their accessibility to the handicapped. The Space Utilizations Committee has constructed a list of the buildings that fall into those categories. This gives them an idea of the amount of work ahead of them. It also enables them to develop a set of priorities, based on the idea that the buildings requiring complete work must be started on right away.

The budget plan for the fiscal year of 1984 has already had some of the more important renovations incorporated into it. The plan allows for ramps to be built at the Institute of Labor and Industrial Relations, Illini Hall, and University High School. Elevators will be constructed in University High School and replaced in Lincoln Hall. Rest room facilities will be modified in the Architecture Building, Chemistry Annex, and University High School. The rest room facilities in Altgeld Hall are due to be

Continued

completed by the end of the year. This does not mean that the committee's work is almost done. In fact, much more work is still neccessary in many locations. Ramps, elevators, and rest room facilities are needed in many other buildings on campus. Obviously, the Space Utilizations Committee has many more years of work.

One might wonder why there is still so much work to do, since the project began in 1959. Actually, the answer is very simple. For one thing, there is a limit to how much can be done in one year. Second, the process that is followed in order to get the funding for the renovations is very complex. If the committee needs state funding, the following steps are followed in order to receive money:

1. A written request must be submitted to the Space Utilizations Committee by December 1.
2. The request is evaluated in terms of importance and budget.
3. The Chancellor reviews the request.
4. University officials review the request.
5. The request goes to the Board of Trustees at the July meeting.
6. The request is sent to the State Board of Higher Education. Their decision is due by January 10.
7. The governor decides on the budget.
8. The State Board decides which jobs are to be done based on the budget allowances. Their decision is due in March.
9. The State Legislature votes on the decision by June 30.
10. The governor reviews it.
11. The Capital Development Board in Springfield acquires the money in October and allocates it to the colleges.
12. The University finds a company to construct the ramp.

Obviously, with such a complicated procedure, not many projects are completed each year. However, the procedure is simplified considerably if the committee does not require state funds. Then, the process is completed at step four. The renovations are conducted by the Operations and Maintenance team of the University.

The renovations that have been done on many campus buildings make up only a small part of a much larger program. This program is called the Division of Rehabilitation Educaton Services. It is a result of the growing number of physically handicapped people who are attending the Unversity. Over the years, there has been an average of approximately 100 students per year who are permanently confined to wheelchairs. All of these physically disabled students attend regular classes in normal degree programs. They live on campus in residence halls or in special centers. There are several specially engineered buses which they use for campus transportation. Accomodations such as the above, and specialized constructions, illustrate our growing concern for the physically handicapped students on our campus.T

Tech Teasers Answers

From page 2

1. He should only need 7 weighings. 1: Weigh out a 4 kg sample using the two weights in different pans; 2, 3, and 4: Weigh out 3 equal 4 kg samples using the first 4 kg sample, which leaves a total of five 4 kg samples; 5: Use the scale to divide one sample into two 2 kg samples; 6 and 7: Divide the two 2 kg samples into four 1 kg samples. Then all he has to do is add one 1 kg sample to each of the four 4 kg samples, and he has four 5 kg samples.

2. When 16 is in base 8, 10 is in base 2, 11 is in base 6, 32 is in base 4, and 211 is in base 5. See if you can find any other cases.

3. 210,526,315,789,473,684 ÷ 2 = 105,263,157,894,736,842. See if you can figure out the pattern to this problem. You can apply the algorithm to any number, and not just 2 or 8.

4.

$$\frac{8.0 + 6 + 3 + 1}{.7' + .2' + .4' + .5' + .9'} = 6$$

Note: This solution requires that you believe that .9 repeating is exactly equal to 1 (which is debatable).

5. Felicia ran 133 ⅓ meters before she caught up with her wombat, who squealed in disgust at only being able to traverse ⅔ the distance between him and the gate.

Louis Wozniak

text and photos by Thom Roe

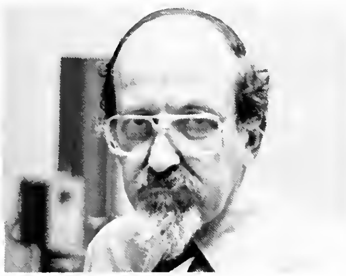
Louis Wozniak is an associate professor of general engineering. He received a bachelor's degree in mechanical engineering and continued to obtain both master's and doctorate degrees in electrical engineering from the University of Illinois, and became a member of the General Engineering staff in 1968.

Professor Wozniak usually teaches three general engineering courses: GE 103, 122, and 242. Of these, GE 103, an introduction to graphical projections, dimensions, analysis, and design, is by far his favorite. Wozniak claims that this class, a requirement for most freshmen in engineering, gives him an opportunity to clarify student's impressions concerning what engineering truly encompasses. There is a need, he feels, to direct new students on a human level, helping them realize career goals. Another course Wozniak teaches is GE 242, senior project design. In this more technologically oriented class, seniors may participate in solving problems relevant to local industries.

Wozniak's area of specialty is the speed control of hydraulic turbines. One of the most specific examples in this field is the study of hydroelectric power plants. He has acted as a consultant for numerous hydraulic planning and control manufacturing firms. Recent work includes simulation of system stability in conjunction with the Department of Interior's expansion of the Grand Cooley Dam on the Columbia River.

Howard S. Ducoff

text and photo by Bill Proctor



The relatively new field of bioengineering started at the University of Illinois in 1974 and now officially has more than 120 students. Professor Howard Ducoff has greatly aided in keeping this program going.

Professor Ducoff got his B.S. in Biology at the City College of the college of the City of New York. After World War II, he obtained his Ph.D. in Physiology at the University of Chicago, and worked at Argonne National Laboratory. Eleven years later, in 1957, he got "an offer he couldn't refuse" from the University of Illinois.

His positions and activities keep him quite busy. Besides teaching Physiology 331, he works with students engaged in Bioengineering Individual Studies and plans Biophysics 411 seminars. He is the Program Director for bioengineering in LAS, a member of the Advisory Committee for the Office of Gerontology, and a member of the Radiation Hazards Committee.

Bioengineering was created when a need to study the effects of radiation on ecology developed. It has been found that insects, unlike humans, can actually live longer after being exposed to radiation. This is what Professor Ducoff's research involves. The theory is that after the young insect is exposed, repair enzymes are stimulated. Besides repairing the radiation damage, the enzymes fix lesions in the cells which may have accumulated during the many somatic cell divisions. This increases the insect's ability to repair damage with age because the information is freed of the lesions it originally had.

Bruce Sherwood

text and photos by Jane Fiala

After graduating from Purdue University in 1960 with a B.S. in Engineering Science, Bruce Sherwood spent a year in Italy at the University of Padua on a Fulbright Scholarship, studying physics. He then attended graduate school at the University of Chicago, and earned a Ph.D. in experimental high energy physics.

Professor Sherwood taught Physics at Cal Tech from 1966 until 1969, when he came to the University of Illinois. He is now Assistant Director of the Computer Based Education Research Lab (CERL-PLATO), a professor of physics, and a professor of linguistics.

Sherwood teaches Physics 106 and has written a book for the class, **Notes on Classical Mechanics**. He is currently working on a cluster PLATO system, which is a new way to deliver PLATO lessons to students, and a computerized speech synthesizer. His work in speech synthesis, which began a few years ago, led him to an interest in linguistics. In 1979-1980, he was granted a Faculty Study in a Second Discipline, in which he audited linguistic courses and taught one course. He is especially interested in Esperanto, a constructed language created for international use. Because it belongs to no country, it eliminates political bias when it is used in international meetings. In recent years there has been a renewed interest in the use of Esperanto. Professor Sherwood teaches a course in introductory Esperanto for Communiversity at the YMCA.

E-Systems continues the tradition of the world's great problem solvers.

Even given the benefit of historical perspective, it is difficult to fully comprehend the enormous contributions to man's knowledge made by Sir Isaac Newton. His *Philosopiae Naturalis Principia Mathematica* is termed by many authorities to be one of the most important single works in the history of modern science. His studies of light are the foundation of physical optics and his laws of motion provided a quantitative description of all principal phenomena in our solar system.

Today, scientists and engineers at E-Systems employ Newtonian principles to develop products and systems for satellite communications, exploring space and the development of solar energy, systems which are the first-of-a-kind.

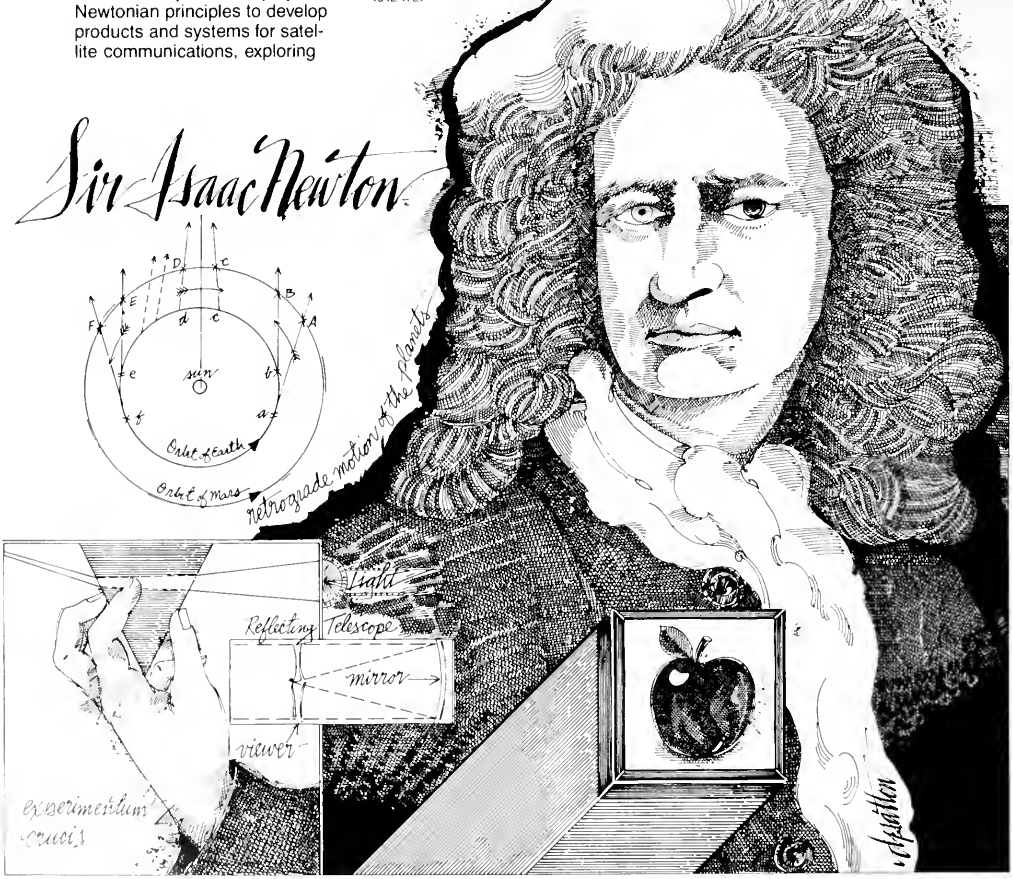
E-Systems engineers are recognized worldwide for their ability to solve problems in the areas of antennas, communications, data acquisition, processing, storage and retrieval systems and other systems applications for intelligence and reconnaissance.

For a reprint of the Newton illustration and information on career opportunities with E-Systems in Texas, Florida, Indiana, Utah and Virginia, write: Dr. Lloyd K. Lauderdale, Vice President Research and Engineering, E-Systems, Inc., Corporate Headquarters, P. O. Box 226030, Dallas, Texas 75266.

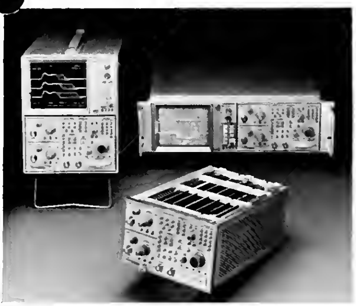
E-SYSTEMS
The problem solvers.

An equal opportunity employer M F H V

Sir Isaac Newton
1642-1727



by Langdon Alger



Tektronix 7D20 programmable oscilliscope makes scoping an easy task.

Scoping Out Capabilities

Tektronix was the first manufacturer of the digital oscilloscope, and their latest model, 7D20, has facilitated the use of programmability to enhance its uses. The fact that it is programmable, as well as simple to use, means that operators do not need extensive training to learn how to manipulate it, their jobs become easier, and the scope takes most of their busy work away.

The 7D20 is a plug-in scope, so individual users may adapt their scopes to their particular needs by plugging in different modules. It has a memory, so you can store up to 1024 points for each of six different waveforms, as well as a reference waveform. The scope can capture and store one-time events up to ten megahertz, and repeating events up to seventy megahertz. This, plus its ability to accept two separate channels at once, gives you digital accuracy and the benefits of analog devices without the pitfalls.

Other features include error tracing; status reporting, where the screen displays the controls' settings; and a special debugging setup. It is priced at $7,750 in the U.S., and it is adaptable to practically any existing mainframe.

You Won't See the Light

DISA Electronics has introduced their "Laser Doppler Vibrometer System" to the market. All you have to do is supply the laser, insert it into the supplied adaptor/beam processor, plug it all in, and you are ready to make extremely accurate measurements of solid and liquid surface movements.

Basically, the way it works is by shooting a beam out to the object being studied and collecting the reflected beam. This is accomplished by the lenses, prisms, and mirrors contained within the laser adaptor. The hardware then examines and analyzes the doppler shift that was induced. If you connect the mainframe to an oscilloscope, you can view any signal you wish, including the shifted signal, the output signal, or the vibration signal.

What makes this system so handy is its accuracy and its general simplicity of use. It is a non-contact measurer, so you can analyze vibrations from 1.2 to 20 meters away without ever disturbing the object's movements. It can pick up amplitudes from 10^{-8} meters to 1 meter, frequencies from DC to .74 MHz, velocities from 10^{-6} m/sec to 3 m/sec, and accelerations from 10^{-11} m/sec^2 to 3×10^5 m/sec^2.

The applications for this product are about limitless. It can be used to make vibrational measurements on loudspeaker diaphragms, eardrums, seismic movements, traffic roads, turbomachinery, and building structures. It also has some unique and interesting capabilities, such as measuring the ripple of nerve cells.

Go Backwards to Move Ahead

All you have to do is talk to anyone involved with writing or filing to find out the name of the game is fast and accurate data retrieval. Secretaries, doctors, students, and even home filers are using computerized word processors now. There are drawbacks to electronic data storage, however. Software bugs, hardware breakdowns, complicated codes and expensive equipment all put a damper on the efficiency and availability of these systems. For the smaller projects, even the initial process of starting up a word processor seems a waste of time.

A company called Indecks, Inc., has an answer, although it is admittedly a step backwards in time. It costs under $30, weighs three pounds, is the size of a thick book, and requires no electricity or fuel. It is called Datasort, and consists of a deck of cards, a handpunch, and a small metal rod. The secret is in the cards: each one has numbered holes on all four sides.

You decide how you want to file all your information, and assign numbers to different categories. Print your information on all the cards,in whatever manner pleases you most. Then just punch out the tops of the holes that correspond to the information on the cards. As an example, say you assign the number 21 to the category of philosophical quotations. To retrieve this information, you stick your knitting needle-like rod into the hole that corresponds to your decided category, in this case hole number 21. Then simply shake the deck, and all cards with hole 21 punched out will fall away from the rod. Cross-referencing is just as simple. All that has to be done is to stick the needle into another hole to obtain a more concise category. Suppose hole 22 is reserved for quotations by Descartes. To find his quotes, you would use hole 21 for philosophy, and 22 for him. You can continue narrowing down the categories until you get exactly what you need. The beauty of this system is that you don't have to remember where each card goes. You can pile them up in any random order, as long as they are right side up and facing the same direction. Because of the retrieval system, all the cards of a category will fall out regardless of their position in the deck.

Indecks designed Datasort for up to 5,000 cards, which is perfect for research papers, small surveys, lists of clients, and anything you can dream up. Data retrieval is simple, fast, and you cannot misfile, because you don't have to file. Who knows, maybe the simple ways are still better.

Luis Castellanos mines copper with software.

Most copper is found deep underground. But the Bell System's 995 million miles of copper cable have tons of it above and below ground. That copper provides vital circuit paths to transmit customer voice, data and video signals for today's Information Age needs.

And Luis Castellanos, seven years out of undergraduate school, supervises one of the groups that helps Bell System companies "mine" all that copper. He works with one of the largest computer hardware and software systems in the world—the Trunks Integrated Record Keeping System (TIRKS). Every day it "mines" the vast Bell network for available circuits and equipment. As a result of efficient use of network facilities, the Bell System saves millions by eliminating the need for certain capital expenditures.

Plus, there's more to TIRKS than "mining copper." It also configures circuits and assigns components needed for each circuit path. That allows Bell companies to respond faster to customer requests for complex services like video and data transmission. Employees are more productive too, because TIRKS helps them set up circuits and forecast facility needs.

Before TIRKS was available, keeping track of communications circuits and facilities required enormous amounts of paperwork and manual calculation. Every day, the average Bell System company handles orders involving 1500 circuits and up to 7500 individual components associated with them. Each detail has to be specified and accounted for.

Now, thanks to people like Luis, TIRKS keeps track of all that information instantaneously using computers. Information is up-to-date. It's instantly available. And it's more accurate.

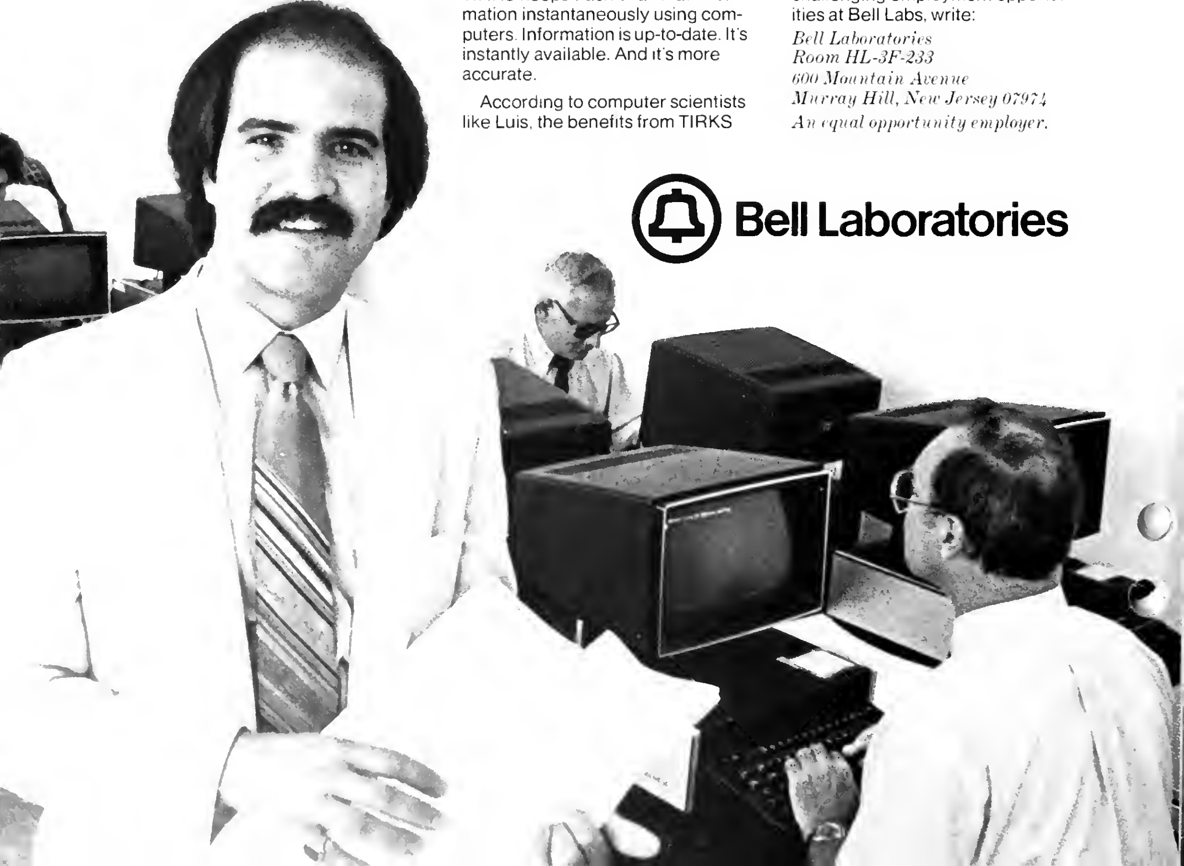
According to computer scientists like Luis, the benefits from TIRKS are just beginning. He believes that, as more computer hardware and software systems like TIRKS interact, new benefits for customers may be possible, as well as additional productivity increases for employees.

Luis joined Bell Labs with a B.S. in computer science from Pratt Institute. Under a company-sponsored graduate study program, he attended Stevens Institute of Technology for his M.S. in computer science. At the same time, he worked part-time assuming responsibility for a large piece of TIRKS software. Working with design teams, he gained valuable insight from experienced members. Now, his technical performance has earned him a promotion to supervisor.

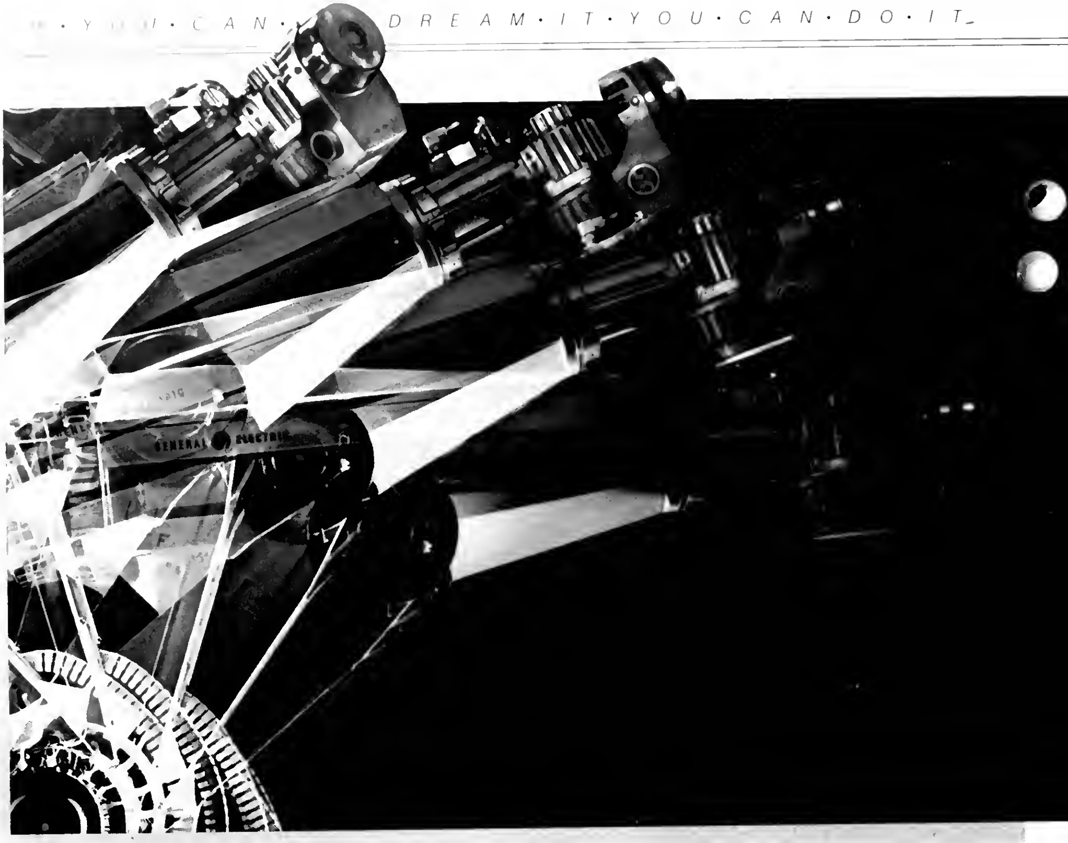
If you're interested in similar challenging employment opportunities at Bell Labs, write:

Bell Laboratories
Room HL-3F-233
600 Mountain Avenue
Murray Hill, New Jersey 07974
An equal opportunity employer.

Bell Laboratories



• YOU • CAN • DREAM • IT • YOU • CAN • DO • IT



Teach a robot the facts of life.

There was a time when most robots earned their livelihoods in comic books and science fiction films

Today, they're spraying, welding, painting, and processing parts at manufacturing plants around the world

Necessity has caused this amazing leap from fantasy to factory

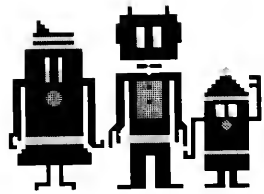
The world wants long-lasting, high quality products, now And robots fit perfectly into this scheme of things They can make those products – quickly, easily and accurately

What kinds of robots? There is GE's Allegro,™ for one It can position a part to within 1/1000th of an inch – or about ¼ the thickness of the paper this article is printed on. Or there's GP 132 (shown here) This loader, unloader, packer, stacker and welder – can lift and maneuver 132 pounds with no trouble at all

So what's left for me to teach robots? You might ask Consider this glimpse into the future by Dr Roland W Schmitt, head of GE corporate research and development

"One of the big frontiers ahead of us is putting the robot's nervous system together with some senses – like vision, or touch, or the ability to sense heat or cold That can give you an adaptive robot, one that can sense how well it's doing its job and make the adjustments needed to do that job better"

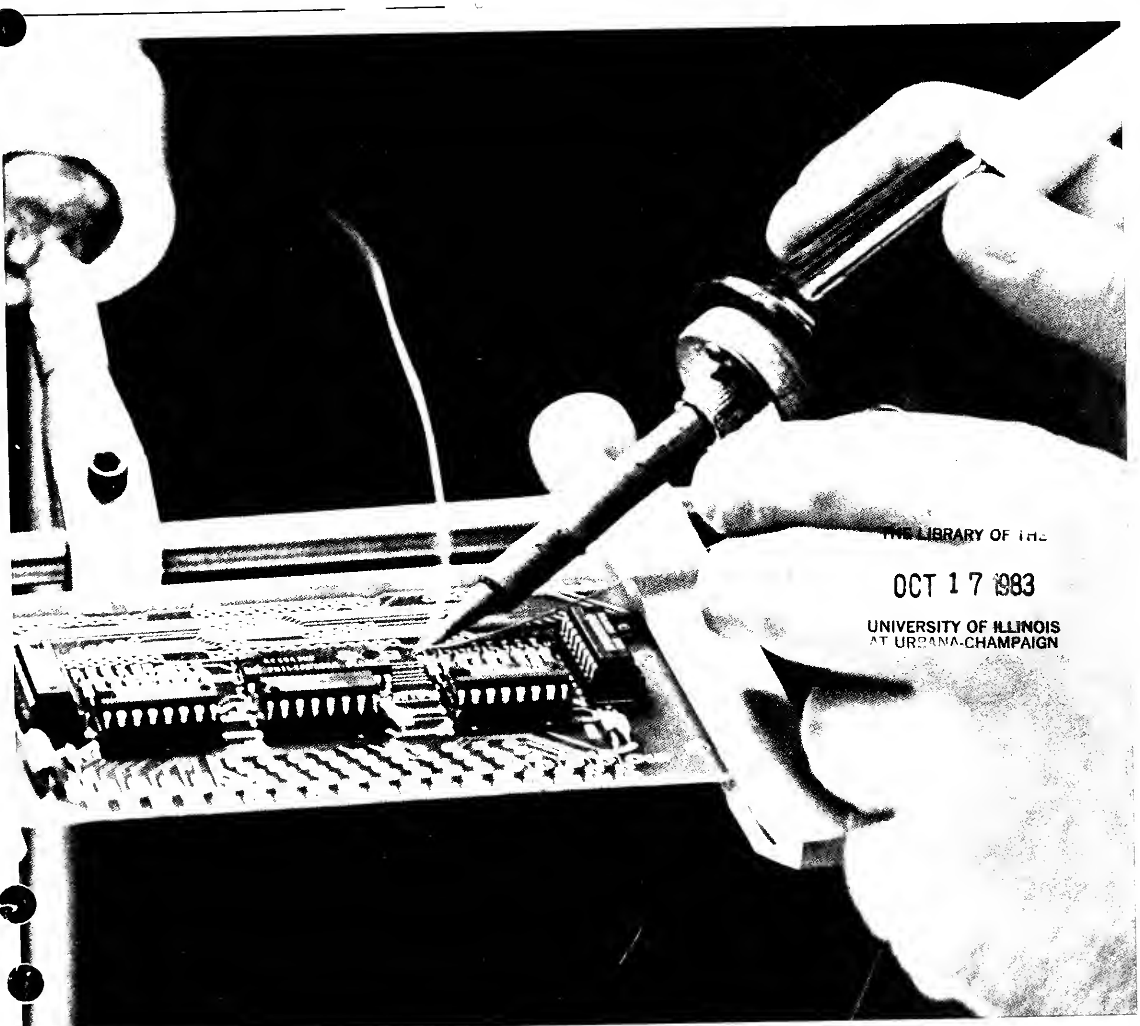
That's a tall order And one we'll be expecting you to fill With foresight, talent, imagination – all the things that robots have yet to learn



WE BRING GOOD THINGS TO LIFE

An equal opportunity employer

ILLINOIS TECHNOGRAPH



December 1982 Volume 98 issue 3
Newsstand $1.25

State administrators look to high technology for a solution to the woes of Illinois.

One of the nation's top companies in sales of electronics-related equipment is Kodak.

Kodak's application of electronics technology is becoming more and more extensive every day. That means we have growing career opportunities for electrical/electronics engineers.

In projects as diverse as the design and production of output driver chips for the logic and control unit of Kodak Ektaprint copier-duplicators. Development of advanced analog and digital technology and sophisticated software techniques for blood-chemistry analysis with the Kodak Ektachem 400 analyzer. And exploration of potential product improvements in the Kodak Komstar 300 microimage processor, a computer peripheral which uses pulsed laser beams to convert digital data to alphanumeric images on microfilm at speeds up to 20 times faster than many ink-jet paper printers.

If you want to expand your horizons to meet the Kodak challenge, see a Kodak recruiter on your campus. Or send your resume to:
Personnel Resources
Eastman Kodak Company
Rochester, N.Y. 14650.

Kodak. The right place. The right time.

An equal opportunity employer manufacturing photographic products, fibers, plastics, chemicals, and electronic equipment. Plants in Rochester, N.Y.; Kingsport, Tenn., Windsor, Colo.; Longview, Tex., Columbia, S.C.; Batesville, Ark.; and a sales force all over the U.S.

ILLINOIS TECHNOGRAPH

December 1982 Volume 98 issue 3 © 1982 Illini Publishing Company

6 Making the Best of Disabilities

Robert Ekblaw concludes his series on accomodations for the handicapped.

8 Opto-electronic Chip

Rob Busse explains how the opto-electronic chip will further minimize circuit size.

12 A New Breed of Reactors

The technical and political intricacies of the Clinch River Breeder Reactor are exposed by Laura Kasper.

16 Industry and Education

Politics and expensive land are among the factors formulating high-tech policy. Joe Culkar reports.

20 Engineers and the Recession

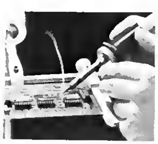
Jim O'Hagan updates current college recruitment.

23 A Monopoly on Life

Charley Kline uncovers some of the mystery of the versatile DNA molecule.

Departments

Tech Teasers 4, Forum 5, Technovisions 14, Technotes 18, Technovations 25, Tech Profiles 27



On the Cover: The governor of Illinois is making a bid to draw high technology industry to the state. Will tasks like this fill the idle hands of Illinois workers in the future? (photo by Randy Stukenberg)

EDITORIAL

Film at Eleven

I know the semester was long, and there was not much time to spend on things other than the bare essentials: eating, sleeping, studying, and drinking, not necessarily in that order. Few were the times we watched the news or perused a newspaper, but we really do have a responsibilty to keep up with our volatile surroundings.

Therefore, I suggest that over the winter break we all try to watch what happens in the news. With this in mind I'll throw out some issues that you might want to pay attention to.

• Extra Strength Tylenol, Extra Strength Anacin, and several other over-the-counter medications including eye drops were tampered with by someone who intended to harm innocent people. Why do crazy people victimize the public with their poisoning schemes, and how can we prevent them in the future?

• How long will the marines stay in Lebanon?

• Since U.S. District Judge Terry Hatter has ruled the last draft registration invalid, will we all have to go through the whole painful process again?

• How did 198 people who earned over $200,000 in 1980 get away without paying a cent in income taxes?

• If Northwestern University tuition is taxed by the city of Evanston, how could that affect the University of Illinois' relationship with the cities of Urbana and Champaign?

• Will the Illinois State Scholarship Commission receive their requested 23% increase from $134 million to $165 million to allow a maximum grant of $2300 as opposed to $2000?

• Leonid Brezhnev has died. What relationship will President Reagan have with the new Soviet leader, Yuri Andropov?

• Will we ever know the whole story of what happened to Lech Walesa during his imprisonment in Poland?

• What went wrong with the shuttle pilots' space suits to prevent them from venturing out into space for the first American space-walk in nine years?

• Another 700 layoffs at Illinois based agricultural equipment firms increased the states already soaring unemployment rate. Which is worse—high unemployment, inflation, or both of the above?

• Who really is the governor of Illinois?

• The Urbana-Champaign Senate approved the proposal to move Reading Day to the Saturday prior to final exams. Why did the faculty senators ignore the desires and needs of the students?

• Is the Reagan administration pursuing an isolationist tack by insisting that valuable European allies obey U.S. economic sanctions against the Siberian oil pipeline?

• Several states passed non-binding resolutions for a freeze on nuclear arms in the recent elections. The people obviously want a change. How long can we collect the weapons of our own destruction at a break neck pace?

• The stadium seems to sway during football games, but structural engineers hired by the University said it was nothing to worry about. Now the University wants to use the stadium for commemcement ceremonies. Will it fall down during graduation?

• Now that the football strike is over, do people realize the economic anguish it caused several major cities with football teams? How can professional sports have such impact on a city?

• Illinois state schools are begging for more money from the state, but the Governor says there is none to be had. Is there a better way to fund higher education?

So there is my list of suggested issues to watch over break. Sometime in between all the yuletide cheer read *Time* or some other publication besides a text book. You might even make it a New Year's resolution to make a habit of watching the world around you even *during* school.

Kevin W. Wenzel

TECH TEASERS

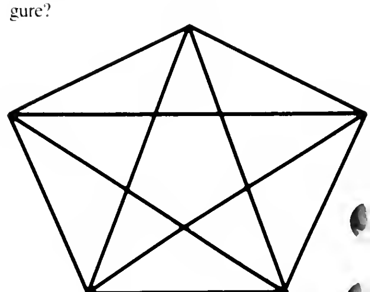
1. 32,547,891 × 6 = 195,287,346. On both sides of the equals sign, all nine digits (1 through 9) are used once, but not necessarily in order. Find another instance where this occurs, using 6 as a multiplier again.

2. A sportsperson wishes to go skiing in the mountains for a week. She packs up her 170 cm skis in a mailing tube for the plane flight, only to find that the airline will not accept any package that has any dimension greater than one meter. Undaunted by this troublesome rule, she re-packs her skis in a manner that the airline will accept. Can you figure out how she packed them? She did not have folding skis, and she did not alter their physical configuration in any way.

3. Find the smallest number which when divided by 45 leaves a remainder of 4, by 454 leaves a remainder of 45, by 4545 a remainder of 454, and by 45454 a remainder of 4545.

4. In 1928, the month of February had five Wednesdays. Find the latest year before 1928 and the earliest year after 1928 where this same amazing thing happened. There are many other dates before and after 1928 where it occurred, and you may find them if you wish.

5. How many triangles are in this figure?



Answers on page 24

FORUM

High Fidelity Piracy
by Eric Guarin

Ruffians with eye patches, wooden legs, and parrots perched on their shoulders are not often seen by the average person; however, one may see dozens or even scores of pirates daily. No, not during Halloween and no, not during the filming of a new swashbuckling epic; these "pirates" are pirates of a different sort. The professionals among them can make six-figure incomes with sales comprising a reputed 30 to 50 percent share of popular tape and other music markets. The more gentile and refined of them can even be found in New York's Metropolitan Opera House. But just what sort of "pirate" is under consideration here? That's an easy question; music pirates, and not of the "Pirates of Penzance" sort either.

Copyright law governs the legality of most forms of copying: words, pictures, music, etc. Copyright laws change with time, but the general idea behind the laws is to fairly reward the artist and other involved parties for their efforts. Consequently, when Joe buys an album and makes a tape of said album for use in his car, that's fine, since when he originally bought the album part of the price he paid went to the artist as royalties. On the other hand, Joe cannot legally borrow an album from Jane and tape it, because the artist then gets nothing from Joe's use of his composition. If Joe not only tapes the album but sells the tape, this hurts the artist even more, since he not only gets nothing from the transaction but the legitimate sales of his work are being cut in two. Of course, the public may not care about the artist's fate, or about the fate of the person who helped the artist produce the work. Therein lies a basic conflict.

Unlawful taping is exactly that—unlawful—but few really seem to care, and they tape anyway. Why would all these people knowingly violate the law? There are two main reasons: lack of enforcement, and economics.

Perhaps the biggest reason people make illegal recordings has to do with money; this is true for both the professionals who are making money and for more common people who save money. New albums or tapes cost about eight dollars each; at those prices, buying illegally for less gains a certain definite appeal.

An example is in order. As an alternative to buying illegal recordings, a person could watch for sales and shop discount music stores or mail-order houses. Depending on the listener's taste in music, this can decrease the cost of a single album to four or five dollars. On the other hand, a premium grade tape will cost somewhat less and will accomodate two single albums, for under half the cost per album on the legitimate market. If just adequate fidelity suffices, decent tape may be purchased for less than one dollar for a length of tape which accomodates two albums. This corresponds to one eighth of the cost of buying new records, and the illustration serves to show how do-it-yourself taping can really save money.

Exactly why these savings are worth the risk of incarceration is easy to explain; the risk is very small. Although professional "pirates-for-profit" are indeed caught and prosecuted, punishment may not be very severe; and home tapists who do not sell their work are even less likely to get caught. Also, home taping lends itself to rationalizing; it is easy, for instance, to simply believe that record companies inflate profits so ridiculously that they deserve to be ripped off. Of course, a savings of fifty to ninety percent lends a lot of weight to such reasoning.

What the whole mess boils down to is this: record companies scream bloody murder and say "that's not legal" while people tranquilly reply "who cares?". Home taping is like speeding; although it's illegal, people do it anyway. The law should concentrate on the speeders more than home tapists, who aren't nearly as dangerous. In the meantime, "damn the torpedoes" and full (tape) speed ahead!

Forum is intended as an open exchange of views and ideas on areas of interest to the Engineering campus. All University students and faculty members are invited to contribute articles for Forum. Articles may be editorial in nature, and must be signed.

STAFF

Editor	**Kevin Wenzel**
Production Editor	**Larry Mallak**
Business Manager	**Jim Lee**
Copy Editor	**Charley Kline**
Asst. Copy Editor	**Raymond Hightower**
Photo Editor	**Randy Stukenberg**
Features Editor	**Langdon Alger**
Design	**Nancy Grunthaner**
Assistant Design	**Beth Beauvais**
Publisher	**E. Mayer Maloney, Jr.**
Production Manager	**Geoff Bant**
Adviser	**Ed Mast**

Editorial Staff

Steve Alexander	Eric Guarin
Rob Busse	Chris Konitzer
Doug Campoli	Laura Kosper
Tushar Chande	James O'Hagan
Joe Culkar	Bill Proctor
Tad Dierkes	John Przybysz
James Ehrhart	Thom Roe
Robert Ekblaw	Doug Shaw
Jane Fiala	Andrew Saporoschenko
Elayne Fletcher	Yuki Spellman
Mary Kay Flick	Robert Strahanowski

Business Staff
Brian Carlson
Jeff Lee
Donna Obermaier

Illinois Technograph
(USPS 258-760)
Vol.98 No.3 December 1982

Illinois Technograph is published five times during the academic year at the University of Illinois at Urbana-Champaign.

Published by Illini Publishing Co., 620 East John St., Champaign, Illinois, 61820. Editorial and Business offices of the Illinois Technograph: Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3730

Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001; 221 N. LaSalle Street, Chicago, IL., 60601

Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879

Illinois Technograph is a member of Engineering College Magazines Associated

Living with Disabilities

Educational and living services allow disabled students more opportunities.

by Robert A. Ekblaw

This is the second part of a two part series on facilities available for handicapped people on campus. The first part appeared in the November, 1982 issue

Imagine walking down Wright Street. All of a sudden, a strange electronic hum is heard from behind. Then, a low voice is heard calling, "Excuse me, may I get through?" A young man in a wheelchair passes and rolls onto a metal platform next to a bus. The platform rises slowly, till it is level with the floor of the bus. The doors close, and the bus drives away. The letters on the side read, "Rehabilitation Education Center." How was the bus equipped to handle the man, and where did the man live? The Division of Rehabilitation Education Services has the answer to these questions.

The University of Illinois Rehabilitation Education Program began in 1947 on the University's Galesburg Campus. When the Galesburg Campus closed in 1949, the program moved to the Urbana-Champaign campus. This program, headed by Professor Timothy J. Nugent, concentrated on providing accomodations for paraplegic and quadriplegic students. Now housed in the Rehabilitation Education Center at 1207 Oak Street, the program is responsible for the arrangements for ramp construction and building refurbishing, as well as exciting extras like the bus lifts, special sports competitions, and the Beckwith Living Center. Professor Nugent, long concerned with the needs of these extraordinary students, devised many original ideas. The Rehabilitation Program here at the University was the first such program to be initiated at a major educational facility. The bus lift, a metal hydraulic platform used to raise wheelchairs from the ground to the bus, was another technical advance created by the Rehabilitation Program. Their national debut was here on the University campus. In fact, until 1980, the University of Illinois was the only college campus in the nation to use a bus lift, and they have been in service here since 1949.

In 1965, the program moved into the Rehabilitation Education Center, its present location. It contains areas focused toward the handicapped students as well as business offices. There are counseling offices, medical offices, a library, a meeting room, a recreation room, and a physical therapy department. The physical therapy department handles special exercises, instruction, and skills designed to tone both the mind and body of the student. The center also contains services and instructional facilities used to train handicapped students and their aides. For example, the center is responsible for instruction in many of the technical utilities available at the center for use by the handicapped. These utilities include braille printers, tape recorders, and talking computers, all of which where either designed or tested by people who attended the University of Illinois.

From within the halls of this building, Professor Nugent and his staff coordinate activities, facilities, and instruction for the handicapped students attending the University. Some of the activities and accomplishments of members of the Rehabilitation Education Services program are:

1. Issuance of varsity letters to outstanding wheelchair and blind University athletes.
2. Selection of a woman wheelchair athlete as Athlete of the Year, as well as several wheelchair athletes of both sexes for Athlete of the Month.
3. Initiation of pilot training for individuals in wheelchairs with the University of Illinois Institute of Aviation (this program has produced over 50 licensed wheelchair graduates).
4. Development of the Ms. Kids women's athletic teams.
5. Continuing the growth of the National Wheelchair Basketball Association, which was began at the University of Illinois in 1948. This program now has 165 teams in 27 conferences.
6. Appointment of a director, chosen from the staff at the Rehabilitation Education Center, to head a special committee to the NCAA regarding creation of a series of intercollegiate sports for wheelchair and other disabled athletes.
7. Research into a multitude of technological, educational, and other disciplines for the purpose of assisting handicapped students and personnel.
8. Merging of physical therapy and exercise therapy into a single, comprehensive clinic, as well as training qualified personnel in athletic training, sports medicine, and other fields which benefit those with disabilities.

The Rehabilitation Education Center and the Division of Rehabilitation Education Services have received many state, national, and international awards and recognitions for the large number of projects completed at the University for use by paraplegics. Several "experiments" run by University students or staff, supervised by members of the Center or the Division, have been emulated by organizations all around the nation. The program here at the University of Illinois was instrumental in creating a new educational field which has to do with the design and construction of tools to assist in the daily living of paraplegics. This field, called Rehabilitation Engineering, is available to students at many universities across the country. The work of Professor Nugent and the Division of Rehabilitation Education Services has made all this possible.

The center's work has not stopped with the activities, education, training, and facilities it has instituted to date. Several years ago, it realized that the dorm facilities for paraplegic living were inadequate. With a healthy donation from Guy M. Beckwith, a retired Illinois farmer, construction began on a new living center for handicapped students. Ground was broken on the two-hundred block of East John Street in Champaign. Finally, in August 1981, the first student moved into the new building. It was officially dedicated on May 12, 1982 as the Guy M. Beckwith Center for Paraplegics.

Beckwith, as stated by Professor Nugent, is "the first of its kind." It is the only facility in the nation specially designed as a living quarters for the severely handicapped. The Living Center is definitely the best furnished facility for handicapped citizens. The first floor of the two-story construction contains twenty sleeping/study

The Guy M Beckwith Center for Paraplegics. (photo by Jane Fiala)

rooms for the occupants of the living center. These rooms contain the finest in technological aids. The light switches are large indented plastic platforms, that activate with just a brush of a hand. There is a push-button intercom on the wall, enabling the residents to signal the directors of the center, Mr. and Mrs. Thomas Thorton, if there is anything wrong. The telephone is connected to a speaker intercom system (similar to that used in business offices), so that it is not necessary to hold the phone up to the ear to talk or listen to the person on the other end of the line. There is a nurse's call button by every bed which can be activated with just the press of a button. Every room has a smoke detector and emergency sprinkler. The bathroom has a low sink accessible from the wheelchair and a bar next to the toilet to allow the resident to transfer from his chair to the seat.

The lounge is located on the first floor, complete with a color television. It is a great place to watch television, meet with visitors, or just relax after a long day. Next to the lounge is the dining room and an adjoining kitchen. Beckwith has a live-in cook who makes three meals daily for the residents. The dining room has tables that are low, only inches above the armrests of the wheelchairs. This enables the residents to wheel under them and eat in perfect comfort, without having to reach up to rest their arms on the table. The tables are connected to the walls, in such a way that they can be raised and stored within them when not in use. Thus, the table has only one "leg", located at the very end of the table. This eliminates the need for the "extra" legs that would only be an inconvenience for a person in a wheelchair.

The last room on the first floor is the library. Not only does the library contain books, but it has three PLATO terminals for use by the residents. Needless to say, this is one of the favorite rooms of both residents and visitors.

Accessible by an extra-large elevator (to allow room for several wheelchairs), the second floor of Beckwith contains two more sleeping/study rooms, as well as one-bedroom and two-bedroom apartments. A married couple, the husband being a paraplegic student, lives in one of the two-bedroom apartments. Each of the bedrooms and apartments on the second floor has a wooden terrace, accessible through a glass patio door. These terraces serve both as scenic overlooks and as fire escapes.

Perhaps the most interesting of the rooms on the second floor of Beckwith is the "efficiency apartment." This place has several appliances found in an average home, with a few subtle differences. The oven, stove, and dishwasher have touch controls. The refrigerator has several low shelves, since those in wheelchairs could not reach up high. The folding "hide-away" bed is hinged so a slight push will retract it into the wall. The closet is large and wide, enabling the paraplegic to just roll his wheelchair in. The bathroom has all the aspects of those on the first floor, plus it has a shower with a seat. If the person does not have the arm strength to lift himself out of the chair onto the seat, a special shower chair is available. The chair, a water-resistant version of the common wheelchair, would just wheel into the shower. The shower seat is hinged and is just lifted and locked against the stall wall.

The second floor also contains a medical office. Beckwith has two professional medical staff members and eight pre-med students available to them for use in medical situations. Next to the medical office, there is a large room used for emergency care, if needed. As of yet, it has not been needed, so the room has been used as a lounge.

Beckwith houses twelve paraplegic residents at the present time. All of them attend class at the University, in the same classes and majors as everyone else. The residents are determined to be like everyone else and to be able to make it on their own. At Beckwith, they are allowed to do everything they can before receiving help. The major job of the staff at Beckwith is to regulate the diet and health habits of the residents. Since most of the residents were victims of car or sports accidents, they knew an active life before, and are extremely determined to remain active. Most of them are involved in fraternity, sorority, and campus activities. From talking with the residents of Beckwith, one can realize the strength of their determination. It is painful to think of what their lives would be like without the work of Professor Nugent and the Division of Rehabilitation Education Services. T

Opto-electronic Chips

Research is being conducted on an improvement to the electronic chip.

by Rob Busse

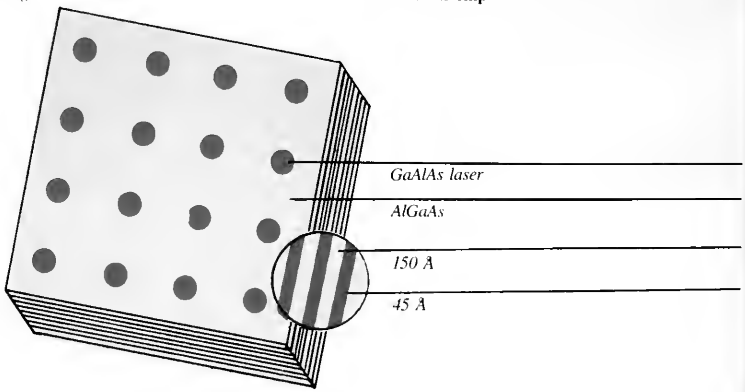
Twenty five years ago, the transistor was still an infant device. The basic theory behind this device was still being explored by Bardeen, Hall, Haynes and Shockley, among others. Out of the work of these people sprung a revolution in the field of electronics. Now, a newly developed technology offers a substitute for the widely used electronic semi-conductor chip.

Researchers working at the University of Illinois Solid State Devices Laboratory, led by Nick Holonyak Jr., are developing a new type of integrated circuit chip which uses photons instead of electrons to carry the signal through the semi-conductor chip. Holonyak is well known for developing the first red light-emitting diode (LED) and the red solid-state laser. His work with solid-state lasers still continues in Holonyak's present research.

Holonyak has been working with gallium arsenide (GaAs) and aluminum arsenide (AlAs) semiconductor lasers. When layers of GaAs and AlAs are fabricated one on top of the other, they form a heterojunction laser which emits light of 1.42 eV, which is in in the near infa-red region. Holonyak has been using 45 Å layers of GaAs sandwiched between 150 Å layers of AlAs, with one chip consisting of 40 of these layers. At these narrow widths, the quantum mechanic wave nature of the electrons becomes important.

Under normal conditions, the light emitted from a GaAs-AlAs laser is proportional to the energy difference between the electron energy levels in the GaAs and AlAs. When the widths of the GaAs layers are decreased, the wave nature of the electron affects the differences in electron energies. At very narrow widths, the electron has a wavelength equal to the width of the GaAs layer. Since the energy of an electron, $E_o = hc \div \lambda$ (h = Plank's constant, c = speed of light, λ = wavelength), the energy of an electron is increased by making the GaAs layers narrower. Increasing the energy of the electrons in the GaAs, causes the energy difference between electrons in the AlAs and the GaAs to decrease. This results in an emitted light with lower energy.

Fig. 1 **AlGaAs chip with GaAs-AlAs laser**

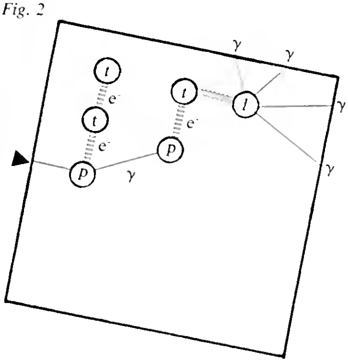


Usually, a GaAs-AlAs laser emits light of 1.42 eV. By making the layers of GaAs narrower, Holonyak has been able to make lasers with energies anywhere between 1.42 eV and 2.00 eV. The result is a wider range of available laser light. Semi-conductor lasers are very efficient and small. A quarter millimeter square semi-conductor laser can emit as much power as a three foot CO_2 laser. Because of their small size and efficiency, semi-conductor lasers are very usefull. Being able to create the wavelength of light required is a desirable quality in a laser.

Since semi-conductor lasers are small, a large number of them can be fabricated on one small piece of semi-conductor material. Holonyak's group fabricates their lasers by forming a crystal with 40 alternating layers of 45 Å thick GaAs and 150 Å thick AlAs. With these dimensions, the lasers emit light with an energy of 1.61 eV. Zinc is then introduced into the crystal except where the crystal has been protected by a mask. The small amount of zinc disturbs the uniformity of the layers of GaAs and AlAs so that a crystal of AlGaAs is formed with regions of the former GaAs-AlAs crystal lattice left untouched (Fig. 1). The result is many areas of GaAs-AlAs imbedded within a crystal of AlGaAs.

Since the GaAs-AlAs lasers are formed in a semi-conductor material, other kinds of semi-conductor devices can be formed in the AlGaAs along with the lasers. With the other devices present, the chip begins to look like an integrated circuit.

Fig. 2



(l) GaAs-AlAs laser
(t) Transistor or any other solid state device
(p) Photo-diode or similar device which changes the light signal into an electrical signal
optical waveguide
— conduction path
e⁻ signal is electronic
γ signal is a light wave

Depicted is a simple opto-electronic device. A light signal enters and travels down the optical path to a photodiode where the signal is split into an electrical signal and an optical signal. The electrical signal is sent to a transistor, while the light signal is transformed into an electrical signal, then back to a light signal by a laser. The resultant light signal is then sent to other devices.

Although they are still in the theoretical stage, these new chips will consist of lasers and transistors contained in one crystal. The lasers would be used to receive a signal coming into the chip and then send the signal to various parts of the chip through optical waveguides or fibers. Transistors in a section of the chip would be connected by conduction paths so that electrons would be used in these parts of the chip. When an electrical signal must be sent a sizeable distance to another section of the chip or to another chip entirely, the signal would be fed into one of the lasers and a light signal would be directed to the necessary place, where the light beam would be reconverted into an electrical signal. (Fig 2.)

The lasers would replace many of the ectrical connections in conventional ntegrated circuit chips. The reduced number of electrical contacts would mean a reduced susceptibility to electrical noise and interference. The lasers would be used to connect different kinds of chips to form larger circuits. Different chips could even be formed in layers on top of each other with the lasers connecting the signal to the different layers. This would enable circuitry which normally consists of many integrated circuit chips mounted on a circuit board to be formed in one layered opto-electronic chip with each layer doing the job of one of the conventional integrated chips. This kind of fabrication would lead to further miniaturization of electronic circuits.

The age of the opto-electronic chip is still at least 25 years away, predicts Holonyak. His group of researchers is still involved with exploring the properties of the GaAs-AlAs lasers so that opto-electronic chips may one day be fabricated. "Twenty-five years ago, we were working on putting a layer of metal-oxide on silicon," Holonyak said. "We didn't actually build the devices. That's the stage we're at now. We are developing the theory of these devices which will then allow other people to design circuits out of opto-electronic chips."

Holonyak further explained that his work was primarilly developing better GaAs-AlAs lasers, which is the heart of the opto-electronic chip. Some of their next experiments involve subjecting these lasers to pressures of over 10,000 atmospheres. High pressures exerted on the layers of GaAs and AlAs would cause the thickness of the material to vary, which would affect the wavelength of emitted light.

The opto-electronic chip is a promising innovation in electronics. Holonyak's group of researchers are just beginning to explore the building blocks of this chip. In time the opto-electronic chip will become as common in everyone's life as the electronic chip is now. All because of some research in solid-state lasers now going on in the University's Solid State Devices Laboratory.T

The Dispersion Analysis

Exhaust dispersion near a roadway is influenced by the turbulence and heat generated by moving vehicles. Findings at the General Motors Research Laboratories have provided a new understanding of the dispersion process.

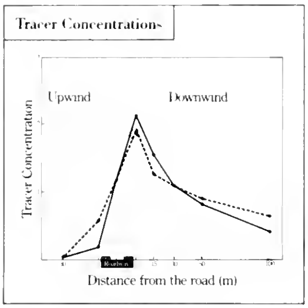


Figure 1 Observed (solid lines) and predicted (dashed lines) tracer concentrations near ground level as a function of distance from the edge of the road. Black lines indicate the case in which the wind is perpendicular to the road, gray lines, when the wind is nearly parallel to the road and opposing the upwind-lane traffic

Figure 2 This representation of a roadway viewed from above shows the location of large vortices formed by local wind shear when the wind opposes the upwind-lane traffic

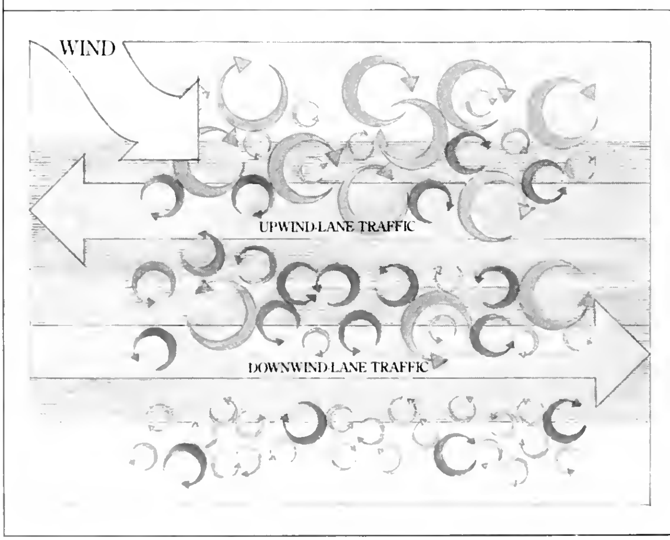
By USING the conservation-of-mass equation, one can describe the dispersion of gaseous molecules in the atmosphere. The equation includes terms for advection, diffusion, sources and sinks. Advection is the transport of air parcels by the mean wind; diffusion is due mainly to turbulent mixing. But the equation is useful only if we have information about the wind and temperature fields in the atmosphere. Specifically, our ability to predict vehicular exhaust concentrations near a road depends on knowledge of the effects of vehicles on these fields.

The conservation-of-mass equation for the mean concentration of any species, C, is

$$\underbrace{\frac{\partial C}{\partial t}}_{\text{Local rate of change}} + \underbrace{\sum_i \frac{\partial (U_i C)}{\partial x_i}}_{\text{Advection}} = \underbrace{\sum_{ij} \frac{\partial}{\partial x_i}\left(K_{ij}\frac{\partial C}{\partial x_j}\right)}_{\text{Diffusion}} + \underbrace{S_o}_{\text{Sources}} + \underbrace{S_i}_{\text{Sinks}}$$

where U_i is the mean wind velocity and K_{ij} is the eddy diffusivity tensor. This equation applies when the length scale of mixing is small compared to that of the variation of the mean concentration. Near a road, this condition is met if the averaging time for the concentration and wind velocity is much longer than the time interval of vehicular passage. For a straight roadway, a long averaging time allows one to assume spatial uniformity in the direction parallel to the road, and to ignore the spatial derivatives in that direction.

The input information for K_{ij} and the mean crossroad and vertical wind components near a roadway became available as a result of a large-scale experiment conducted by the General Motors Research Laboratories. The experiment has provided an understanding of the influence of moving vehicles on mechanical turbulence and buoyancy near a roadway. Dr. David Chock was responsible for the design of the experiment and the analysis of the data. The experiment, which duplicated a heavily traveled, level roadway, was conducted under meterological conditions minimizing dispersion.



Moving vehicles affect the mean crossroad and vertical wind components in the following ways. Vehicles act as an obstacle to the mean wind, causing it to slow and move upward as it approaches the vehicles and downward as it leaves the road. In addition, vehicles release heat, which causes a net upward motion. It was established that the increase in the mean vertical wind component due to the exhaust heat was (B/U), where U is the crossroad wind component.

The buoyancy flux, B, is proportional to the heat emission rate of the vehicles.

Moving vehicles also enhance both turbulence intensity and mixing. To determine how this modifies the eddy diffusivity tensor, K_{ij}, Dr. Chock invoked a "second-order closure" assumption, which relates eddy diffusivity to Reynolds stresses and the gradients of mean wind velocity and mean temperature. Eddy diffusivity was assumed to be the sum of ambient and traffic contributions. To determine the traffic contribution, the length scale of the traffic-induced turbulence was assumed to be comparable to vehicle height—1.5 m.

USING THE vast data base compiled during the experiment, Dr. Chock was able to specify K_{ij} and the mean crossroad and vertical wind components, and solve the equation numerically. To test the model, half-hour measurements of a tracer gas were used to map out experimentally the exhaust dispersion under various meteorological conditions. The case where the wind speed is low and the wind direction is nearly perpendicular to the roadway is represented by the black lines in Figure 1. Both the model and the experiment show the same dispersion pattern. The peak concentration is on the downwind roadside.

When the wind is nearly parallel to the road, the situation is much more complicated. Figure 2 shows that when the wind and traffic flow on the upwind lanes oppose each other, a high shear region occurs immediately upwind of the first traffic lane. When the wind and traffic are in the same direction, the high shear region occurs in the median of the road. In these high shear regions, large eddies are generated and turbulent mixing is intense. The gray lines in Figure 1 show a comparison of the model's predictions with the tracer data for the case illustrated by Figure 2. Notice that the peak concentration can actually occur on the upwind roadside, due to the exhaust transport by these large eddies. Dr. Chock's model is the first to predict this occurrence.

Under all combinations of wind speeds and directions, the predictions based on the model compare favorably with the measured tracer concentrations. There is little systematic bias with respect to wind direction.

"In light of this new model, exhaust dispersion near a roadway can now be predicted with reliability," says Dr. Chock. "This is of importance for environmentally sound road planning, and opens the door to the investigation of dispersion on city streets, where the presence of tall structures introduces even further complexity."

THE MAN BEHIND THE WORK

Dr. David Chock is a Senior Staff Research Scientist in the Environmental Science Department at the General Motors Research Laboratories.

Dr. Chock received his Ph.D. in Chemical Physics from the University of Chicago. His thesis concerned the quantum mechanics of molecules and molecular crystals. As a Postdoctoral Fellow at the Free University of Brussels, he did research work on the dynamics of critical phenomena. He did additional postdoctoral work in the fields of solid-state physics and fluid dynamics.

Dr. Chock joined the corporation in 1972. He is leader of the GM atmospheric modeling group. His current research interests include the phenomena of atmospheric transport and reactions, and the statistical study of time-series data.

A New Breed of Reactors

Nuclear fuel controversy burns from Tennessee to Washington.

by Laura Kasper

The Clinch River Breeder Reactor Plant Project (photo courtesy of Project Management Corp.)

For over twenty years the feasibility of a breeder reactor in the U.S. has been thoroughly researched, and the research has finally gone the way of production. As with every major issue, though, the thought of a reactor in Tennessee has raised quite a controversy.

The Clinch River Breeder Reactor Plant Project, in planning stages since 1972, will be the first breeder of its kind in commercial production in America if it receives Congressional approval. It will utilize plutonium-239 (Pu^{239}) and uranium-238 (U^{238})in a fission process that produces an excess of fuel.

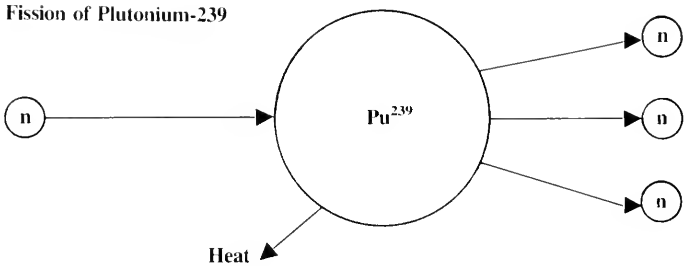
Plutonium-239 is the fissionable material. It collides with a neutron, which causes the plutonium to break apart and release a large quantity of energy in the form of heat. The heat is used to boil water and create steam that rotates the blades of a turbine. The axle of the turbine turns a generator that produces electricity.

The fission process also produces two to three neutrons. One of these keeps the chain reaction going, and the other one or two are absorbed by U-238, which becomes Pu-239. This brings the process back to step one, where Pu-239 was used as the initial fuel. The process has completed its cycle, and at the same time, it has provided energy for public use.

As planned, the Clinch River Plant will be a Liquid Metal Fast Breeder Reactor (LMFBR). This type of reactor utilizes a metal, in this case sodium, at temperatures above its melting point. "Fast" refers to the velocity of high energy neutrons as opposed to "thermal", which refers to the lower velocity of lower energy neutrons. Governments worldwide consider the LMFBR to be the most practical of all types of breeders. There are breeders in operation today such as the Phenix in France, the BN-350 in the U.S.S.R., and the PFR in the United Kingdom.

Although the research has been completed and parts such as steam generators have been contracted and built, the project is still having problems in Congress. Under the Nixon administration, the planning was begun, and the project

Shown is the fission reaction undergone by Plutonium when struck by a neutron. The process produces three neutrons, heat, and two fission products usually about half the mass of Plutonium.



would have been completed by late 1982 if the Carter administration hadn't been so vehemently opposed to its construction. As of this writing, Congress is split over the issue. It is quite likely that the project will be completed, however, due partially to President Reagan's pro-nuclear policies, and also to the support of Senator Howard Baker. According to plan, the Clinch River Plant will be located in Oak Ridge, Tennessee—in the state that Senator Baker represents. The plant will create 4,100 jobs at the height of construction, and about 240 employees will be needed while the plant is in operation. The 4,100 jobs would be an economic plus for Tennessee, thus Senator Baker wants the project for his state.

Critics of Clinch River have compiled a surprisingly large number of arguments against the completion of the plant. A Senate subcommittee has published a report detailing many of its major criticisms entitled "A Cost and Technical Fiasco". The three main arguments cited in the report are financial abuse, safety quirks, and the effects of obsolescence in a project of this size.

The project was originally financed at $669 million, but due to delays and what the committeemen refer to as financial abuse, it now carries a price tag of $3.2 billion. There have been legal problems having to do with contracts that are unclear and incomplete; there are some contracts that are lacking in technical specifications. Labor costs, along with the costs of several delays have turned a $5 million steam generator into a $71 million project.

Although the people in charge of Clinch River claim to have everything under control, the coolant used in the reactor has become a controversy. The liquid sodium used for heat transfer is highly volatile.

Another safety problem concerns the use of plutonium as an energy source. Critics are worried about using plutonium due to the high security risk. They imagine terrorists infiltrating the Clinch River plant and stealing plutonium to produce nuclear bombs. Also, this fear will add to the breeder's price tag in the form of more elaborate security systems.

The obsolescence angle is another worry. Though Clinch River would be a first for the U.S., breeder reactors already in existence in foreign countries are more innovative and technologically advanced than the one which still lies on U.S. drawing boards. The subcommittee members argue that Clinch River would be a waste of money and time if it turns out to be obsolete prior to its existence.

Proponents of Clinch River have counter-arguments for all of the preceeding points. They claim that the overall price has been increased due to stalling on the part of Congress. When the project was started in 1972, it would have cost much less than today's projected cost. As far as safety is concerned, this is not the first, nor will it be the last instance where engineers will work with and benefit from the properties of hazardous materials such as sodium and plutonium. The toxicology of both elements has been well researched.

Much has been done to inform the public of the importance of breeder reactors. The U.S. Department of Energy has been in charge of managing the Clinch River Project; other day-to-day management duties are handled by the Tennessee Valley Authority, Commonwealth Edison Company, and Project Management Corporation. The Project Management Corporation was organized especially for the Clinch River project. These companies have all put money into the project; their latest public relations campaign was a display at the 1982 World's Fair in Knoxville that featured a full-scale mock reactor core along with a computer game explaining the details of the plant.

Some of the economical details of the plant's function include a breeder's relatively low cost in the long run. Not only does it produce more fuel than it uses, but U^{238}, used in a breeder with a neutron to create Pu^{239}, is virtually useless in its present state. The conversion to plutonium fuel enables efficient utilization of existing stockpiles of U^{238}, which presently consists of over 280,000 short tons. If used in a breeder, that much uranium would have a potential energy equal to 2,400 billion barrels of oil. Theoretically, no more uranium would have to be mined for several centuries. Clinch River is the U.S.'s first step toward relying on nuclear power in massive quantities.

Clinch River will have the capacity of generating 375 megawatts of electric and operate under the Tennessee Valley Authority System. The breeder has been referred to as a "stepping stone to a 1200 megawatt plant". It is a basic, logical step in research and development to build a plant of this size. Also, the project is 86% complete, waiting only for a license from the government. If the plan is halted at this stage, over a billion dollars in equipment and technology would be lost.

Now it is up to Congress to decide whether Oak Ridge, Tennessee, gains a nuclear breeder reactor or a $1.2 billion pile of scrap metal and ore.T

text and photos by Randy Stukenberg

Liberty Bowl Bound

The Fighting Illini finished regular season play with a 7-4 record, qualifying them for a Liberty Bowl bid, which will be played on December 28. This will be the Illini's first bowl game appearance since the Rose Bowl in 1963. Quarterback Tony Eason and kicker Mike Bass broke several NCAA and Big Ten passing and kicking records. Next year . . . ? Rose Bowl, Rose Bowl, Ooh Ah.

Industry and Education

Bonding business and education is a sticky situation.

by Joe Culkar

Unknown to many people here at the university, the Governor's Task Force on High Technology has been working on making recommendations on how the state can attract high-tech industries. The Task Force submitted its ten page report to Governor Thompson in March. The Task Force, which included presidents from four universities in Illinois and an impressive list of business leaders, presented an outline for the attraction and "nurturing" of companies within the state based on new and emerging technologies. Recommendations include establishing, in the appropriate areas, centers of technical excellence that will draw upon the work being done at a nearby university, as well as special incentives, such as loans and industrial revenue bonds. All in all, the Task Force suggested a "...comprehensive long range plan...".

The plan, or a part of it, has already been put into action. On August 24, 1982 the state and the University of Illinois Circle Campus announced the formation of a research park in Chicago. The park is to be located on or near the UICC campus with the specific task of fostering research and development in biomedicine and biomedical applications. On October 29, the state and the University of Illinois—Urbana/Champaign announced a plan for the creation of a microelectronics center on campus. The $8.25 million plan is to begin in July of next year and will be completed in 1985.

The announced center, to be one of four in the nation, is to be a main focus of university research. The major element of the center will be an electron beam lithography facility for the production of very large scale integrated circuits, the prime component in today's sophisticated computers. The microelectronics center is certain to be a magnet for people, attracting top researchers, students, and industries to the area as did the Illiac IV computer project and as the Plato project still does.

The microelectronics center is a small but important part of the "bait" used to attract industry to the area. More important is the area's busines climate. Changes must be made during the next several years if industries are to seriously consider the Champaign/Urbana area as a home.

To date, there has been no announcement of a research park in the area. This is one of the more important recommendations made by the Task Force. Without a state aided site or the necessary special financing, there is virtually no place for a new company with limited capital to locate. Interstate Research Park is the most likely sight for a new company. The park,located at I-74 and Mattis in Champaign, now contains many businesses, including the Army's Construction Engineering Research Laboratory, Carroll Touch Technology, and Tower Hobbies. The costs, however, are high. With land selling for about $50,000 per acre, a sight with a building and reasonable room for expansion costs about $1 million. Granted, not all new companies need to start with such a facility, but compare it with Stanford University's policy of giving land to new companies. This is one of the many reasons for the growth of technical companies in the areas surrounding Stanford University—someone gave them help at the start.

This University, with its renowned faculty and high quality students, is a high caliber institution. This can be seen in part through the number of research grants and through past University projects like Illiac IV and the ever-evolving Plato system. It has been a while, though, since a major, well-known project has been announced. It is these projects that attract talented people to this area. It is also through these projects that people receive invaluable non-scientific training.

There is a link between the lack of new high-tech industry in town and the

Far Left. High Technology organizations have already begun to come to the Champaign area. This Construction Engineering Research Center is located in an industrial park located on Mattis Avenue near Interstate 57.
Left: The Water Resources Laboratory will be moved to Adler Center, a former home for mentally retarded citizens.(photos by Randy Stukenberg)
Below: The new Microelectronics Research Lab will be located in the Water Resourses Building on the corner of Springfield Avenue and Wright Street. (photo by Steve Alexander)

absence of a major project at the University. This stems from what is learned here at the University in the college of engineering. The University is a major research institution and as such isn't concerned with familiarizing researchers with the operations within a company. Professors and graduate students work within relatively small groups, each person with their own focus or interest. In contrast, the Illiac IV project brought together many people, from the project manager to the technicians. Each person worked on a different aspect of the same project. The job of coordinating the work of the scientists and others isn't something which is likely to be learned within today's engineering curriculum. All this knowledge and more is needed to run any major project.

The Illiac IV project provided Art Carroll with additional experience in these important areas. Mr. Carroll, president and founder of Carroll Touch Technology in Champaign, worked for two and a half years as Deputy Chief Investigator (second in command) on the Illiac IV computer project. After working for several years in the electronics industry, Mr. Carroll came to the University to work on the Illiac IV project. His responsibilities included the supervision of over 100 technical personnel, overseeing project finances and subcontractors, and various technical tasks. After the project was completed, Mr. Carroll went on to found several successful local companies using the technology and, more significantly, the experience he gained from working on the project.

The Illiac IV project also provided skilled jobs for local residents. These jobs and the skills developed by the project team members play an important role in attracting industry to this area. An area such as this can appear to have all the essentials desired by a company: a university, inexpensive land, and a helpfull local governvent. But if there is no skilled labor in the area, forget it. It is expensive to relocate workers and time-consuming as well as expensive to train them. Industry is naturally attracted to those areas that already have a large, well-trained work force.

Attracting industry is not an "overnight" operation. It is going to take years. The work force needs time to expand, and various support industries, such as metal fabrication and printed circuit board manufacturing, need to gain a foothold in the area. It is also not simply a matter of expanding existing facilities. The University, the state, the Champaign and Urbana governments and the residents are going to have to work together on the "long term plan" mentioned in the Task Force's report.

It is step forward that the State has decided to help build a microelectronics facility here on campus. It is also progressive that they are going to use existing buildings in order to save time and money. But what about working on a state research park? The Task Force submitted its report eight months ago and the first steps were taken in August toward its implementation. The planning of the microelectronics center should not slow the efforts to establish a research park or work on any other of the Task Force's recommendations anywhere within the State, but should serve to rekindle interest.T

New Solutions to a Miner Problem

To the Editor:

Concerning Tech Teaser 1 (Nov. 1982), why do you need 7 weighings? It seems much easier to use only 3!

(1) Put the 3 and 7 kg weights in the same pan and weigh 10 kg of gold (note the weights aren't even necessary as one can divide the 20 kg into two 10 kg portions in the first weighing).

(2 & 3) Divide the two 10 kg portions into 4-5 kg portions.

Have I missed something?

Mike Binder,
Associate Professor,
Mechanical Engineering

To the Editor:

When creating the solution to the first Tech Teaser of your November issue, you certainly outdid yourselves. Although the miner may require seven weighings to apportion his 20 kilograms of gold evenly among his four children, I suggest that any engineer worthy of his pocket protector could handily distribute the wealth in no more than three weighings and without using the weights.

Sincerely,
Dave Fathauer

Indeed, the easiest solution is 3 weighings without the weights. In the words of one of my former professors, "I was just testing you." Good to know you are all awake!—Features Editor

Illinois Technograph invites letters in response to its articles and editorials, or any other item of interest to our readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.

by Langdon Alger

Bucks for Brains

Just a quick note that may be of interest to all, as it points to the apparent importance of a technical education. Governor Thompson has outlined a program that will provide assistance to "low-income youths" who want to be trained in some form of high technology—via scholarships. The program is being carried out by the Department of Commerce and Community Affairs (DCCA) in ten areas of Illinois. Thompson has allocated $300,000 between the DCCA and the Community Service Block Grant funds.

This is how it will work: the money will be given to community college students who are fiscally disadvantaged and interested in computer science, engineering, electronics, and medicine (medicine is now considered high-tech). These students will be awarded maximum scholarships of $1000 per year. The students in the 10 areas of Illinois in which the DCCA is implementing this program will receive their shares of the $300,000 from now through August 1983, and a statewide program will take over from then on.

Thanks, Evans & Sutherland

The University of Illinois is one of the fourteen universities across the country that will receive a PS 300 Computer Graphics Systems from Evans & Sutherland Computer Corporation. Seventeen other universities have already received the donations.

The U. of I. is receiving the generous gift because the school is involved in applying state-of-the-art computer graphics to several different education and research fields. Like the UIUC, all the other schools are applying these computer skills to the areas of Chemistry, Mechanical Engineering, Computer Science, and Geophysics.

Evans & Sutherland's business is special purpose computers used for graphics, and their PS 300 system is the first in its family of new graphics display systems. The system has the capabilities of real-time, three dimensional imaging without large computer intervention. Evans & Sutherland's products currently appear in some pilot training simulators, and plenty of them are being used for engineering, research, and design applications.

Gillies Lectures

This is the year for the seventh annual Gillies lectures, and the speaker will be Professor Arthur Burks, from the University of Michigan.

The lectureship was endowed through the University of Illinois Foundation, which was given a generous contribution from the Digital Equipment Corporation for the honor. It serves as a memorial for Donald B. Gillies, who passed on in 1975 after serving as a computer science faculty member here at the College for nineteen years.

Burks is a professor in both Philosophy and Computer & Communication Sciences at Michigan. He helped to develop the logistics of an electronic digital computer in the late '40s at Princeton's Institute for Advanced Study, and the design eventually became the model for modern-day computers. Burks has also been awarded quite a few honors, including the Louis Levy gold medal of the Franklin Institute, an honorary doctorate from DePauw, and the Russel lectureship at the U. of M.; the latter is the highest honor a senior faculty member can receive at that school.

Professor Burks will arrive in February to lecture and work with the computer science students and faculty.

Super Center

Governor Thompson is showing more interest in building up Illinois' high technology rating, and he's starting with th[e] school. He announced that Illinois will use 5.25 million dollars over the next three years to establish the University's Microelectronics Center.

This is the second cooperative project from the Task Force on High Technology, the first being the biomedical research park in Chicago's West Medical Center. The Task Force is trying to group together high technology research and private industries to make Illinois a high-tech center, and all of the Task Force's projects are supported by Thompson's administration.

It is up to the University to obtain three million dollars from private sources to buy the equipment for the center. About two-thirds of those funds will go to the development of an electronic beam lithography installation, which is used to make integrated circuits. The UIUC will be one of four schools across the entire country that will have the same capability as the Microelectronics Center.

This whole thing is just one more of the many that puts this school into the ranks of a landmark.

NSBE Regional Conference

On the weekend of November 12-14, Region IV of the National Society of Black Engineers held its 1982 regional conference at the Americana Congress hotel in Chicago. In attendence were six representatives from the University of Illinois Chapter.

The primary purpose of NSBE is to encourage blacks to pursue careers in engineering. To fufill its goal, the society sponsors scholarships, problem-solving competitions, and social events on both the collegiate and high school levels. Since its inception in the early seventies, NSBE has planted chapters at over one hundred universities throughout the United States.

At the conference, several events ccured at once. There were seminars and discussions at which decisions were made about the growth and structure of the gion. There was also a job fair, at which dents could discuss internship opportunities. While the seminars and job fair were in progress, students from several Chicago area high schools competed in a technical quiz contest, in which they were required to solve several science and math related problems (Tech-Teaser number two was one of the competition problems).

Although much of the weekend was spent in a business atmosphere, there was some time for the conference participants to get to know one another. As one Illinois representative put it, "The conference was enjoyable, but it was productive as well. At the end, there was a definite feeling of accomplishment."

Todd Barrowclift, senior in biomechanics, employes an overhead single frame projector and computer located in the Biomechanics Research Laboratory. He is analyzing how gait patterns change in walking with no shoes to tennis shoes to high heels.

Making Future Leaders

The sixth annual Engineering Student Leadership Conference took place on November 13, and it was quite a success. The program began at 8:30 in the morning, continuing on through 3:30 that afternoon. Everyone who attended felt that it was a worthwhile experience.

Once the participants had registered for the day's activities, Associate Dean of Engineering Howard Wakeland, Engineering Council President George Mejicano, and Engineering Council Personnel Vice President Donna Fritzsche combined their efforts to deliver a rousing introduction. Afterwards, seven workshops were conducted, each exploring a different phase of the leadership enigma.

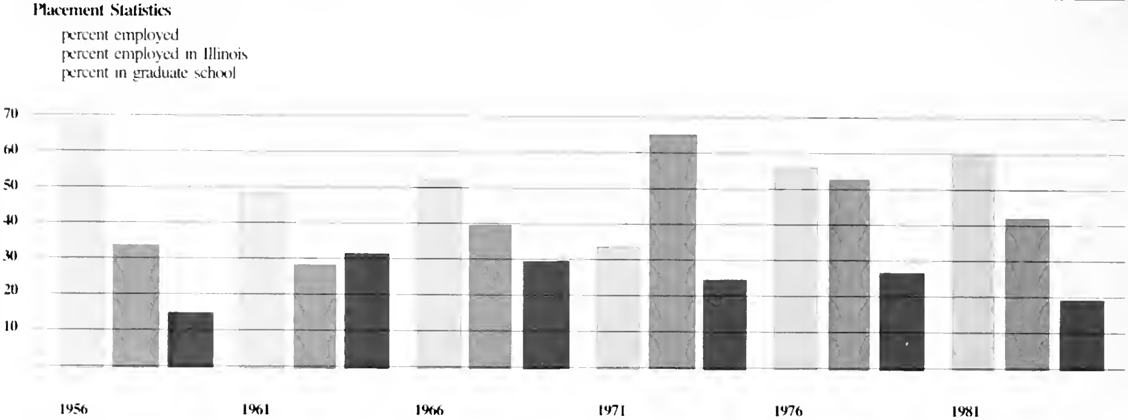
Professor Jackson, professor emeritus in psychology, held the first general workshop, called "Knowing Yourself," in which he discussed how a person can measure himself against his abilities. Jim Trail gave a concurrent talk on "Delegating Authority" during the second session, as did Hugh Satterlee on "Communications," and Jim Pracher on "Planning an Event." During the third session, Stuart Lerner and Associate Professor of Mechanical Engineering, David Offner gave concurrent sessions on "Types of Leaders" and "Brainstorming." Toby Kahr ended the day with a general session, "Evaluations," where he discussed the evaluation process as seen by the manager.

This year's conference continued in the tradition that has been set for the past five years; those who attended left with new knowledge about the field of management in general. With the latest statistics showing that by 1990, 50% of all management personnel will have technical backgrounds, it is good to know that such leadership conferences are being offered to engineering students at such an early point in their careers.

Engineers and the Recession

Jobs are not as plentiful as they used to be.

by Jim O'Hagan



With the increasing emphasis on high technology industry in the United States economy, the need for engineers to plan, design, and implement new systems and machinery has become great. This is reflected not only by the steadily increasing starting salaries offered to graduating engineers, but also by the heavy emphasis placed upon technical know-how by the nation's top corporations and government agencies. Nevertheless, post-graduation employment is by no means certain, even for graduates in this vital field.

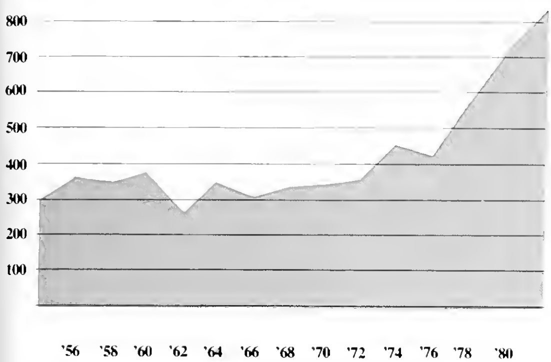
While unemployment nationwide hovers around 10 percent as the United States finds itself plunged into it's worst business slump since World War II, even the traditionally economy-proof engineering field is feeling backlash. And so are graduating students. Major companies such as Xerox, Atlantic-Richfield, and Ford have slashed hiring by 20 to 25 percent since one year ago.

"This time is the worst job market in a decade," said David R. Opperman, Director of Placement for the University of Illinois College of Engineering. Job offers are fewer and the increase in salaries is smaller than the past couple of years.

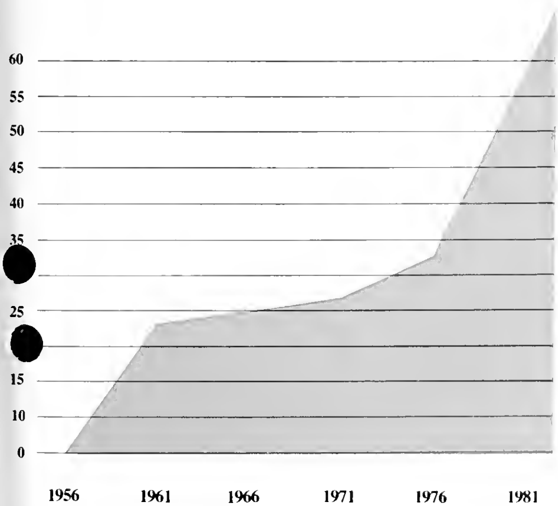
"Last fall was the most active (more companies talked to students) of any fall in the last decade," explained Opperman. "This took place at a time when the job market was decreasing rapidly, however." As a result, their plans didn't result in the same action, and job offers declined 35 percent below the levels of the previous year.

"By spring," Opperman continued, "they (the companies) were beginning to see the recession was for real. There was decreased action over the last year and job offers continued to come in 35 percent slower than the spring before."

Number of May Graduates
Bachelor of Science in Engineering



Increase of Average Salary
(in percent)



Now that the economy is mired in a deep recession, job offers continue to lag behind levels of past years. The number of companies talking to students has declined, although it is still too early to determine the number of job offers for fall engineering graduates. "This fall is not as active as last," explained Opperman. "Action is 33 percent below last fall." Of the hundreds of job offers received each year, only 31 have been recorded to date, as opposed to 52 a year ago. Opperman is quick to point out however, that "It is really too early to say much about the offers. I'm not expecting this fall to be worse than last fall or last spring."

Job offers are expected to keep up with last year's levels because while companies hire fewer graduates, they also visit fewer schools. As a result, the number of job offers per student interviewed remains essentially the same. In fact, some companies, such as Johnson and Johnson, have found they are free to be more selective in their hiring practices because other companies are cutting back.

The long-awaited economic recovery now forecasted by many analysts should benefit job-seekers graduating next spring. "This fall I see a bottoming out. Offers should increase by the spring semester," predicted Opperman. Indeed, 310 companies have already reserved dates to conduct interviews for the spring semester; roughly one company for every three graduates. This number can go up even further notes Opperman. "It is entirely possible because companies haven't reserved dates and if the economy begins to recover they will be reserving dates then."

Once the country pulls out of its current economic difficulties, the demand for engineers is likely to climb again. *Fortune* magazine recently reported that the demand for new engineers is likely to grow at a rate of 10 percent due to the shortage of trained engineers currently in the market. Although larger corporations can be satisfied with physicists or draftsmen who can do engineering work, smaller, less diverse

Continued

companies are hurting. Once a stronger economy frees these businesses to hire qualified personnel, the demand for engineers will rise again.

This shortage of engineers has even prompted a number of economic models to forecast the direction of this engineering demand in the years to come. The American Association of Engineering Societies (AAES), with the help of the National Science Foundation, is preparing a mathematical model that will predict the number and distribution of engineering graduates for the next ten years, reports *Chemical and Engineering News*. The value of such predictions is great in that they will aid schools and employers in planning for the arrival of upcoming graduates. In fact, the American Electronics Association forecasts that 15,000 electrical and computer engineers will graduate in 1985 for a market in need of 51,000 engineers.

The demand for engineers has resulted in a rise in starting salaries. "Generally speaking, there are bigger influences on supply and demand although wages are a function of each," explains Opperman. Since 1956, wages decreased only in 1972, a low point in recruiting. "This time, in the worst job market in a decade, I still see a slight increase," Opperman predicted, although he cautioned this increase would not approach the double-digit percentages of recent years.

Because of the drop in interviewing companies this year, changes in the college placement system were developed to aid employment-seeking graduates. Because non-interviewing companies obviously had no job openings, interviews had to be increased in other ways. This was accomplished by granting more interviews to students graduating in this semester than previous years had seen, with fewer interviews scheduled for next semester's graduates. As a result, fall graduates had a better opportunity to find jobs immediately after graduation.

Because of the large number of jobs available to engineering graduates in the past, other difficulties have arisen. With wages rising at double-digit rates, more graduates are choosing to enter the work force rather than attend graduate school and earn advanced degrees. This results in fewer engineers qualified to teach, and thus, increased competition for professors. This has hindered state universities in particular. Unable to compete with wages offered in the job market or by private institutions, many schools have had to delay hiring plans.

Since 1975, the percentage of graduates choosing to attend graduate school from the University of Illinois has dropped from 32.6 percent to only 20.4 percent last year, while the number of undergraduates has nearly doubled. This decrease reflects not only the strong job market for engineers over the past few years, but the difficulties in recruiting felt by top graduate engineering schools. *Fortune* recently reported similar statistics. Although the number of engineering undergraduates has doubled in the last 10 years, the number of American Ph.D.s graduating who are qualified to teach these students has actually declined from about 3,000 to 1,800. As a result, classrooms are more crowded, and students at some schools are being told they should expect to wait five years before graduating so they can find room in required courses.

The reason behind both of these trends is the high salaries offered by large businesses. While graduating engineers with merely a B.S. degree find starting salaries in business hovering near $22,000, salaries for professors for the nine-month year are little higher. A survey by The American Council on Education noted that over 10 percent of engineering-faculty positions of U.S. engineering schools were vacant in 1980. Although most professors can make additional wages by advising businesses or doing summer work, the corporate job market remains attractive.

One advantage of teaching has traditionally been the increased oportunity for research. No longer is this the case as many businesses, realizing the threat from foreign competitors, are originating new research departments to preserve their technological edge.

Despite the changing conditions under which today's graduating engineers seek employment, the skills and attributes sought by recruiters remain essentially the same. Although specific types of jobs may call for specialized training in a given field, recruiters are basically searching for employees with high grades in their technical classes. "I don't think many recruiters look at electives," explained Opperman. "Instead they're looking for academic performance, leadership potential, and previous engineering experience. Some recruiters might look for extra-technical background, but for the most part class performance is important. Specific jobs are different."

Success in college along with experience in the field can help hopeful graduates find work. Coupled with the efforts of college placement offices and an upswing in the economy, the attributes of today's graduates will reverse the downswing in job offerings not only to their benefit, but to the benefit of the expanding businesses for which they will work. T

A Monopoly on Life

A new frontier of science allows scientists to design and manufacture life.

by Charley Kline

It's a little like getting in on the act of creation itself. Using a biochemical technique known as recombinant DNA synthesis, it is possible to modify the activities of living organisms in order to serve a particular function with a new branch of science called genetic engineering.

To understand how the operation of a living creature can be changed, let us first examine the mechanics by which an organism performs its assigned duty. Within every cell's nucleus is a set of chromosomes—a string of genes unique to the organism. Each gene is a coiled strand of DNA (deoxyribonucleic acid), which forms the genetic material of the cell.

The structure of the DNA molecule, the famed "double helix" proposed by James Watson and Francis Krick in 1953, is what makes it ideal as a carrier of the genetic code. DNA can be visualized as a spiral ladder, with the uprights formed of alternating sugar and phosphate groups. The rungs of the ladder are formed of four organic bases: adenine (A), guanine (G), cytosine (C), and thymine (T). Adenine and thymine form a strong chemical bond when located opposite each other on the chain. Similarly, cytosine and guanine form especially strong bonds.

This means that the two strands in a DNA molecule are complementary: rungs are formed of the four compounds in any of four combinations: AT, TA, CG, or GC. By reading the code along one side of the chain, say . . . ATGCACGTCG. . . , the genetic makeup of the cell is determined.

Now, the genetic code is used by the cell to build protein molecules. Protein molecules are composed, like a train of railroad cars, of building blocks called amino acids. There are 22 amino acids, and since there may be many thousands of amino acid groups in any given protein molecule, the possible number of proteins is virtually infinite. Each cell has its own set of proteins which it uses to perform its job—a cell in the human adrenal gland, for example, builds proteins of adrenal hormones, while an invading strep bacterium produces proteins which are toxic to human cells. Each cell must also produce proteins to give itself energy, to reproduce its own substance, and to defend against bacterial invaders.

Each protein a cell produces is manufactured from a particular segment of the genetic code. A blueprint, if you please, of the protein is stored in the DNA of the nucleus as follows: Every amino acid is represented in the DNA as a group of three ladder rungs. Each such group of three is called a *codon*. The amino acid valine, for example, may have AAG as a codon. Certain codons are reserved as *stop codes*, to signal the boundaries between protein blueprints in the DNA.

Consider, then: by appropriately adding or changing portions of the genetic code in the DNA of a cell, the cell can theoretically be made to manufacture any protein, or to perform any function. This is the concept of genetic engineering. Through the careful manipulation and splicing of the DNA genetic code in the nucleus of a cell, the cell's function can be altered to suit man. And, since the cell is still alive and still reproduces, once one of these organisms is manufactured, it makes copies of itself and need only be grown in a medium and distributed to customers.

How does one go about altering the genetic code of a cell? One way is to let the organisms do it themselves. Recently, a strain of bacteria has been made to consume otherwise non-biodegradable chemical waste. Normal bacteria were first allowed to multiply in a nutrient solution. Then the nutrient concentration was decreased while introducing small amounts of the waste compound. Through natural differences in the genetic makeup of the individual bacteria, and through cooperative conjugation, some of the bacteria in the solution were able to survive the change in environment. They were then allowed to grow until their numbers equaled the original colony size.

The process was repeated, with successively decreasing amounts of food and increasing amounts of chemical waste, until finally the bacteria found themselves subsisting only on the chemical waste product with no other food around. Through environmental manipulation, a new strain of bacteria was artificially *evolved* to serve a certain purpose.

Another method of artificially creating new organisms is to splice new genes into the organism's chromosomes in the laboratory. This method receives most of the media attention since it is more sensational. Suppose a pharmaceutical company decides to make an organism which will produce human growth hormone (HGH), an otherwise very expensive compound obtainable only from the pituitary glands of human cadavers.

The first step is to isolate the gene in the cells of the human body responsible for producing HGH (since each cell in an organism contains the genetic makeup for all cells in the organism, no matter how specialized, the genes can be obtained from, say, skin scrapings, and not necessarily from the pituitary gland itself). This is an arduous task which involves analysis of the HGH protein and of the human genetic code itself. Once the proper gene has been isolated, it is extracted from the DNA molecule using enzymes which cleave the DNA into pieces at the proper stop codes.

Continued

Then an appropriate bacterial strain is selected to receive the HGH-producing DNA segment. Bacteria are used because their genetic code is far simpler than that of humans, and the job of splicing the DNA is consequently easier. Often, the strain *E. Coli*, the bacteria present in human intestines, is used, since it is easily obtained and has been studied extensively. Also through the use of enzymes, the foreign DNA is spliced into the genetic code of one bacterium. The bacterium is then placed in an incubator and allowed to reproduce.

After large colonies of the new strain of bacteria have been produced, all that needs to be done is to tap off the HGH that they have been producing due to the genetic implant, purify it, and release it to hospitals. All the real work is now done; the company can simply let their newly manufactured organisms make the drug and watch the profits roll in.

Organisms artificially altered in the laboratory to date include a strain of bacteria to break down ocean oil spills into harmless soluble compounds, and cells to produce human insulin. The companies which did the research work to produce the new life have obtained patent rights on their products. The supreme court ruled that life itself, if presented in the form of an original product, is eligible for a patent. Although this would seem to have little impact on strains of bacteria, current research is leading towards recombinant DNA synthesis of higher organisms, and the critics fear that the thought of a monopoly on higher life forms is too frightening to allow research to continue.

Another area of criticism is that of safety. Like any expanding frontier of science, recombinant DNA research is highly experimental. Sometimes mistakes are made, and the resulting organisms may not perform the desired function. Normally, the products of such errors are destroyed. However, if such an organism were to be carried free of the controlled laboratory environment (remember that only one need escape, since bacteria reproduce by division, and that these bacteria cannot be seen with the naked eye), it could find its way into the outside world, and there could have unpredictable effects. It could, for example, cause an unfamiliar disease in humans, or consume a scarce resource.

The scientific community has enforced strict laboratory isolation rules on itself in the area of recombinant DNA research. It insists that such a danger is minimal, and that the current uproar is unwarranted. At a biological convention, government standards were set for laboratories involved in such projects. In more recent action, however, the stringent rules were relaxed slightly, in view of the greater understanding and control biologists are achieving over their experiments.

The ability to alter life to suit man smacks of science fiction, and there are many possible consequences of the current research, such as strange new diseases and patents on life, which seem to come out of a fantasy novel. But, like any other advancing field, it can be expected to be met with criticism. The mass production of critical compounds such as insulin, Human Clotting Factor VIII (used in treating hemophiliacs), and interferon is a great accomplishment for our science. And since this research helps to solve other biological mysteries such as the causes of cancer, perhaps genetic engineering is worth our applause and respect as a true server of mankind.T

Tech Teasers Answers

From page 4

1. 94,857,312 × 6 = 569,143,872.

2. She found a cubic box with one meter edges. Then she placed the skis along the diagonal that connects opposite corners of the box. It can be shown algebraically that the length of this diagonal is exactly equal to the square root of three, which is greater than 1.7 m (or 170 cm, the length of her skis).

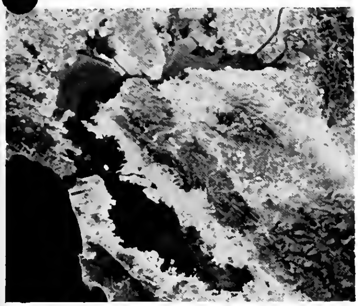
3. The smallest number is 35,641,667,749. Another number is 46,895,573,610 or any multiple thereof.

4. The new calendar was adopted in 1752, so there are no years where this happened before then. The times it occurred were the years of 1764, 1792, 1804, 1832, 1860, 1888, 1928, and 1956. If we go past 1982, the years of 1984 and 2012 are also blessed with the phenomenon. So the answer is 1888, the last year before 1928, and 1956, the first year after 1928.

5. There are 35 triangles in the figure.

TECHNOVATIONS

by Langdon Alger



Here is San Francisco as seen fom 500 miles above. This picture was taken by General Electric's Landsat 1 satellite

EnGulfing Land

Spirolite is a special kind of lightweight plastic pipe that remains malleable when heated. It is produced in diameters from ten feet to eighteen inches, and is practically non-corrosive and unbreakable. It weighs a tenth as much as concrete piping, and a sixth as much as iron piping. With credentials like those, you can imagine it must have a use in the oil business.

Indeed, the high-density polyethylene piping is going to be produced in Gulf Oil Chemicals Company's (GOCHEM) new plant in Waxahachie, Texas. GOCHEM purchased the land in September, and the plant should be finished in the fall of 1983.

Part of the reason this plant is being built is because the pipe is so economical. Spirolite's lightweight structure means that it can be installed much less expensively than either of its iron or concrete counterparts. It also has an infiltration-free linkage system which makes for lower maintenance costs. Spirolite was introduced in the U.S. in [illegible]9, and has been gaining popularity in various sewer and water systems ever since. It has been around outside the country for 20 years, and will no doubt continue its long success internationally.

Only You Can Prevent Fires

It tends to be difficult to imagine how a company's product can feasibly be "two decades ahead of its time," but Pyrotronics' XL3 Advanced Protection System definitely seems to surpass any state-of-the-art fire alarm system. This package intertwines three separate systems: fire/smoke/heat detection, supervision, and alarm control.

The system consists of two parts: a main control panel and the satellite systems. The control panel keeps tabs on all the satellites, continually checking them to be sure they are functioning. It will also tell you if any one of the satellites are in alarm condition or out of order, displaying its number on the control panel. The satellites can be any one of a number of different types of equipment, but most of the time they are the detectors. They utilize photoelectric, ionization, and contact devices to identify the presence of a hazard. The satellites can also be external horns or bells, or extinguishing systems.

The system will tell you when any of the detectors have found a hazard, or when one of them is installed incorrectly. The system will stay in control when only a few of the detectors go into alarm condition, will tell you where the detectors are, and what kind of emergency exists. You can set the detector sensitivities, test them, and output performance reports. You can even make use of special options, such as timers that will pause before discharging extinguishers for health and safety sake.

Another Bright Idea

Many new products are hitting the market, but every once in a while there is one that outshines all the others. Such is the case with this simple, ordinary, not highly technical innovation. It is called Redilite, from a company in California called The Idea Works, and it is the greatest help in the dark since the lighted pen.

The Redilite (under $3) is installed in a drawer or cabinet with the double-faced sticky tape that comes with it. Once it is installed correctly, it turns on whenever you open the door or drawer. It has a rolling two-way switch that causes this to happen, and it operates on two AA batteries. The light it gives off is bright enough to light the entire drawer, cabinet, or wherever it's put. Just think of the possibilities. . . use it in the car's glove compartment, in an underwear drawer, in workshop storage compartments, the refrigerator, and anywhere else imaginable.

Dump it on Somebody Else

A computer which disengages while hard-copying can be quite a problem. Quadram Corporation, based in Atlanta, Georgia, has a solution that makes tons of sense.

Microfazer is its name, and it is a printer buffer. It simply consists of a small box, and it stacks well with other peripherals like modems. All the user has to do is dump the data to be printed into the Microfazer, which accepts it as fast as the computer dishes it out. Then the buffer takes over, dumping its data onto the printer, freeing the computer for use again. This can more than double the efficiency of word processing systems, and triple the efficiency of graphics systems.

This printer buffer has at least 8000 bytes of memory, and depending upon what model you purchase, or how much memory you add through plug-in memory interface cards, you can get up to 512K bytes—the upper limit of expansion for the new IBM personal computer. This is the first printer buffer that comes with up to a half-megabyte of memory, which is equivalent to about 250 typewritten pages. The original models were usable only with a parallel computer and a parallel printer, but the new line also has units compatable with serial-serial, serial-parallel, and parallel-serial systems. Thus the Microfazer can be added to any system on the market. The price of the Microfazer varies depending on memory and model, starting at $169, and continuing on up to $1395.

Fellowship Story.

In 1949, Hughes awarded its first fellowship. Since then, more than 4,000 men and women have earned advanced degrees in engineering and science with the help of Hughes fellowships — advanced degrees to prepare the men and women of today to meet tomorrow's technical challenges.

Hughes Aircraft Company will again offer more than 100 new fellowships in the coming year for graduate study in:

- **Engineering (Electrical, Mechanical, Systems, Aeronautical)**
- **Computer Science**
- **Applied Math**
- **Physics**

Just a few months from now, you could be working on your Master's, Engineer, or PhD degree — and receiving from Hughes:

- **Tuition, books, and fees**
- **Educational stipend**
- **Full employee benefits**
- **Professional-level salary**
- **Summer employment**
- **Technical experience**

Total Value: $18,000 to $40,000 a year

As a Hughes Fellow, you will gain valuable technical experience working summers at Hughes in Southern California or Tucson, Arizona. Work Study Fellows study at a nearby university while working part-time at Hughes.

Full Study Fellows work at Hughes in the summer and study full-time during the regular academic year.

The range of technical assignments available includes the option of the Engineering Rotation Program to diversify your work experience.

Fellowship Story. An invitation to advance your education and your career — with assistance from a company that is advancing the frontiers of technology. Write yourself in.

Fill out and mail the coupon, or write to: Hughes Aircraft Company, Corporate Fellowship Office, Dept. 104, Bldg. 4006/W870, Culver City, California 90230

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY

Proof of U.S. Citizenship Required
Equal Opportunity Employer

Write yourself in.

Hughes Aircraft Company, Corporate Fellowship Office, Dept.104, Bldg. 4006/W870, Culver City, California 90230.

Please consider me a candidate for a Hughes Fellowship and send me the necessary information and materials.

____
PLEASE PRINT Name

____
Address

____
City State Zip

I am interested in obtaining a ________ Master's ________ Engineer degree ________ Doctorate

in the field of. ______________________________

DEGREES NOW HELD (OR EXPECTED)

Bachelor's: Date ____________ Field ____________ School ____________

Master's. Date ____________ Field ____________ School ____________

TECH PROFILES

Gary Eden

and photo by Jane Fiala

In 1972, J. G. Eden received his B.S. in Electrical Engineering from the University of Maryland, College Park. He later received a Masters in 1972 and a Ph.D. in 1973, both of which he earned from the University's Electrical Engineering department.

Dr. Eden was awarded a National Research Council Postdoctoral Associateship at the Naval Research Laboratory in Washington, D.C., in 1975. In 1976 he joined the Laser Physics Branch of NRL where he studied the rare gas-halide exciplex lasers and the photolytic and proton beam pumping of visible and ultraviolet lasers. He joined the University faculty in August of 1979.

He spends a large amount of his time in the Gaseous Electronics Laboratory where he is working on the development of lasers in both the visible and ultraviolet ranges. These lasers have applications in communications and power transmission. He is also studying the multi-photon excitation and ionization of rare gasses with applications toward the study of kinetics of rare gas halide molecular formations. One the newest areas of Dr. Eden's research in excimer lasers, used in the growth and production of semiconductor films.

In the Gaseous Electronics Laboratory e are fourteen students and they have scovered seven new lasers within the past year. Among these is the first high temperature (above 400 °C) discharge pumped molecular laser which uses cadmium iodide.

David R. Opperman

text by Raymond Hightower

As the time of graduation gets closer, the engineering student begins to look for an employer that can use his newly aquired skills. It is more than likely that this search will lead him to the engineering placement office, which is under the direction of Dean David R. Opperman.

Opperman entered the University in the fall of 1942 as a student of electrical engineering. After his fourth semester, he joined the Navy V12 program and was sent by the Navy to the California Institute of Technology, where he earned his Bachelor of Science degree. Following Midshipman's school at the University of Notre Dame, he spent three years on active duty in the Navy.

During an eight year period as an instructor at Chanute Air Force Base, Opperman worked towards his Masters of Science degree here at the University. In the spring of 1956 he was awarded the degree, and in the fall he began his faculty career as an instructor for a course equivalent to today's GE 103. In the spring of 1957, Opperman was appointed part-time Assistant Dean of the College, while still serving as part time instructor. He was appointed full-time Assistant Dean in the fall of 1957. As Assistant Dean, he directed the University's newly begun co-op program. In 1973, Opperman was appointed director of placement, and the co-op program was absorbed by the placement office.

As director of placement, Opperman acts as the liason between company personnel departments and the College. Day-to-day duties include arranging meetings and interviews. Although Opperman spends alot of time working, he does find time to relax. Camping and hiking are among his favorite recreational pursuits.

Jack Groppel

text and photo by Dave Colburn

Most engineering professors start their education in some science-related field and finish with a doctorate in their field of concentration. Assistant professor Jack Groppel did it a little differently.

In his undergraduate career at the University of Illinois, Groppel earned his B.S. in agriculture in 1973 and went on to get a masters in physical education two years later. However, it was not until he went to Florida State University that he started studying in his field of concentration, human movement science. He received his Ph.D. there in 1978, and then returned to Illinois to become an associate professor in this field.

Professor Groppel teaches Physical Education 130 and 355. P.E. 130 focuses on basic human motion. In P.E. 355, Groppel takes these basic concepts and teaches the application of cinematography to analysis. He also heads the Biomechanics Research Laboratory.

Groppel specializes in racket sports. Recently, Groppel flew to California to apply his expertise to John McEnroe, who had a stumbling problem. High speed filming demonstrated that he reacted faster than his feet could. Groppel determined that a special type of shoe would solve the problem. Professor Groppel is proud to report that since McEnroe started wearing this shoe, his record has been 24-1. The one loss was to Bjorn Borg.

The Illini Publishing Company is proud of its tradition of service to the students, faculty and friends of the University of Illinois. Our student-operated media entertain and inform while providing the student managers and employees a valuable experience to supplement their classroom education.

The Daily Illini newspaper is a consistent award winner in collegiate and professional competition. For more than 100 years, UI students have combined their editorial and advertising knowledge to produce a high quality newspaper five days a week.

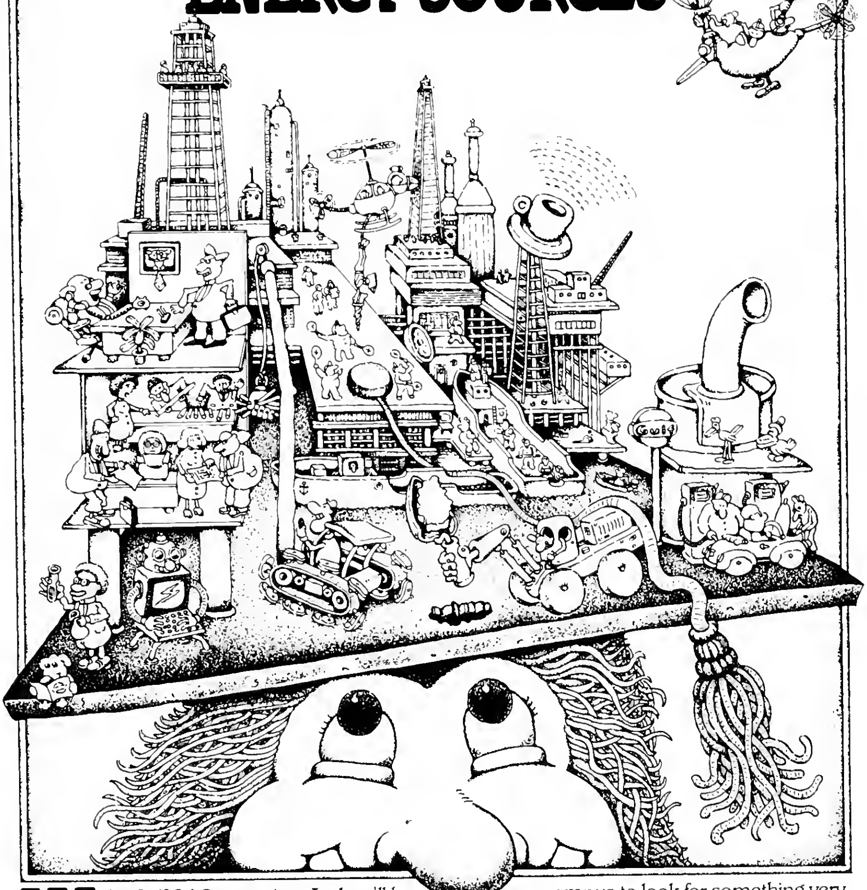
WPGU, FM 107, is one of a very few completely student-operated radio stations in the country. Seven days a week, 24 hours a day you'll find students working on programming, playing music, selling and producing commercials and being involved in community and University promotions.

The Illio yearbook is a respected tradition that preserves the events of the University. Each year creates new memories that are presented on the pages of the Illio. Student staff members work long hours to make the UI experience a valuable one to be remembered forever.

Illinois Technograph magazine reports on one of the nation's truly great engineering programs. New developments in research are detailed as are achievements by faculty and students. Technograph is distributed on campus to engineering faculty and students as well as to all high schools in Illinois.

G U L F · E N E R G Y **Gulf** C R E A T I N G · E N E R G Y

WE'RE TAPPING NEW ENERGY SOURCES



We're Gulf Oil Corporation. And we'll be on campus to look for something very much in demand these days. New energy. Specifically, new human energy.

The fast-changing energy field will continue to be one of the most exciting and rewarding places to launch a career. And Gulf has exceptional opportunities for new people with new ideas about finding and developing America's fuel resources.

If you're about to earn your degree in Petroleum Engineering, we'd like to meet you. We're also interested in Chemical and Mechanical Engineers. In Geology and Geophysics majors. In Computer Science, Accounting, and Business Administration majors. In students in Petroleum Land Management programs. And in people in technical disciplines with a flair for sales.

Check the placement office to confirm a date for our Gulf Representative's visit. And sign up for an appointment. If we miss you, send your resume to Coordinator, College Relations, Dept. B, P.O. Box 1166, Pittsburgh, PA 15230.

Gulf is a world leader in training young, motivated people to solve today's energy problems. When we find you, we'll be that much farther ahead.

For a 15¾" x 20⅛" color poster of this illustration, please send your request to: Poster, College Relations, P.O. Box 1166, Pittsburgh, PA 15230.

IF · YOU · CAN · DREAM · IT · YOU · CAN · DO · IT

Expand the mind of the microchip.

Remember when electronic calculators were considered a luxury? Well, consider this sign seen recently outside a gasoline station in Schenectady, New York: "Free calculator with an oil change."

That's just one sign of the enormous impact microchips have had on the way we do everything from banking to game-playing.

But how will we use microchips that are smarter, faster, more reliable, and less expensive to design? How will these new microchips be used to improve systems, products, and processes? As one GE engineer puts it, "The sky's the limit!"

That sky is replete with a number of integrated circuit concepts that GE is applying right now.

There's the custom IC, a chip that performs highly specialized functions. Traditionally, creating this chip has been an expensive, time-consuming job. So we're working on ways to cut design time and cost.

We're using computer-aided design (CAD) to design and simulate chips right on computer screens. We're also developing gate arrays, a system that allows you to build inexpensive prototype chips that can be "played" in systems before the final design is fixed.

Another area that GE is developing is VLSI (Very Large Scale Integrated) circuits. These ICs will eventually squeeze one million transistors onto a single chip.

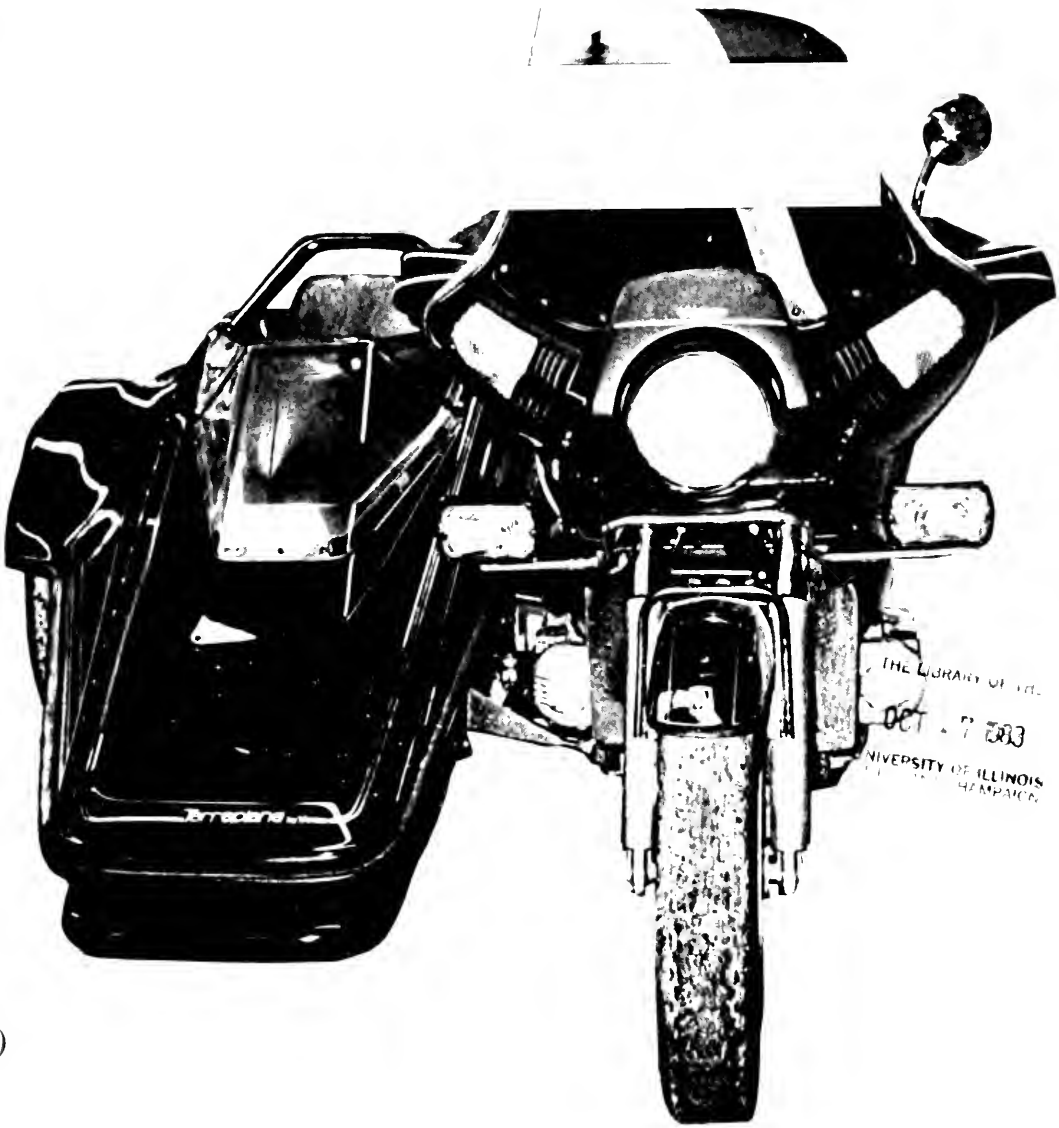
Where will all this super electronic power be applied? GE engineering manager Don Paterson sees it this way:

"At GE you can innovate from the system down to the chip to create whatever ignites your imagination."

In other words, you can dream it ...and do it.

WE BRING GOOD THINGS TO LIFE

An equal opportunity employer



Engineering against the wind

The Chromium Mechanism

The first comprehensive explanation of electrochemical activity during the plating of chromium has recently been formulated at the General Motors Research Laboratories. This understanding has aided in transforming chromium plating into a highly efficient, high-speed operation.

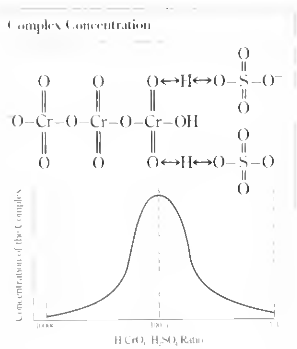


Figure 1 The electroactive complex and a theoretical plot of its concentration as a function of chromic acid to sulfuric acid ratio

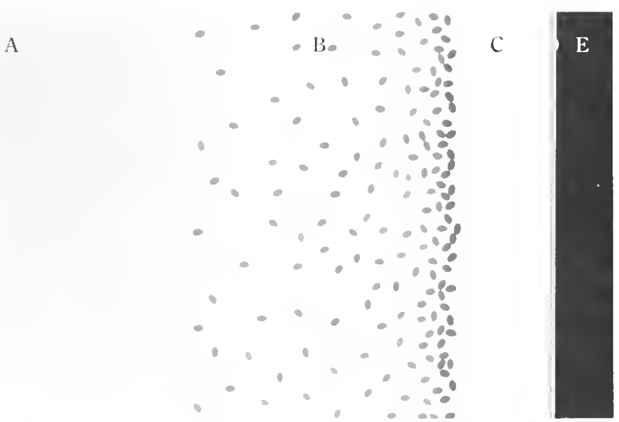
Figure 2 The electroactive complex diffuses from the bulk electrolyte solution (A) through the diffusion layer (B) to the Helmholtz double layer (C) to be discharged as metallic chromium (D) on the cathode (E) surface

FOR MANY industrial applications, chromium coatings of more than 0.2 mil thickness are required for wear and corrosion resistance. But the conventional method of plating chromium is neither fast nor efficient. Nor, until the recent work of a GM researcher, had the steps involved in the century-old plating process been explained in detail. Through a combination of theory and experiment, Dr. James Hoare has devised the first comprehensive mechanism for chromium plating. This increased understanding has helped electrochemists at the General Motors Research Laboratories develop a system that plates chromium sixty times faster than the conventional method, while improving energy-efficiency by a factor of three.

The electrolyte for plating is a chromic acid solution which contains various chromate ions: chromate, dichromate and trichromate. From a series of steady-state polarization experiments, Dr. Hoare concluded that trichromate is the ion important in chromium deposition.

Sulfuric acid has been recognized as essential to chromium plating and has been assumed by some to be a catalyst for the process. In this strongly acidic solution, sulfate should be mostly present as the bisulfate ion $(HSO_4)^-$. Dr. Hoare found, contrary to expectations, that the addition of sulfuric acid to the plating bath decreased the conductivity of the solution.

Combining these findings with the results of previous investigations, Dr. Hoare concluded that the electroactive species was a trichromate-bisulfate complex (see Figure 1). From equilibrium considerations, he theorized that the maximum concentration of this species occurred at a 100-to-1 chromic acid sulfuric acid ratio. The observation that the maximum rate of chromium deposition also occurred at this ratio supports the conclusion that this trichromate-bisulfate complex is the electroactive species.



During the plating process, the complex diffuses from the bulk solution toward the cathode (see Figure 2). Electron transport takes place by quantum mechanical tunneling through the potential energy barrier of the Helmholtz double layer and the unprotected chromium in the complex (Cr atom on the left in Figure 1) loses electons by successive steps, going from Cr^{+6} to Cr^{+2}. Decomposition of the resulting chromous dichromate complex takes place by acid hydrolysis to form a chromous-oxybisulfate complex:

$$^{+}Cr-O \leftrightarrow H \leftrightarrow O-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}}-O^{-}$$

The positive end of this complex is adsorbed onto the cathode surface. Electrons are transferred from the cathode to the adsorbed chromium ion, forming metallic chromium and regenerating the $(HSO_4)^-$ ion. Thus, Dr. Hoare's mechanism explains how sulfuric acid, in the form of the bisulfate ion, participates in the plating process.

IT HAS long been known that chromium cannot be plated from a solution when initially present as Cr^{+3} because of the formation of the stable aquo complex, $[Cr(H_2O)_6]^{+3}$. Yet chromium can be plated when initially present as Cr^{+6} even though it must pass through the Cr^{+3} state before being deposited. Dr. Hoare's mechanism handles this paradox by explaining that the chromium ion being deposited (on the left in Figure 1) is protected by the rest of the complex as it passes through the Cr^{+3} state, so that the stable aquo complex cannot form.

The diffusion of the electroactive complex apparently controls the rate of the process, so that shortening the diffusion path increases the speed of chromium deposition. A high rate of relative motion between the electrolyte and the cathode will shorten the path. This can be accomplished by rapid flow or by agitation of the electrolyte.

Dr. Hoare found that the rate of chromium deposition increased with electrolyte flow until the process was no longer diffusion-controlled. He also found that the use of dilute electrolyte significantly increased plating efficiency.

"This project is an excellent example," says Dr. Hoare, "of how basic research and engineering principles can be combined to develop a new, successful process. Now, we'd like to take on the challenge of plating successfully from Cr^{+3}, which would be an even more efficient way to provide corrosion and wear resistance."

THE MAN BEHIND THE WORK

Dr. James Hoare is a Research Fellow at the General Motors Research Laboratories. He is a member of the Electrochemistry Department.

Dr. Hoare served as an electronics technician in the U.S. Navy during the Second World War. In 1949, he received his Ph.D. in physical chemistry from the Catholic University of America. After an assistant professorship at Trinity College in Washington, D.C., he joined the US Naval Research Laboratory as a physical chemist. He became a staff member at General Motors in 1960.

Dr. Hoare's sustaining interest has been in electrochemical kinetics and the mechanisms of electrode processes. He is best known to the scientific community for his basic studies of hydrogen and oxygen electrode mechanisms. His book, *The Electrochemistry of Oxygen*, published in 1968, is considered a work of primary importance to the field. In addition to his work on chromium plating, he is responsible for the fundamental research that helped make electrochemical machining a precision process.

Illinois **Technograph**

February 1983 Volume 98 Issue 4

6 **Removing the Over-the-Counter Menace**
Jim O'Hagan
How can drug manufacturers go about making their products safe against tampering?

8 **The Multifarious Laser** *Tushar Chande*
Laser processing offers many advantages over traditional methods.

10 **The Ins and Outs of Water Towers** *Mary Kay Flick*
Water towers require intricacies to perform their many duties.

16 **Against the Wind** *Raymond Hightower*
The most popular motorcycle fairing manufacturing firm operates in nearby Rantoul.

Departments
Editorial 5, Tech Teasers 5, Technotes 13, Technovations 21, Tech Profiles 23

On the cover: A motorcycle, equipped with a Terraplane sidecar and a Windjammer fairing, sits ready to bring a world of adventure to its owner. What kind of company builds in defiance of the wind? Technograph *finds out. (photo by Raymond Hightower)*

Illinois Technograph
(USPS 258-760)
Vol.98 No.4 February 1983

Illinois Technograph is published five times during the academic year at the University of Illinois at Urbana-Champaign.

Published by Illini Publishing Co., 620 East John St., Champaign, Illinois, 61820. Editorial and Business offices of the Illinois Technograph: Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3730.

Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001; 221 N. LaSalle Street, Chicago, IL., 60601.

Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879.

Illinois Technograph is a member of Engineering College Magazines Associated.

Editorial

Grad School Provides a Necessary Alternative to Work

Four years is a long time while you are living through it, but once you join the ranks of professional engineers, it will seem like your college days flew by like minutes. After those four long years of all night research sessions, endless hours in labs, and hundreds of problem sets, it seems insane to go on to graduate work. It takes at least another year to obtain a masters degree, and another three years to receive a doctorate.

That's another four years of school on top of the four that you've already struggled through. Four years at the average annual starting salary for a B.S. of $24,816 (as of July 26, 1982) amounts to a gross income of $99,264. That's a lot of money, and to make matters worse, you have to spend money to continue your education.

It seems that from an immediate economic standpoint, it is unwise to continue school after you receive your baccalaureate. The problem is that too many people believe that. There are not enough people graduating from engineering programs with Ph.D.'s to feed both the industrial and academic communities.

The number of Ph.D.'s granted per year has dropped from an alltime high in 1972 of 3774 to the 1981 figure of 2841, according to the Engineering Manpower Commission, AAES, 1981 survey. To compound the decrease in available doctorates, there has been a distinct increase in the number of foreign students working on advanced degrees who will return to their own countries upon graduation. Administrators claim that the figure is as high as 50%.

The great influx of foreign students is not very obvious here at the University. The College of Engineering has been operating under the general guideline of limiting foreign graduate students to 20% of enrollment. The EE department runs at about 17%, while approximately 30% are enrolled in the nuclear engineering curriculum.

Consider the following scenario. There are 2800 Ph.D.'s graduating in a given year. From that group, maybe 1400 will stay in this country. Universities and industry desire the top 20%, narrowing the number to 280. There are about 250 universities who want to hire Ph.D.'s. The result is obvious: industry and universities must compete for the most desired graduates, and universities cannot compete with the pay available in industry.

So who is teaching our classes, and who will be teaching the classes of tommorrow? Obviously, not all of the top people go to industry, but most do, and more tenured professors are leaving universities to join industry all the time.

This trend must be reversed if industry and academia intend to maintain the high quality of engineering research taking place in this country. Industry and universities can work together to curb declining graduate enrollments. Industry can provide more grants and funding for graduate schools. Universities can then use this money to make graduate study more attractive to prospective students.

Students can also work to reverse this trend. Students with outstanding talents, or a desire to teach should seriously consider going on to earn advanced degrees. There is money available to support graduate students; you just have to find it. The Massachusetts Institute of Technology granted $1.8 million in financial aid, assistantships, and fellowsihips to graduate students in engineering in 1981.

Before you graduate, look into graduate school, take the Graduate Record Examination, and send out some applications. Once you are at work, those eight years will seem like they flew by like minutes.

Kevin W. Wenzel

Avoid Hi-Tech Bandwagon, Professor Urges

To the Editor:

Your December, 1982 article (A New Breed of Reactors, p. 12) states that $1.2 billion has been spent on the Clinch River Breeder Reactor (CRBR), and that it carries a price tag of $3.2 billion. It also cites proponents' claims that it is 86% complete. New math?

The CRBR project was originally justified on the basis of a fear that we would soon run out of fissionable uranium. Due to the slowdown of electricity demand during the '70's, this is no longer an urgent problem. The real issue now is whether to spend an additional $2 billion on concrete and steel to finish the project (because the French and Soviets did so), or spend it on researchers' salaries to develop an advanced breeder technology—hopefully one cheaper, safer and more proliferation-resistant than the CRBR's plutonium fuel cycle.

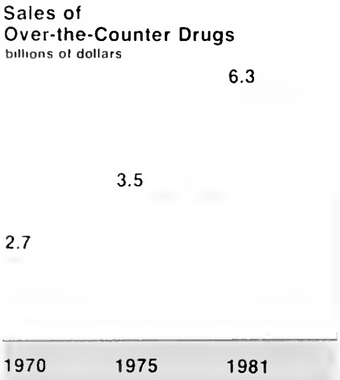
We faced a similar decision 12 years ago with the SST. We opted to scratch the U.S. program and learn instead from the mistakes of the French and Soviets. As a result, talented U.S. engineers were available to develop technology for the super-efficient fleet of subsonic airliners dominating the world market today. As a former die-hard SST supporter, now older and wiser, I caution engineers against jumping on hi-tech bandwagons hyped by politicians, without first analyzing alternative public policies.

Clark Bullard
Associate Professor,
Mechanical Engineering

Illinois Technograph invites letters in response to its articles and editorials, or any other item of interest to our readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.

Removing the Over-the-Counter Menace

For everything from "sinus pressure" to "nagging backaches," pills have become an essential part of an American's needs. Keeping these pills secure from tampering has recently developed into a problem. The solution to this problem involves everything from economics to psychology.



The growing tendency of the American public to rely on tablets, capsules, and lozenges for relief from various illnesses and discomforts has resulted in skyrocketing profits for producers of drugs and pharmaceutical supplies. Since the well-publicized Tylenol poisonings, however, the public outcry for these cure-all pills has been matched by another demand: tamper-proof containers.

Late September saw the deaths of seven Chicago area residents as the result of cyanide-laced Tylenol capsules. Although the exact debasing of the drug still has not been determined, investigators now feel that Tylenol capsules were purchased, opened, and filled with cyanide. The capsules were returned to the bottle, then randomly distributed on the shelves of drug stores along Illinois State Route 53.

Efforts to thwart future attempts at drug sabotaging have taken several forms. Authorities have urged improvements in communication to warn consumers of potential dangers sooner, sought stricter laws to control the sale and packaging of non-prescription drugs, closely watched local-level drug distribution, and have urged manufacturers to develop "tamper-proof" containers. Such containers can serve to deter potential poisonings by making it easy for the consumer to spot previously opened boxes and bottles.

"They should've had them a long time ago," said Derryl G. Singley, Registered Pharmacist for Cavett Drugs in Champaign, Illinois. "I was always surprised Tylenol didn't (have tamperproof bottles), being such a large supplier. Anacin 3 has already come out in tamperproof. It's about time. Even grocery stores are beginning to see them. There are too many chances for some cuckoo to do something," he explained.

Anacin 3's tamperproofing consists of a special piece of cellophane tape over the lid of the box and a warning to consumers to beware if the seal is broken. Other drugs, such as Ecotrin, used this method even before the Tylenol cases. "People will always be opening boxes to see what's inside," cautioned Singley. "We watch them (the customers) as best we can, but some still get by undetected."

Some drugs, such as St. Joseph's aspirin, come in boxes which are glued shut. Another remedy would involve encasing the entire box in cellophane, as phonograph records are now sealed.

A different type of tamperproof container which has already been in use is the plastic blister pac. This arrangement, commonly seen in boxes of Contac, encases each capsule in a foil and plastic bubble which must be broken to remove the pill. Although this system is most readily adapted to protection of drugs, their manufacture is expensive. Scott Ricci, Registered Pharmacist for McBride's in Champaign, Illinois, said,"(The blister pac) is ideal, but it is more expensive. I think you will definitely see a cost increase as a result of the new tamperproof containers."

Additional tamper-resistant seals may be located over the mouth of the container, under the lid. Paper, foil, or plastic covers must be broken to get to the pills. Another system requires the container to be vacuum sealed, so that once the lid is removed, the seal would visibly bulge. Both of these methods would deter tampering by making access to the pills without readily apparent rips or tears nearly impossible.

Tamperproof lids, such as those currently found on many beverage bottles, are also being examined. These lids separate into a removable cap and a metal ring which stays on the bottle when opened.

The shrink wrap already used on many grocery items is another potential deterrent to drug tampering. This method covers the lid and the neck of the bottle with a sheet of plastic which melts and shrinks when exposed to heat. To remove the lid, the plastic must be removed, leaving obvious signs of tampering.

Similar to this is a method which, along with the box seal and paper liner, will soon be employed on Tylenol containers. By using a plastic ring of tape around the bottle lid joint, the container cannot be opened without breaking the seal and leaving apparent remains. Nevertheless, cautions Ricci,"It will be up to the consumers to closely examine what they buy for signs of tampering."

Besides tamperproof containers which leave tell-tale signs of handling when opened, the pill itself is being examined for tamperproof modifications.

The easiest form is not a capsule at all, but a tablet. Aspirin tablets already are known well in this form. "The tablet form is tamperproof," explained Ricci. "Still many people prefer the capsule. I guess they find it easier to swallow." Johnson & Johnson has another theory: they feel capsules can help cure people simply because they look more like prescription drugs, and thus have a psychological effect similar to kissing a child's hurt knee.

To meet this market, several tablet types have been developed. The soft gelatin capsules currently used for liquid drugs, such as vitamins A and E, will leak and self-destruct if tampered with. Locked capsules are also being experimented with: the two-piece tablet is sealed with a special band, making it impossible to take apart and reseal the capsule at will.

While many tamperproof containers have already appeared on the market—even prescription drugs are sealed—more are soon to follow. Consumer demand will necessitate some changes as various competitors fight for Tylenol's 35 percent market share. In fact, when Tylenol is reintroduced, it will have three tamperproof seals. "...they may be going a little overboard with three seals," notes Singley, "but if they want to regain 75 percent of their previous market, as they hope to do, they have to regain the customers' trust."

Change will also be forced by local, state, and federal regulations. Chicago Mayor Jane Byrne has demanded that within 90 days, all drugs sold in Chicago are to be in tamperproof containers; former Attorney General Tyrone Fahner has recommended that the state government adopt similar legislation. Massachusetts introduced laws in early October to the same extent, which would also require state inspection of random samples. Drug-company executives and Food and Drug Administration (FDA) authorities have formed a committee to channel these local laws into national guidelines. This will eliminate conflicting regulations and limit those which are impractical.

Although these new safeguards will cost the consumer millions of dollars in price increases of one to two percent—Tylenol's new packaging alone will cost 2.4 cents per bottle—they have already resulted in profit for packaging firms. Time magazine reported that Anchor Hocking Corporation has seen skyrocketing demand for vacuum-glass jars, PCM Corporation expects a large demand for its plastic blister pacs, and Milwaukee's Tiny Pillar Corporation is struggling to keep up with orders for its sealing machinery. Similar gains have been seen in the stock market, as analysts see increased demand for the new containers.

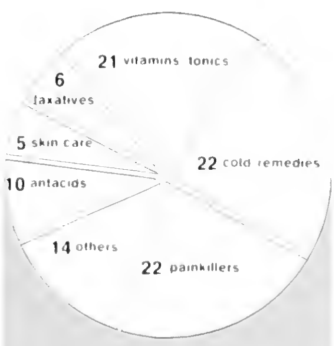
Despite these safeguards, a truly tamperproof container is unlikely. Hypodermic needles could penetrate many barriers leaving a hole visible only under close scrutiny. Some barriers are easily replaced with simple machinery, and others such as glued or taped boxes are defeated with everyday materials like razor blades, cellophane tape, and white glue. Furthermore, unless consumers are alert to the absence of tamperproof barriers, they could be removed entirely and not be missed. Said FDA chief Arthur H. Hates, "...it is impossible to make clear that a tamperproof package is not possible."

Still, the development of safeguards will tend to re-assure the public and deter all but the most determined maniac. "I think they'll be effective," said Ricci. "Not completely foolproof, but they'll help."

Whatever the final form of the tamperproof containers, they cannot be effective solely by themselves. Consumers must look at the medicine they take and the seals containing them; the FDA is outlining a new system for faster reporting of poisoning cases; the federal government expects to have packaging guidelinges available soon. Possibly, through a combined effort, the threat of similar crimes can be reduced.

Although the Tylenol tragedies have left a grim image on the drug industry and the general public, changes have arisen which will result in more respect, higher standards, and a greater degree of safety in the pharmaceutical industry ■

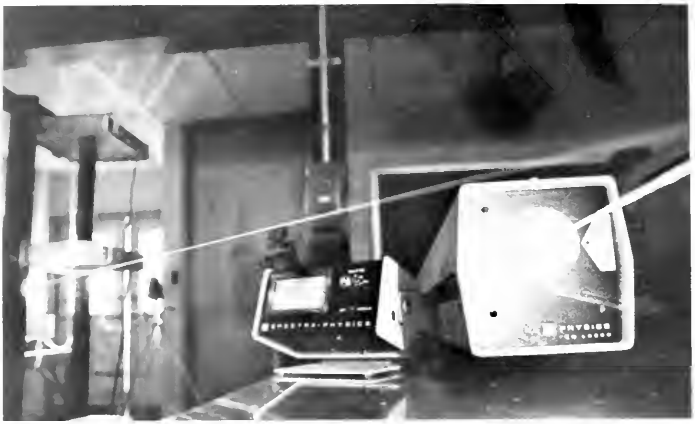
Proportions of 1981 Sales
(in percents)



Source
Product Marketing Proprietory Association

Tushar Chande

The Multifarious Laser



This is the second part of a two part series on laser processing. The first part appeared in the November, 1982 issue.

"LASER", the acronym, has become a noun. It's listed as "a device that amplifies light waves and concentrates them in an intense, penetrating beam"[1]. With laser applications on the rise, the related glossary is expanding too. Soon, "laser" the noun must grow into a verb, even take on a suffix or two. In anticipation, we provide "-ation", a suffix meaning "to act, condition or result from"[1]. Laseration would generically include transformations brought about by laser processing, or lasering.

Why is laseration worth knowing about? Because it involves jobs and money. *Newsweek* magazine in its November 18, 1982, issue estimates that by the end of the decade, there will be up to 600,000 new jobs in industrial laser processing. Being high-tech jobs, they require skills which net good salaries. The long term outlook is good—in tune with the changing nature of the American workscape.

Lasering means doing it with precision and intensity. Precision is as high as can be obtained by numerically controlled instruments. Intensity was first measured in "gillettes", the number of shaving blades that could be burned clean through. Today, intensity is quoted in watts per square centimeter. Typically, laser intensities approach a million watts per square centimeter. To get this power per unit area, a conventional light source would have to emit a staggering total power of approximately a million watts. This means that while the ordinary 200 watt light bulb cannot melt metal, a continuous laser with the same power can.

The laser-material interaction depends on the nature of the laser as well as the properties of the material itself. The wavelength of the laser beam, its power, beam diameter and spatial distribution play important roles. The reflectance of the material surface, its absorbency, the ability of the material to conduct heat, and the quantity of heat required to bring about a phase change in the material determine its response to laser irradiation.

The wavelength of the laser determines how well it can be focused. Also, lower wavelength lasers couple better with metals. The power and beam diameter determine the power density in the beam. The power density distribution is crucial in materials processing. Materials with lower surface reflectance tend to fuse much easier with the aid of laser radiation. A material that is an efficient conductor of heat is difficult to melt, as is a material with a large latent heat of fusion. The choice of a laser system depends on the material to be processed and the particular application.

Laseration can be classified by the maximum operating temperature attained. Desired transformations could be obtained by heating above room temperature but below the melting temperature, as in laser heat treating. Laserations involving a melting step are welding, cutting, alloying, cladding and glazing. Drilling and marking requires melting and vaporization of the substrate.

Laseration enjoys many advantages over conventional production processes. Since a beam of light is used, no actual contact between the "tool" and the "workpiece" occurs, a feature that adds flexibility and versatility. The high intensities permit rapid, localized heating, reducing distortion and making precise operations possible. It is clean, and responds instantly to commands altering its speed or power.

The laser beam has a relatively large depth of focus, and permits easy handling of complex shapes and structures. It can be transmitted through air, and made to reach all optically accessible areas. Laser settings are reproducible and a single beam can be used at multiple workstations using suitable optics. Operational safety can be readily assured, and high rates of productivity can be easily attained.

However, the laser system is a major capital expense, and does not cut costs significantly as a direct substitute to a conventional process. But, its unique properties can be exploited to develop new processing methods that yield qualitative and quantitative advantages over existing ones. This is their strength, and for the innovative engineer, this is the dream beam.

continued on page 12

Mary Kay Flick

The Ins and Outs of Water Towers

Anywhere a person travels in this country, rural town or sprawling metropolis, a water tower is almost always one of the things that is noticed. After all, a structure as large as a water tower isn't easily missed.

A water tower has two main functions. First, it balances the fluctuations between the water supply and demand. Second, it acts as a safeguard to insure an adequate and continuing source of water in case of a breakdown in the system. The use of elevated tanks also reduces pumping costs (due to gravity, the pump is required to do less work). Storage tanks are also used for fire protection or advertising. A small system can be placed either near the center of a large demand area, or opposite the pumping station with a large demand area in between. With a large system, several tanks are used in the center of each area of heavy demand.

Water towers are normally made from two basic materials: concrete and steel. Both have their advantages and disadvantages. Most concrete tanks are made of a pre-stressed concrete, which is circular in shape at ground level. The tank is pre-stressed by winding a high-strength wire around the core wall of concrete. After the wire is wrapped, a pnuematic mortar is applied to the outside wall to bond the wire to the wall and protect against corrosion. Thanks to this process, concrete tanks have fewer maintenance problems with respect to corrosion, but they are more susceptible to damage from rapid and severe temperature fluctuations, which makes them more susceptible to leaks.

In steel tanks, on the other hand, the constant problem of corrosion must be dealt with. Corrosion can be caused by rust deposits or by deposits which result from the presence of minerals in the water. Because of this, some sort of cathodic protection must be provided. One advantage of steel structures is that due to their elevaton, the pressure created by gravity is greater.

Steel structures are those most easily seen and most widely used in Illinois. Because few areas in Illinois have a high enough elevation to facilitate a concrete ground based storage tank, elevated water towers must be used. There are some ground tanks (standpipes) made of steel, but most are elevated.

Water towers of steel can be constructed in many different shapes and sizes. Most are spherical, and are supported by one or more columns. The largest manufacturer of steel storage structures, Chicago Bridge and Iron Company, makes several different designs, depending on the needs and resources of the area.

The four major design types are: (1) a spherical or cylindrical tank mounted on a large fluted or plain column ("Watersphere ™" or "Waterspheroid ™"), (2) a spherical tank mounted on a thinner center column with extra support from five smaller columns (ellipsoidal, or spheroidal), (3) a cylindrical, funnel shaped design on a tripod of columns (Tripod ™), and (4) steel ground reservoirs and standpipes. If the water source is relatively near, then the first three designs are used according to the needs of the area. When the water supply is obtained from a distant source, ground reservoirs and standpipes are needed. They assure an adequate supply whenever water is needed.

The difference between a standpipe and a ground reservoir is simply their shapes. A ground reservoir has a diameter wider than its height, whereas a standpipe has a height greater than its diameter. So, there is a storage tank shape to meet every need.

Each shape may also be built in several different capacities. The single column structure can range in capacity from 25,000 gallons to 2,000,000 gallons. Multiple column tanks also range in capacity from 25,000 to 2,000,000 gallons. The smaller tripod tanks start at 15,000 gallons and can only reach a capacity of 100,000 gallons. Therefore, the type of tank used also depends on the amount of water needed to meet the demands of the area.

Constructing a water tower entails a sizable outlay of funds for an industrial plant or a municipality. Estimates given by Chicago Bridge and Iron Company (CBI) show that a 100,000 gallon tank with a 100 foot depth would cost approximately $175,000. A 500,000 gallon tank would run about $400,000 while a one million gallon tank for industrial fire protection would cost about $800,000.

continued on page 12

continued from page 10

CBI receives orders for about one to three structures per month; the most common ones being built are the 100,000 to 500,000 gallon capacity structures. Some structures, like those in Champaign-Urbana, are owned by the water companies who use them. Champaign's are owned by Northern Illinois Water Company which is therefore responsible for their maintenance.

The inner workings of water towers are hidden from the outside so their internal processes often are unknown. As stated, water towers are used to regulate daily consumption, insure an adequate supply, provide fire protection. Water is pumped from the source at an hourly rate according to relative peaks and lows in demand. The amount of water kept in a tower is usually one third to one sixth of total demand. This is determined analytically or graphically by water supply engineers.

Leakage, which also must be taken into acount, is determined to be about ten percent of water consumption and fire demand. The amount used is also determined by the area where the tower is located relative to the source and the center of demand. For example, a business zone of a city may need high pressure from water mains to keep up with demand. Although in industry, the major purpose for towers is fire protection, they may also be used when an adequate supply of water is necessary for safe and efficient production.

Once a storage structure is built, its most pressing need is maintenance. If properly maintained, a water tower can last anywhere from twenty-five to fifty years. The major problems concerning maintenance are the reduction of leaks, protection from external weather damage, and protection against icing damage.

Steel tanks must periodically be emptied, cleaned, inspected, and repainted as required. On the outside, a rust-inhibitive primer and two coats of long oil alkyd enamel or long oil spar varnish aluminum are used. On the inside, a number of vinyl epoxy ester, catalyzed epoxy and other paint systems may be used. The structures also need protection. Maintenance people supply this protection by maintaining properly varying water levels or perhaps through the use of internal heaters. In addition, towers must constantly be watched for leaks.

However, the problem most dealt with in water storage maintenance is protection against corrosion. Corrosion may be in the form of mineral deposits or, more commonly, in the form of rust which may corrode the steel in the tank. Corrosion occurs when a scratch or nick develops in the protective coating and base steel is exposed.

Cathodic protection consists of metal rods of a metal more reactive than the steel in the tank. Because of their higher reactivity, these rods corrode away instead of the sides of the tanks. The metal rods, called anodes (the steel sides are cathodes in the chemical reaction which takes place), must be replaced periodically to insure continuing corrosion control.

Water towers are not simply mammoth structures to indicate the name of the city to those passing through it. They serve to maintain an adequate supply and quality of water whether it is needed for public use, industrial use, or for fire protection. While they are extremely functional, they can be made to add interest and character to the area which they serve. ■

continued from page 8

In materials processing, lasers have been used to weld, cut, heat-treat, drill, mark, shape, machine, hardface, alloy, shock-harden, and anneal. They have also been used to punch holes in cigarette paper, cut cloth for men's suits in the garment industry, drill holes in ceramics, strip insulation from wires and to trim resistors in elecronic circuits.

Metals such as titanium are easily cut by lasers in the presence of a reactive gas. Laser cutting is cleaner, smoother and more accurate than conventional methods. The cut has narrow kerf widths and more parallel sides. There is minimal distortion and waste. The Grumman Aircraft Corporation has been using lasers in production for nearly a decade, and rough trimming costs have been cut 60 to 80 percent. Also, simple holding and positioning tools can be used, as the process exerts almost no cutting pressure on the part being trimmed[3].

Automobile exhaust valves readily show that the automotive engine provides adverse working conditions for a part. General Motors uses laser surface alloying to alloy exhaust valve seats. A cost analysis of laser alloying versus conventional hardfacing techniques suggests that cost savings of up to 80 percent can be achieved[4]. Pistons, camshafts, and gear teeth are other automobile parts that can be laser surface treated for improved performance at significant cost reductions.

As an example of the problem-solving potential of lasers, consider the welding of aluminum-magnesium alloys. Such alloys are good conductors of heat, and thus a large quantity of heat is required to melt them. The high temperatures that are reached cause the magnesium to boil off, leaving a porous, unsound weld. Researchers at the University have shown that it is possible to laser weld these alloys in combination with appropriate gas shielding procedures to produce sound welds with little porosity and low magnesium loss[4].

Another interesting recent development is the use of lasers in the recrystallization of thin film semi-conductors. Thin films of semi-conductors can be overlayed on a silicon substrate to develop three dimensional integrated-circuits. The laser beam can also be used to anneal semiconductors during manufacturing, especially in VLIC and VHSIC applications, when the scale of processing would seriously limit furnace methods. These are still not part of a production process, but point to future trends.

The potential of the laser in industry is only just being tapped. The powerful pencil of light has a bright future. ■

REFERENCES:
1. Webster's New World Dictionary.
2. L. Michael Heglin, in "Applications of Lasers in Materials Processing", E. A. Metzbower, ed., ASM(1979), p. 101.
3. John Huber and Warren Marx, ibid, p. 273.
4. David A Belforte, Colloq. on Lasers and Electro-Optical Equipment, Tokyo, Japan, 24 Oct., 1978.
5. A G Blake, MS Thesis, University of Illinois, 1982.

Tech *Teasers*

1. A 1982 newspaper stated that a man died when his age was one twenty-ninth the year of his birth. How old was he in 1952?

2. Crafty Constance Carter's candid instructor Carl told her to "form the number ninety-two from x and y, given that x = 2514 and y = −2422." Obviously, one would assume that she would have added x and y, because 2514 − 2422 = 92. However, being a card, like her sister Candy, Constance said "No. I can create ninety two out of just one of the numbers you gave me." The teacher, Carl, and Constance's classmates watched in amazement as she did just what she said she could. What did she do? There can be no rearranging of the order of the digits of x or y.

3. Can you imagine a rope ladder (you know the kind—knotted rope, wooden rungs, right?) hanging down the side of a ship? Good! Now imagine that the ladder is 40 feet long, and the tide is out. Suppose the tide comes in at the rate of 5 feet an hour, and the distance between rungs is 2 feet. If the water level starts below the ladder a distance that is one-fifth the length of rope that will be left unwet after the tide comes in, how many steps of the ladder are underwater if the tide comes in for 3.5 hours?

answers on page 18

Tech*notes*

Tau Bates and Legislators

Seven Illinois legislators were the guests at Tau Beta Pi's First Annual Legislative Forum last December 6. The forum was intended to benefit both the legislators and the students involved, and it did exactly that.

The event lasted all day, and it started with a brief registration. At this time, the guests were welcomed, given information packets for the day, and Robbie Rubik was on hand to solve a puzzle simpler than most political ones. Then the legislators were taken on a tour of the University's high technology laboratories.

After the tour, everyone sat down to a special luncheon, at which President Ikenberry and Chancellor Cribbet gave speeches. Then the afternoon rolled around, and it was taken up by panel discussions. These discussions were probably the most educational and informative for both students and legislators. The talks were informal; each was conducted between two legislators and about eight students. To conclude the day, all parties enjoyed a banquet, and this time Dean Drucker was the speaker.

The forum was extremely well received, and every one of the legislators commended TBΠ's excellent job and encouraged its continuation. As a result of the forum's success, it was decided that it would become an annual event for many years to come.

The Bomb

The Physics Department here at the University tends to offer excellent courses, including one that can really have some explosive subject matter. The course is PHYCS 199, "The Bomb—A Beginner's Tour of Nuclear Weapons, War, Strategy and Arms Control."

Last Fall, the course was taught by twelve professors from the physics, astronomy, and nuclear engineering departments. This fall, professors from other non-technical fields will hopefully help in the instruction. The enrollment last fall was 65 for credit and twenty auditors. It dropped to only fifteen by the middle of the semester, probably because the course delved deeply into technical areas early on.

The semester was divided into four units, which included the nuclear arms race, the future, nuclear weapons themselves, and terrorism and proliferation. Various topics were discussed and presented during these sections, including the consequences of a nuclear war and an attack on a nuclear power reactor. The goals of the course seem to hinge on awareness. In a course such as this, politics may be somewhat removed by concentrating on the technical aspects of the subject, and this was the method the instructors used. The professors presented facts, and tried to stimulate awareness, conversation, and thinking about the entire nuclear arms situation, in hopes of helping to bring about a safer world. Professor of physics and astronomy Frederick K. Lamb, who organized the course, feels that it is necessary for educational institutions to provide such instruction since informed and concerned citizens are vital to society.

Lamb said the course was conceived through several meetings of concerned scientists last spring. All the people involved provided a tremendous amount of help in getting the course started. Physics 199 is a giant step in the right direction which will bring awareness of this important issue to society.

Langdon Alger

SCIENCE/SCOPE

Two communications satellites made history as the first to be launched from NASA's space shuttle. The first of the pair, SBS-3, is operated by Satellite Business Systems and will carry high-speed data for many U.S. companies. The second, Anik-C, is operated by Telesat Canada and will improve telephone, television, and data service in Canada. The satellites are versions of Hughes Aircraft Company's HS 376, the world's most widely purchased communications satellite. Hughes now has built 70% of the world's operating commercial communications satellites and has more successes than all other companies combined.

A safety device that snuffs out explosions in the blink of an eye, originally developed for the military, is being applied commercially where fire poses an immediate threat to human life. The Dual Spectrum™ sensing and suppression system has been evaluated in New York Transit Authority toll booths. It detects fire bomb explosions set off by criminals, and suppresses them in one-tenth of a second -- before transit employees can be injured. The system could be applied almost anywhere fire explosions occur within an enclosed area. It was developed by the Santa Barbara Research Center, a Hughes subsidiary.

The Smithsonian Institution is installing a new security system to monitor many facilities continuously. The Hughes system includes burglar alarms, fire-sensing devices, voice communications channels, and closed-circuit TV. It will let Smithsonian personnel control entrances and exits, and watch over areas open to visitors. A computer will collect and display information on TV monitors and printers at a central control station. Hughes previously installed a facilities management system at the Smithsonian's National Air and Space Museum. That system provides a wide range of exhibit monitor and control functions.

The new thematic mapper aboard Landsat 4 has distinct advantages for mapping vegetation and land covers in comparison to the multispectral scanners used on previous Earth resources satellites. Improvements give the instrument better resolution (30 meters versus 80 meters) and enable it to see in narrower bandwidths. The green band measurers reflections from vegetation more precisely. The red band better distinguishes differences in the chlorophyll absorption of plants. The near-infrared spectral band reduces the chances of atmospheric vapor like fog and haze from obscuring land surfaces. Hughes and its Santa Barbara Research Center subsidiary built the thematic mapper from NASA.

Hughes needs graduates with degrees in EE, ME, physics, computer science, and math. To find out how you can become involved in any one of 1,500 high-technology projects ranging from subminiature microcircuits to advanced satellite technology, contact: College Relations Office, P.O. Box 1042 (C2/B178-SS), El Segundo, CA 90245. Equal opportunity employer.

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY
EL SEGUNDO, CALIFORNIA 90245

Against the Wind

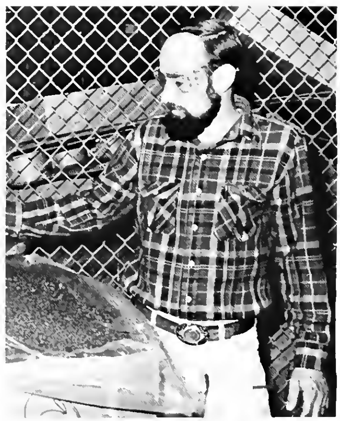
Windjammers are manufactured by the Vetter Corporation, which is located in Rantoul, Illinois. At one time, there was a Vetter factory in San Luis Obispo, California, but the plant was closed in 1978. Vetter products can be found at over 3700 dealerships in the United States, and motorcycle enthusiasts in foreign countries can order Vetter products through overseas distributors. Last year's sales totaled $31 million, which makes Vetter the leading manufacturer of fairings in the country. Other Vetter products include lightweight helmets, sidecars, luggage, and protective gauntlets known as "Hippo Hands".

Vetter was founded in 1968 by Craig Vetter, who earned his degree in industrial design here at the University. Vetter, Charlie Perethian, and Dwayne Anderson were the chief designers of the company's early products. In 1978, Craig Vetter sold the Vetter Corporation in its entirety to Rick Binet.

Craig Vetter hasn't given up motorcycling, however. Each year he and the Central Coast Motorcycle Association sponsor the Craig Vetter High-Mileage Contest. Vetter, along with several major manufacturers, supplies a total of $4,000 in prize money for the various events. This year's run was made along the 135 mile stretch of highway between San Luis Obispo and Carmel in southern California. Several teams entered the contest, each with its own exotic fairing design. Vetter was quoted in the November 1982 issue

A fairing is a structure used on a vehicle to reduce drag. To most motorcycle riders, the words "fairing" and "Windjammer" are nearly synonymous. This is not surprising; studies have shown that the Windjammer outsells its nearest competitor by more than two to one. But what of the company behind the Windjammer?

Above: Vetter accessories on display at a local cycle shop. (photo by Randy Stukenberg)
Right: The ABS scrap is granulated and prepared for shipment to the recycling facility. (photo by Raymond Hightower)



Raymond Hightower

Left: Before they are painted, all fairings must be sanded in order to insure a smooth, aerodynamic finish. Vetter employees in one section of the facility are responsible for this step. (photo by Raymond Hightower)

of *Cycle Guide* as saying, "I'm sponsoring contests to encourage people to believe it's okay to use less energy."

Energy conservation is not the only reason why a motorcycle owner might choose to purchase a fairing. There are other considerations. First of all, fairings provide protection against the elements. A steady flow of wind at the legal highway speed limit of 55 mph can introduce a high wind chill factor. Second, a fairing is an excellent place to store items such as a stereo, CB radio, or odds and ends. Ideally, a fairing should do nothing to change the way the motorcycle handles.

The fairing manufacturing process in itself is fascinating. The raw materials come from many manufacturers throughout the United States. The basic material used in all Vetter fairings, with the exception of the Ghost, is Acrylonitrile Butadiene Styrene (ABS). ABS arrives at the facility in sheet form, the length, width, and thickness of which are specified by Vetter prior to shipment.

Upon arrival, the ABS sheets are taken to one of the two rotary vacuum formers in the plant. The rotary vacuum formers, like most of the plant's equipment, were designed and built by Vetter employees. The machine consists of three main stations: the input/output station, the heating station, and the forming station.

As its name implies, the input/output station is the place where the sheets are initially laid. After the sheet has gone through the remaining two stations, it returns to the input/output station for cooling and removal.

At the heating station, the sheet is heated to temperatures in the range of 250° Fahrenheit. When exposed to this high temperature, the sheet becomes soft enough to be put through the molding process.

The sheet is moved to the vacuum former station to be molded into the desired shape. After the forming stage, the product is moved to the input/output station where it is cooled and removed.

Only one-sixth of the material that goes through the rotary vacuum former is used in the final product. The extra five-sixths is necessary because the vacuum former, being an automatic machine, needs something to "grab on to". Since humans will be doing most of the handling from this stage onward, the extra material is band-sawed off the product. This scrap is run through a granulator and then sent back to the supplying company to be melted into new sheets. Thus, there is little waste.

The product, which now has the basic appearance of a finished fairing, is taken to another room to be sanded. When all blemishes have been removed, the product is coated with a polyurethane-based paint which is allowed to harden for one to three days.

When the paint has hardened, the fairing parts are taken to another area of the plant for assembly. A bonding agent developed by Vetter chemists is used to hold the parts together. In ideal situaions, that is, with perfect temperature and humidity, the bonding agent will harden in about 14 minutes; but it is allowed to cure for 30 minutes just to be on the safe side. After the adhesive has cured, a second measure is taken to insure that the fairing parts are safely bonded together. The fairing is put through an ultrasonic welding process.

Next the product is taken to an automatic drill, another Vetter-designed manufacturing tool. Forty-three holes are drilled simultaneously, while a worker rounds the edges of the product with a router.

The pick-and-fill process follows the work with the drill and router. Any small gouges which developed during the earlier steps of production are filled with a substance made especially for this stage. Next comes the semi-final inspection. The fairings are reviewed individually for mistakes; any imperfections are marked with a grease pen by the quality control people. Once pointed out, these flaws are corrected.

continued

continued from page 17

Fairings which pass the semi-final inspection are then treated to an array of finishing touches. These include the installation of wiring, the application of edging and striping, and finally, the applicaton of the fairing insignia, i.e. Windjammer, Quicksilver, etc. Next the product must go through a rigorous final inspection under the watchful eyes of twenty-six quality control people. Imperfect fairings are sent to the proper department for corrections, or possibly destruction. If the product makes it through the final inspection, as most do, a serial number is applied. Finally, the fairing can be packaged for shipment.

Products other than fairings undergo a manufacturing process quite similar to the one described above. Differences include the type of mold used in the vacuum former, the number of holes drilled by the auto-drill, etc. Some products, such as the Ghost fairing, are molded by a drape-former instead of a vacuum former.

The Ghost is made from a sheet of transparent acrylic which is cut to size and laid on a mold. The mold rests on a conveyor which runs through an oven. As the temperature of the acrylic rises, the sheet becomes soft, and it collapses under its own weight. Normally, this would be catastrophic, but since the sheet is sitting on top of a mold, it merely collapses into the desired shape.

Product safety plays an important part in design and marketing decisions at Vetter. Of course, before such decisions can be made, the finished product must be put through rigorous testing. The test subjects are picked off the assembly line at random; products which have undergone testing cannot be sold because the tests are destructive. These tests can range from the high-tech type using sophisticated electronic test equipment to the more exotic tests in which a rider rides over a series of railroad ties.

Newly introduced products are put through the most rigorous of tests. One of the latest Vetter products to go through this initiation was the Terraplane sidecar. Vetter had planned to market a sidecar a few years back, but they scrapped the project for safety reasons. The Terraplane design, however, looked promising. The prototype was built in 1980, and put though extensive road tests. Then came the final challenge.

On January 6, 1981, two test riders departed from the Vetter facility in Rantoul. One rode the bike, the other rode in the Terraplane. Their mission was to put the Terraplane through all possible driving conditions: rain, ice, snow, cold, etc. Based on the information gathered on this trip, a manual for potential owners and operators was written. Experience is the best teacher, especially in cases such as this.

It's obvious that there is a lot more to a fairing than a simple description could explain. And what of the company behind the Windjammer? Behind it, there's a company full of people, and each product is a result of their combined efforts. Managers, designers, inspectors, etc. all put in their share. But when a biker is cruising on the highway, enjoying the smoothness of the road and the beauty of the scenery, these things are furthest from his mind. It's much more comforting to relax and enjoy the ride ■

from page 13

Tech Teasers Answers

1. If z is his age at death, then $29z$ is his date of birth. His date of birth plus his age at death will yield his date of death, or $29z + = 30z$. Since he was alive in 1952 and dead by 1982, which is information gleaned from the question, he must have died between these two dates. His death date must be divisible by 30, so the date of death must be 1980. $1980 \div 30 = 66$, $1980 - 66 = 1914$, so he was born in 1914 and was 38 years old in 1952.

2. Constance simply took $x = 2514$, and converted it into its hexadecimal equivalent. 2514 in base ten equals 9D2 ("nine-d-two") in base 16.

3. Since it is a rope and wood ladder, the ladder will float on top of the water. Thus, none of the ladder will ever be underwater.


Bring Out Your Best At
It took pride, talent and a commitment to excel in all you do, to take you where you are today. That's why you're determined to find a career that brings out your best, a career
and room for growth, both personally and professionally.
At Anheuser-Busch, we've been bringing out the best in talented people for over one hundred years, with stimulating projects and a commitment to quality that inspires superior achievement.
You can make the most of our talents in one of these positions.
Central Engineering
B.S.M.E.—M.E.'s will gain experience in such diverse fields as material handling, equipment layout, piping system development, steam generation, compressed air systems, ventilation, heating and air conditioning, and high speed bottle and can packaging.
B.S.E.E.—E.E.'s can expect to work in such areas as electrical machine design and application, power distribution, sub-station layout as well as industrial and commercial lighting, electrical control circuits and systems control.
These positions are project-oriented and allow you the opportunity to work on a project from conception to completion.
Corporate Management Trainee Program
The Corporate Management Trainee Program comprises various divisions of Anheuser-Busch Companies, Inc. Under this one year program trainees will receive "hands-on" first line supervisory experience in specific areas of the company. Trainees will also be exposed to various management concepts by attending several management development seminars.
Trainees are evaluated on their knowledge of the company and their ability to apply this knowledge as demonstrated by several written reports and the ability to function in various job assignments.
Upon completion of the program, Corporate Management Trainees are usually placed in our Operations or Brewing Divisions.
Find out how you can bring out your best at Anheuser-Busch by speaking with our recruiters when they come to your campus.
For more information and sign-up, please contact your placement office. ANHEUSER-BUSCH COMPANIES, INC.; Corporate Employment; College Relations; One Busch Place; St. Louis, Missouri 63118. An Equal Opportunity Employer M/F.
...Anheuser-Busch
ANHEUSER-BUSCH COMPANIES

Waste Not, Want Not

Three years of construction and planning was ended symbolically with the breaking of a bottle of American champagne last November 17. The celebration was the christening of *Vulcanus II*, Chemical Waste Management's new ocean incineration vessel.

The incineration process starts in the ship with its gorators, which change any solid wastes into a liquid form. This liquid is pumped hydraulically, at an average rate of over 5200 gallons per hour, to the rear of the ship, where three incinerators await in readiness at temperatures between 1250°C and 1500°C. Combustion occurs at an average rate of eight tons per hour, and the gaseous products are moved to the stack portions of the furnaces. Once there, any residual chlorine is converted to combustion gases which are sent into the ship's wake, where the sea water absorbs and neutralizes them.

Vulcanus II is 307 feet long, has a total capacity of 837,000 gallons, and has eight cargo tanks, each of which can be connected directly to the furnaces. The ship can destroy up to twenty million gallons of waste per year, which is necessary due to the demands for its services in both the U.S. and Europe. However, the U.S. market will supposedly exceed Europe's, and will steadily grow until 1990.

The new ship departed for its "initial survey burn" on December 10, in order to be certified by the U.S. EPA and IMCO. In mid-February, the vessel will be introduced to American government officials and industrial leaders in Washington, DC, and will then start servicing the U.S. waste market.

Chemical Waste Management, Inc., is a wholly owned subsidiary of Waste Management, Inc., and has its headquarters in Oak Brook, Ill.

Beam Me Up . . .

International Business Machines Corporation has started the first large-scale use of electron-beam methods to manufacture ROM's (read-only memory chips). Each chip is personalized, and can store up to 18,432 bits, which is about 400 words of data. The chips are used in IBM's most powerful central processing units (CPU's), which are the 3081, 3083, and 3084.

Before the new process was developed, IBM used an optical photolithographic process, involving a mask and chemicals, to etch the bit patterns on the chips. Now, the time is cut down to a third of its original length, as a computer-controlled electron beam tool directs electrons onto the chip to create the bit patterns. The chip is designed at IBM's Poughkeepsie, NY, facility, and the design information is sent via computer to their plant in East Fishkill, at the rate of one instruction per 8.5 nanoseconds. IBM also makes the personalized chips in Essonnes, France, using the same process. The whole process, from design to production, now takes about twenty days.

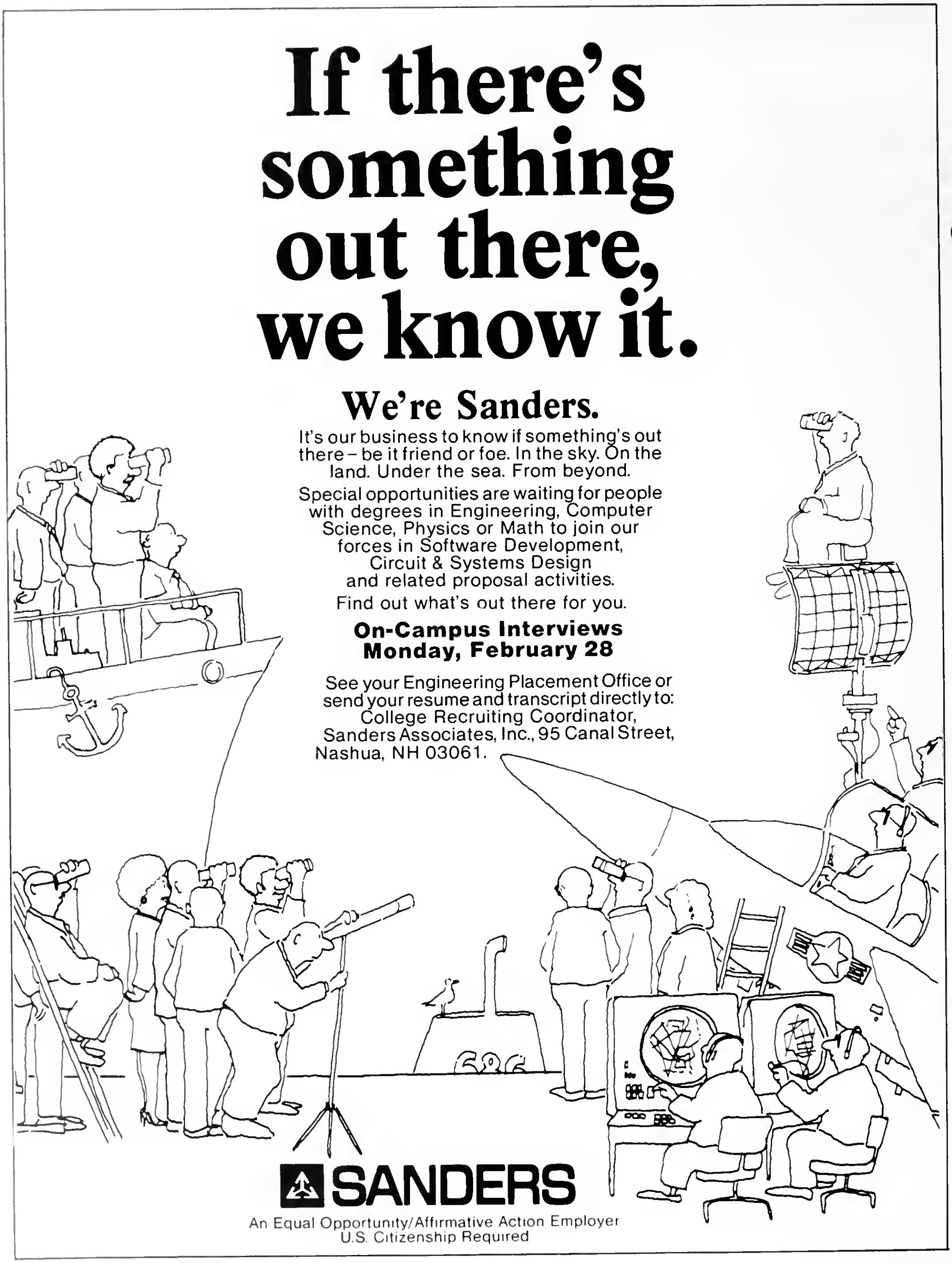
The chips are mounted onto thermal conduction modules (TCM's), which hold 118 of these chips. The TCM's are a major part of the computer's processor—they cool, protect, and interconnect the computer circuit components.

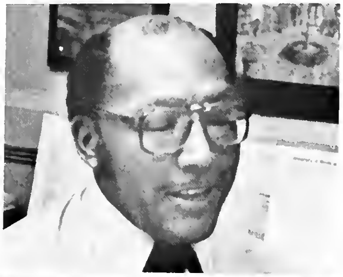
A Third Arm

Mitsubishi Electric now gives you that third arm you sometimes wish you had. It is called the RM-101 Movemaster, and it is a miniature robot. The Movemaster is ten inches high, and weighs under eighteen pounds. It can pick up about 1.125 pounds, has a maximum grasp of 3.125 inches, and operates at up to 2.75 inches per second. Three separate hands are provided, in order to handle any task. There are six axes, each driven by a stepper motor, and five degrees of freedom of motion. The robot can be repeatedly repositioned, automatically, to positions within only three millimeters of each another.

Mitsubishi designed their robot to function exactly like the industrial ones used on assembly lines. Thus, the Movemaster is intended for use by schools, colleges, universities, and hobbyists. The robot comes with fourteen pages of instructions, and a Centronics printer interface to facilitate computer control. Inside is a microcomputer, so the movement instructions can be given in a simple robot language, and may be programmed using BASIC. Finally, the most important feature of this product is that it is built to withstand the trials and tribulations of novices.

Langdon Alger


If there's something out there, we know it.
We're Sanders.
It's our business to know if something's out there – be it friend or foe. In the sky. On the land. Under the sea. From beyond.
Special opportunities are waiting for people with degrees in Engineering, Computer Science, Physics or Math to join our forces in Software Development, Circuit & Systems Design and related proposal activities.
Find out what's out there for you.
On-Campus Interviews Monday, February 28
See your Engineering Placement Office or send your resume and transcript directly to: College Recruiting Coordinator, Sanders Associates, Inc., 95 Canal Street, Nashua, NH 03061.
686
SANDERS
An Equal Opportunity/Affirmative Action Employer
U.S. Citizenship Required



Parker received his Bachelors in Mechanical Engineering (ME) from the North Carolina Agricultural and Technical State University in 1961. He began work on his Masters in ME while employed at Bell Aerosystems, and he received the degree from the State University of New York in 1969.

Dean Paul E. Parker Engineering students with administrative problems seek solutions in 207 Engineering Hall. Located in 207 are the offices of the assistant deans, including Paul E. Parker.

In 1967, Parker joined the ME department of North Carolina Agricultural and Technical State University (NCA&T). He was appointed department chairman in 1970, and in 1971 he became assistant dean of the NCA&T College of Engineering. Parker became an assistant deans here at the University in 1973.

Parker acts as a counselor for students in the college. His duties include providing curriculum advice, handling transfer students, and working with co-op programs. Parker also serves as the coordinator of minority relations in the College.

Presently, Parker spends most of his time working with or for students. He also does some consulting work for companies such as Standard Oil, Inland Steel, and Union Carbide.
Raymond Hightower

Professor Eisenstein received her undergraduate degree in physics in 1964 from Barnard College. In 1964 she earned her masters from Columbia University, and by 1969 she had received her doctorate in physics from Harvard University. Professor Eisenstein came to the University in 1967 where she was a research assistant doing work here for her PhD.

Laura Eisenstein More than nine hundred students taking physics 108 were in for a pleasant surprise on the first day of class when Professor Laura Eisenstein, walked in to lecture.

After receiving her degree, Eisenstein worked as a research professor for two years, and from 1971-1980 she was a research assistant professor, teaching sections in physics 101, 106, and 108. She is now an assistant professor, and also teaches physics 321 and 322.

Among the professor's credentials are a NATO post-doctoral fellowship in Paris from 1973-1974 and a membership on the editorial board of *Biophysical Journal*. In June of 1983 she will be a member of the nomination committee of the the American Association for the Advancement of Science. She is member of the American Physical Society Committee on the Status of Women in Physics, and will chair that committee this January.

Currently, Eisenstein's main interest is biological physics. Specifically she is studying light induced reactions in biomolecules called rhodopsin (vision pigment) and bacterorhodopsin. *Steve Alexander*

A native of Switzerland, Professor Wolfgang J. Poppelbaum received his Ph.D. in physics from the University of Lausanne in 1952. He came to the University in 1954 to work with John Bardeen on the development of the transistor, and he started teaching computer design classes right away.

Wolfgang Poppelbaum In 1954 Poppelbaum joined the Computer Laboratory research team in designing and building one of the first transistorized computers, the ILLIAC 2. He later became the director of the Computer Science department's Information Engineering Laboratory.

Poppelbaum is currently working with the multiplexing of information signals on optical fibers using "color modulation" and "spectrum sample transmissions". He is also working with computer speech processing systems, and a new kind of computer system called an "array" system in which internal information is "moved around much like a train."

Poppelbaum has published well over 40 technical articles along with several books, including a text on computer design. He is a Fellow of the IEEE, and has become well known as an expert in his field. He currently teaches CS 281, 381, and 497.
Gunnar Seaburg

The Career Is Yours.
The Place Is Ours.

Now that you have established a foundation for your career in engineering, your next step is to take your education and build a rewarding future.

At Black & Veatch, we can help you do just that. We seek out graduating engineers who are eager to work with an experienced team of experts to find solutions to some of the world's most pressing problems. We want individuals who will continue our internationally recognized efforts in power generation and transmission, pollution control, water resource development, solid and hazardous waste management, and industrial plant design.

The opportunities are yours. The place is ours. Tell us more about your career goals and explore your future at Black & Veatch. Write:

Cindy Sommer, College Recruiter
Black & Veatch, Engineers-Architects
Dept C
P O Box 8405
Kansas City, Missouri 64114
(913) 967-2000
An Equal Opportunity Employer M F

Black & Veatch
Engineers-Architects

we can put you in this picture

If you are a college freshman or sophomore in good academic standing, the Naval ROTC Program can be your chance for the experience of a lifetime. The Naval ROTC Program can provide you a path to great career opportunities, and also assistance now in your college education. Naval ROTC Scholarship and College Program opportunities are available now.

SCHOLARSHIP BENEFITS

- Full tuition and fees
- Book expenses
- $100 subsistence/month
- "Hands On" training during summer cruises onboard Navy ships and installations

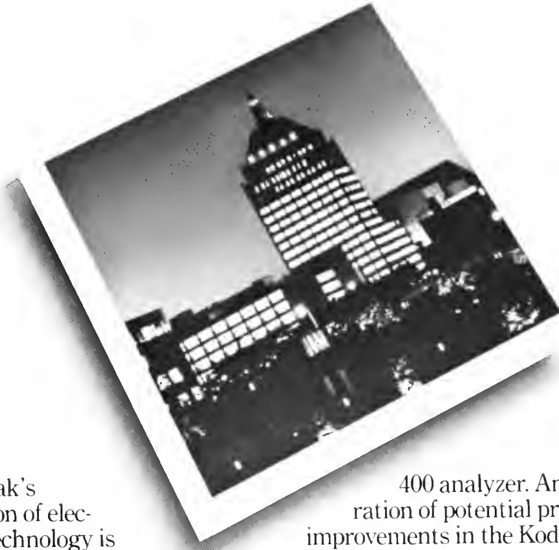
As a commissioned Naval or Marine Officer you can start immediately with:

- $17,000/year Basic income increasing to as much as $24,000/year in four years.
- Specialized training fields of
  - Nuclear Submarines
  - Naval and Marine Corps Aviation
  - Surface Warfare
  - U.S. Marine Corps

Let us give you the whole NROTC picture. Contact:

LT BOB BURNS
239 Armory Bldg.
Phone: 333-1061/1062

One of the nation's top companies in sales of electronics-related equipment is Kodak.



Kodak's application of electronics technology is becoming more and more extensive every day. That means we have growing career opportunities for electrical/electronics engineers.

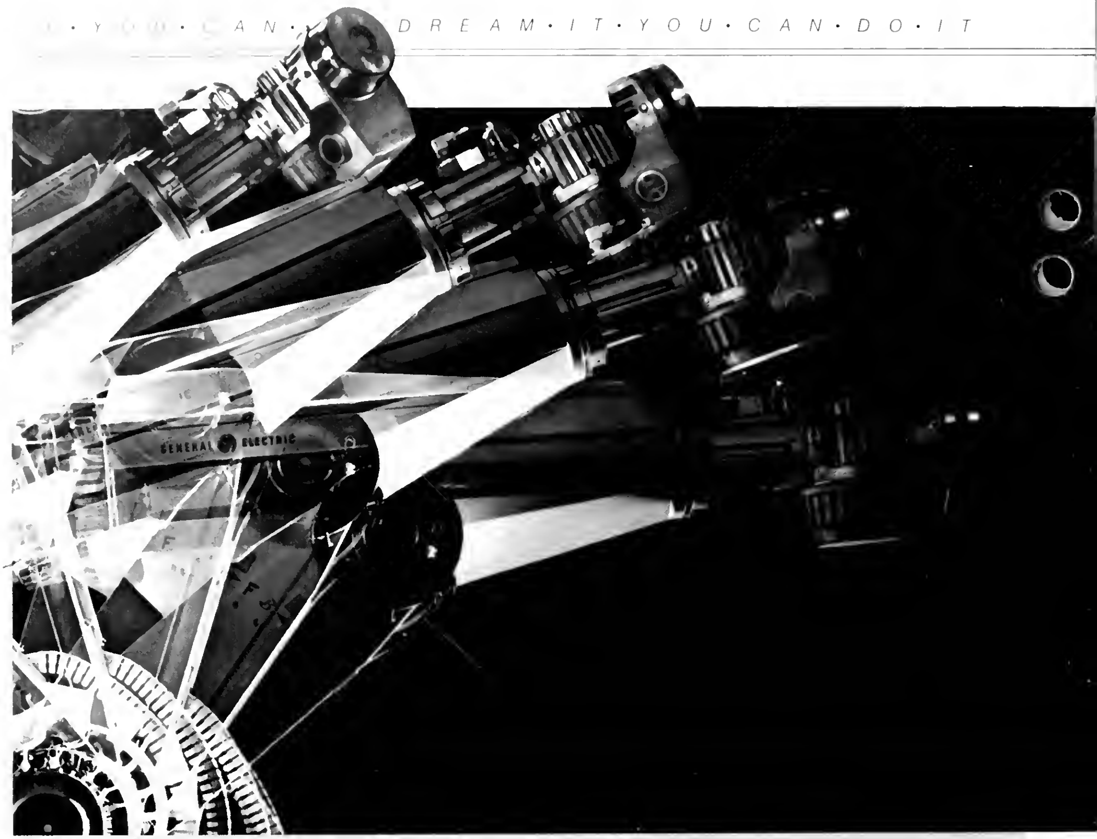
In projects as diverse as the design and production of output driver chips for the logic and control unit of Kodak Ektaprint copier-duplicators. Development of advanced analog and digital technology and sophisticated software techniques for blood-chemistry analysis with the Kodak Ektachem 400 analyzer. And exploration of potential product improvements in the Kodak Komstar 300 microimage processor, a computer peripheral which uses pulsed laser beams to convert digital data to alphanumeric images on microfilm at speeds up to 20 times faster than many ink-jet paper printers.

If you want to expand your horizons to meet the Kodak challenge, see a Kodak recruiter on your campus. Or send your resume to: Personnel Resources, Dept. DECM, Eastman Kodak Company, Rochester, N.Y. 14650.

Kodak

Kodak. The right place. The right time.

An equal opportunity employer manufacturing photographic products, fibers, plastics, chemicals, and electronic equipment. Plants in Rochester, N.Y Kingsport, Tenn.; Windsor, Colo.; Longview, Tex.; Columbia, S.C.; Batesville, Ark.; and a sales force all over the U.S.


GENERAL ELECTRIC

Looking into television

Illinois

Technograph

April 1983 Volume 98, Issue 5

4 **Chipping a New Lab** *Pete Kacmarek*
The ground floor of the Electrical Engineering Building is the home of a new microelectronics laboratory.

6 **Alternative Television** *Robert Ekblaw*
Public television offers a pleasant escape from commercial networks, and educates as well.

8 **The Crisis Continues** *Kevin Wenzel*
Without a tax increase, the College of Engineering could lose its shirt as well as its reputation.

10 **What Do Engineers Respond To?** *Larry Mallak*
Communicational conveyance is calling for easier terms.

12 **A Futuristic Parable** *Andrew Saporoschenko*
A fictional account of future engineering lifestyles is relayed.

Departments
Editorial 3, Tech Teasers 3, Technotes 11, Technovations 13, Tech Profiles 15

Editor: *Kevin Wenzel*
Production Editor: *Larry Mallak*
Business Manager: *Jim Lee*
Copy Editor: *Charley Kline*
Asst. Copy Editor: *Raymond Hightower*
Photo Editor: *Randy Stukenberg*
Features Editor: *Langdon Alger*
Design: *Nancy Grunthaner*
Assistant Design: *Beth Beauvais*

Publisher: *E. Mayer Maloney Jr.*
Production Manager: *Geoff Bant*
Adviser: *Ed Mast*

Editorial Staff: *Steve Alexander, Rob Busse, Dave Colburn, Doug Campoli, Tushar Chande, Joe Culkar, Tad Dierkes, James Ehrhart, Robert Ekblaw, Jane Fiala, Elayne Fletcher, Mary Kay Flick, Eric Guarin, Pete Kacmarek, Laura Kasper, Chris Konitzer, James O'Hagan, Bill Proctor, John Przybysz, Thom Roe, Doug Shaw, Andrew Saporoschenko, Robert Strahanowski*

Business Staff: Brian Carlson, Jeff Lee, Donna Obermaier

On the cover: A television camera stands ready to tape Illinois Press, a talk show aired by WILL-TV. Technograph takes a look at how the television station works.(photo by Randy Stukenberg)

Illinois Technograph
(USPS 258-760)
Vol 98 No 5 April 1983

Illinois Technograph is published five times during the academic year at the University of Illinois at Urbana-Champaign

Published by Illini Publishing Co., 620 East John St., Champaign, Illinois, 61820 Editorial and Business offices of the Illinois Technograph Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3730

Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001, 221 N. LaSalle Street, Chicago, IL., 60601

Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879.

Illinois Technograph is a member of Engineering College Magazines Associated

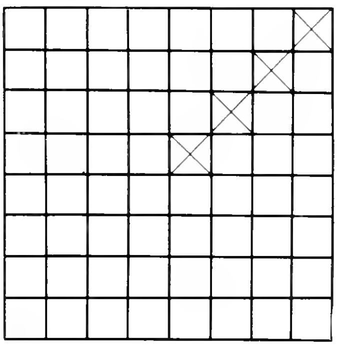
Tech Teasers

1. What is the largest product you can form by multiplying two numbers that are created by using each digit 1 to 9 (once and only once) between the two numbers? (example: 9876 × 54321 would satisfy the requirements, but their product is not as large as it could be)

2. If 92.5% of a town's population own gerbils, 71.3% own newts, 95% own pirhanas, and 63.4% own boa constrictors, what is the minimal percentage of people in the town who own all four kinds of pets?

3. A girl has to take three steps to keep up with her father's two when they walk together. If they both start out on their right feet, how many steps will the girl have to take before they both step together on their left feet?

4. In the quasi-generic chessboard below, each cross represents a king. Divide the board into four equal (equal in size, shape, number of squares, etc.) parts, where each part has one and only one king in it. You may not cut up and/or rearrange the board, and you may not move the kings.



Answers on page 14

Editorial

Keep it in Perspective

The room was huge, decorated in a putrid green, and filled with hundreds of engineering students like me, going to their first engineering class ever. Engineering 100, I thought, would be where I learn what engineers really do. I was entering the wonderful cosmos we all know and love, the College of Engineering.

The first man who spoke to us seemed bigger than life; he was a real dean, a man of power and control over our destinies. He began to speak about the greatness of the college, its facilities, its faculty, and the incredibly qualified students who graduate from here and get inundated with job offers at incredible salaries.

He compared the college to a forest. As you walk through the forest, you will meet giant redwoods who make this forest great. The Nobel Prize winners, the eminent professors of this college, they were the redwood pillars this institution rested on. I left my first engineering class with an unprecedented enthusiasm for being a student here; I was a part of a new world, exciting and different, and I had to channel my energies to make it the best world it could be.

At the second meeting of Engineering 100 I learned about my future job prospects. I would probably get 3.5 job offers at an average salary of $1800 per month. There were two things to do before I could expect success though.

The first thing I had to do was keep my grades up. In our class we saw charts and graphs that showed a clear correlation between grades and salary. If you want a high salary, they told us, you have to have high grades. I realized my goal now: straight A's every semester.

The second thing to do was to be active. My future employer would want to examine that all-encompassing record of my academic and professional achievements—my resume. How can I get a good resume? Be involved in every single organization on campus, and be an effective leader in all of them. Leaders from Engineering Council, Tau Beta Pi, Society of Women Engineers, the departmental societies, and of course, Technograph came to tell us how good their organization was. They all sounded great, so now I had another goal: do everything.

I was ecstatic. Here I was in a whole new world with new goals: always get straight A's, and do everything. These goals may seem conflicting, but they really aren't for a good engineering student. Ask anybody who has spoken at Engineering 100; they'll tell you that a good engineer lives for the College of Enginering and the extracurricular activities surrounding the college.

I admit, maybe I am exaggerating a little. No freshman in engineering is that enthusiastic about his new situation. Nobody takes on everything. The goals of involvement and supreme academic performance are conflicting. Part of education is learning how to balance those objectives.

The College of Engineering isn't really a world in itself. It's a part of the University, and the University is part of the state, and so on. The college is a small part of the whole, and without the whole, it cannot work. Witness the current financial struggle in the college, and you can see it is very dependent on external situations.

Extracurricular activities shouldn't define a student's life either. Students need to learn leadership ability and organization during school through participation in professional or social societies. But there is a fine line between devotion to a society and fanaticism.

The bottom line is perspective. Keep your classes, your societies, and the college in view. Remember to keep the whole in mind as you work to improve the parts.

Kevin W. Wenzel

Chipping a New Lab

Bigger is cheaper. Some people say, "No, no, no. In today's world of microelectronics and mini-computers we all know the smaller the product the cheaper it gets." So maybe we should store away this motto together with "the bigger, the better" into the loneliest, darkest memory locations of the latest state-of-the-arts computer.

For years, many solid-state engineers have been chanting "bigger is cheaper" just as often as "smaller is better." The practice of this "bigger" philosophy by the semiconductor industry has been met with much satisfaction by the Electrical Engineering Department at the University, especially from Professor George Anner. For it is this philosophy that has helped the department add a new lab to its present semiconductor fabrication facilities—FAB II.

How does the solid state industry save money by using this philosophy? Today, integrated circuits (IC's) are processed using a modern technique called batch fabrication. That is, many IC chips are processed simultaneously on one large, circular chip or wafer, usually made of silicon, and later separated into individual chips. Currently, an average small chip measures approximately 18 mils x 18 mils. The cost of processing is independent of the number of single devices comprising the circuits or the size of the wafer. Therefore, the industry uses two methods to decrease the unit cost of a device. They reduce the size of the device and/or increase the size of the wafer. Besides the continuing trend to produce smaller and smaller devices, manufacturers are also making the wafers bigger, in an effort to achieve lower unit costs. Wafers grew from 1 inch in diameter to the 3 or 4 inches in diameter which are used today. And yes, companies are already playing with the idea of 5 or 6 inch wafers. However, there is one disadvantage. When companies begin using larger wafers they can no longer use their previous processing equipment. This leaves many semiconductor manufacturers with a large supply of slightly used, highly sophisticated equipment.

In 1977, electrical engineering professor George E. Anner began contacting many University alumni now in the solid state industry, inquiring about their company's supply of obsolete processing equipment. He hoped to acquire some of the equipment in order to improve the present undergraduate microelectronics lab. The companies responded very favorably to the request. National Semiconductor Corp.; Motorola, Inc.; Texas Instruments, Inc.; Teletype; Delco Electronics; Harris Semiconductor; Fairchild; Mostek Division of United Technologies Corp.; Intel Corp.; Tektronix, Inc.; General Electric Co.; General Motors Corp.; IBM Corp.; Zenith; Westinghouse; and Whirlpool Corp. supplied enough equipment to update the present lab and then some. George Anner now recognized there was enough equipment to furnish a whole new lab. It was at this time he proposed the idea of FAB II. But money was still needed for the construction of the lab. In 1980, United Technologies Corporation

Left, equipment to be installed in FAB II sits in the outer room of the lab. At right is a view into the Gold Room through a hole that will be a ventilation duct. The Gold Room is one of the "clean" rooms of the lab with a controlled environment. (photos by Dave Colburn)

(UTC) donated $500,000 to the EE department: $100,000 per year for five years. The electrical engineering department used $250,000 of the UTC gift to fund construction of FAB II.

FAB II will be located front-and-center on the ground floor of the electrical engineering building. When one looks through the vertical glass panels into the "clean room" of the partially completed FAB II, many large grills can be seen on the ceiling. These grills cover air intake filters. After double-filtering, the air is returned via the vents located on the walls just above the baseboards. The 1700 square foot "clean room", characterized by its white, sterile interior, also has temperature, pressure and humidity controls. This controlled environment is required when fabricating semiconductor devices. The lab also consists of another room without a controlled atmosphere.

The construction of the lab began in the summer of 1982 and is a collaborative effort of many local contractors. Coordinating the project is the engineering firm Henneman, Raufeisen, & Associates of Champaign. The original site of the lab was to be in the west wing of the ground floor. The entrance to the present site is difficult to find. A person wishing to enter the lab must go to the west wing and use the north hallway.

According to Anner, the present undergraduate microelectronics facility is "the only school lab dedicated to undergraduate teaching of solid state fabrication". Anner, who has retired from teaching as of May, 1982, has gained the respect and admiration of both students and faculty in this area of undergraduate education. He has received the Everitt Award for Teaching Excellence from the College of Engineering in 1980 and 1972 and the Award for Excellence in Undergraduate Teaching from the University in 1975.

Other schools, such as Purdue, have similiar labs, but these are reserved for staff and graduate students only. Anner also stressed that the University lab teaches simple device fabrication, not IC processing. The lab,located in 133 Electrical Engineering Building, serves two groups of students: those enrolled in EE 344, Theory and Fabrication of Solid State Devices, and those students who have already taken EE 344 or who are already familiar with device fabrication. The latter group consists mainly of graduate students in other curricula such as physics, metallurgy and ceramic engineering. The 70 students per semester enrolled in EE 344 have priority in the lab. Therefore, the second group of students are often left out in the cold. FAB II will provide more time and superior equipment for these advanced students. There are no plans to schedule any EE 344 sections in the lab.

The facilities available in FAB II will enable students to make smaller devices and prepare the masks needed to etch semiconductor materials. Company donated equipment will include a scanning electron microscope, chemical vapor deposition equipment, an electron gun evaporator and planetary fixture, diffusion and oxidation furnaces, a projection mask aligner, an automatic profiler, and a lead bonder. Most of the equipment was used to process 3 and 4 inch diameter wafers. Anner likes to refer to the lab as an independent facility available to students of all curricula who are in need of semiconductor fabrication equipment.

FAB II is expected to be ready in the fall of 1983. EE research engineers John Hughes, Arno Schriefer, and K. S. Yang are currently moving equipment into the lab and completing the final tasks of hooking up the exhaust, gas, deionized water and electrical systems. Some equipment may be available for use in a few months. J.J. Coleman, Professor of electrical engineering, will assume responsibility for the lab due to Anner's retirement.

When speaking with Anner about industry's role in education, he commented, "The semiconductor industry says the schools are not turning out enough engineers." He said companies are willing to help improve education as demonstrated by the success of FAB II. He pointed out that companies would like to give direct financial help, but the present tax structure makes it impractical to do so. If the state's high technology plan goes as scheduled, the EE department will be preparing for a new microelectronics center, to be housed in the Illinois State Water Survey building on Springfield Ave.

What if information about FAB II were fed into the state-of-the-art computer discussed at the beginning of this article? The display screen would output, "Education is better." Smart computer. ■

Alternative Television

Imagine a bored student on Saturday afternoon. He drags himself to the television. In a weak motion, he flicks the dial to turn on the set, and spins the channel dial, and passes up the ordinary sports games, interviews, and old movies. Suddenly, the screen is ablaze with gunfire. Entranced, the student sits back, preparing himself for a thrilling adventure.

The channel this student found was WILL, Channel 12. WILL is the local Public Broadcasting System (PBS) station. Like all PBS stations, WILL doesn't show the usual sports games, soap operas, game shows, and situation comedies that flood the other channels. They show educational programming, documentaries, and movies. Best of all, the programs shown are freshly picked each year, so there are no boring reruns.

Since the programs are changed every year, new programs must constantly be screened. This is done by the Interregional Programming Service. The service is an association composed of representatives from several public television stations throughout the United States. They preview many prospective programs for use on the Public Broadcasting stations. As they view the shows and movies, they rate them for entertainment and interest value. Then they compile their data and create a list of those programs which they feel are the best. Clips of shows from this list are distributed to the program directors of all PBS and other public television stations across the country.

The program director of WILL is Elaine Sprenkle. Her job is to decide what programs to present on the air, and when these programs should be shown. She views the Interregional Programming Service's presentation of possible programs. From among those, she decides which ones the station should purchase for broadcast on the air.

"I basically look for programs that our audience will enjoy," Sprenkle said. "From reviews we've received from past programs, I have a good idea what appeals to our viewers." She has come up with many favorites, which backs up this claim.

One production that appears to be a big favorite is the Adult Education telecourses. The classes are run by local colleges and presented by WILL on Saturday morning and early Saturday afternoon.

It's very easy to determine which of the telecourses to broadcast on the air. "I decide which to broadcast by the number of people who sign up to take the course. The more people who sign up, the better the chance of that one getting on the air," Sprenkle said. How does one follow the course once signed up? "The students purchase the books needed for the course when they sign up. The televised sessions are based on chapters in the book. Without the book, the course would be very difficult to take."

With all the new programs to purchase, money is a necessity. In order to maintain a proper budget, an annual telethon is held to raise money from the local community. This year's telethon took place from December 3 to December 12. The telethon is very important, because a large part of the station's funding comes from private sources and the community, and the amount of money needed increases every year.

In Fiscal Year 1982, 30% of the station's budget came from state funds, 21% from federal funds, and 49% from private donations and the local community. For Fiscal Year 1983, the federal funds de-

Robert Ekblaw

Opposite page, Floor director Henry Radcliffe III gives instructions to John Messman on camera 2 during taping of the Illinois Press show for WILL-TV. At left, Radcliffe applies make-up to Bob Zimmer of the Assocated Press while Lex Peterson of the Champaign News Gazette checks her glasses. Producer Carl Caldwell, right, discusses the show with IBHE director Richard Wagner. (photos by Randy Stukenberg)

creased to 17%, state funding remained at 30%, but the community's slice of the pie increased to 53%. Compound this situation with a 7% budget increase and one realizes that WILL requires a lot of money from the community. If they had fallen short of their budget, many new programs and needed equipment would not have been bought, which lowers the quality of programming at the station. Fortunately, the telethon was successful this year. Their goal was met, so the fine programming can resume.

Because of the success of the telethon, WILL was able to purchase new programs. Along with the common PBS shows like Seasame Street, MacNeil/Lehrer Report, Nova, and Masterpiece Theatre, new comedy shows and new movies can now be seen on WILL. The station is also busy aquiring new episodes of the highly—popular series called "Doctor Who". All of these additions are meant to raise the quality and entertainment of WILL.

WILL Channel 12 is located on University property, since their offices are in the Communications Building on Main Street. Thus, one would think that they would interact with the University. This is true. WILL interacts and cooperates with the University in several ways, the most common of which is filming "fillers". Fillers are shown at the conclusion of programs which do not end on exact hours or half-hours. This is important since WILL is commercial-free, so soon after one program ends, the next begins. To maintain a nice schedule, they begin and end programs on the hour or on the half-hour. If a program is only fifty minutes, a nine or ten minute filler is played following the show. These fillers are typically focused on the University. They may be interviews with professors or announcements and previews of University events, like Engineering Open House.

Fillers are not the only way the University works with WILL Television. University cable channels are filmed with WILL personnel and cable equipment. If the University has a program to be shown on television, they may use a WILL studio.

University students have even found WILL to be a prospective job market. WILL may use some University students during winter holidays to replace vacationing staff. They may ask them to help during the telethon, when additional personnel are needed to answer phones and keep records. University students may also be used for University programs or fillers. Commonly, the help comes from the College of Engineering, so students in need of a job might find one available.

Despite the deluge of programming available on the three commercial networks and the many options offered by cable and satellite television, public television provides a pleasant method of being entertained or educated without the commercials or monthly bills. ■

The Crisis Continues

A story ran in the April 1980 issue of Illinois Technograph entitled Crisis in the College. That story painted a bleak picture of the College of Engineering, a college in financial trouble. Today the picture is much bleaker.

"Quality is a strange business; it takes decades to build it up, and in a few years you can tear it down," Daniel C. Drucker, Dean of the College of Engineering, said this in reference to the possible fate of the Engineering College.

Quality is a valid word to describe what the college has developed over the past few decades. The University College of Engineering is ranked consistently among the top four in the nation based on faculty, research facilities, and the number of engineering degrees awarded each year.

The quality in the college runs a real risk of drastically declining, however, if the present financial status does not improve soon. The faculty is being drawn away by higher paying industry, the research facilities are becoming out-of-date, and because of these factors, it is necessary to limit enrollment.

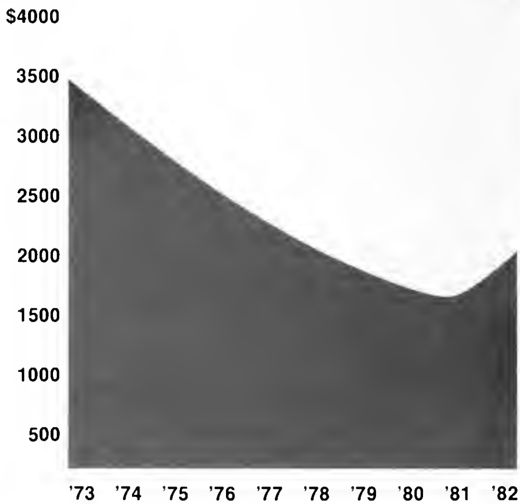
The status of the college has been slowly declining for quite a few years in terms of the amount of money received per student. In 1972 the college had a total undergraduate enrollment (including computer science) of 3127. By 1980 that figure had soared to a high of 5359, representing an increase of 71%.

The money coming into the college from the state had not followed the same trend. In Fiscal Year (FY) 1973 (academic year '72-'73) the college's state-funded appropriations totalled $10,863,000, and by FY 1979 that number had declined to $9,901,000 in constant 1973 dollars, a decrease of 8.8%. The college was fighting a losing battle.

To alleviate some of the financial strain, administrators hiked enrollment requirements, decreased the number of out-of-state transfer students to almost zero, and curtailed foreign student enrollment. Due to these actions, the college realized a decline of about 20% in undergraduate enrollment from the 1980 level to 5122 in 1982.

Things appeared to be improving in September of 1982, because the FY 1984 budget included a $34.4 million increase for faculty compensation. This was to provide a 12.5% salary increase across the board with an additional 8% going to engineering faculty.

State Dollars per Engineering Undergraduate
deflated to 1973 dollars



Source: College of Engineering, University of Illinois at Urbana-Champaign

Then something went wrong. October revenues in 1982 fell $107 million short of the 1981 mark. Unemployment and the recession in general caused income and sales tax receipts to plummet. In response to this loss, Governor James Thompson was forced to slash state spending 2%, for a total of $164 million. The University suffered a recall of $7 million from operating expenses.

University administrators went into action, cutting weaker programs and searching out other ways to save money. In December they announced a three part plan to reduce spending. Students would see a $100 increase in their tuition bills; faculty would not see their 3% pay raise, originally scheduled for January, until March; and personel would be reduced by at least 2%.

Most students agreed they could stand the tuition increase; after all, they are the direct benefactors of the education they receive here. The students hurt most were those with financial aid, but most programs provided extra help for those who needed it badly.

The 2% cut in personel hasn't caused major waves of turmoil across the campus yet either. Most of the decrease will come as people retire without being replaced. This will cause serious problems as class loads grow and some sections are canceled, but it is not the major effect of the cuts.

That distinction belongs to the postponement of the faculty salary increase. Most faculty can live with that delay, but the question of future pay raises is a much deeper issue. What will happen to the proposed 20.5% increase for engineering faculty in FY 1984? It probably will never materialize without tax increases in Illinois.

Engineering faculty are different from other faculty with respect to pay raises and industrial job offers. As Drucker pointed out, "Engineers don't bargain". When an engineering faculty member is interested in a job offer from industry, if he wants the college to improve his salary to induce him to stay, he must submit a proposal to the head of his department, who passes it on to the dean, who sends it to the president, who must present it to the Board of Trustees. The Board then evaluates the proposal and sends its response back through channels to the waiting professor. Unravelling the University red tape for this process takes time, and most engineering professors don't like to wait long.

Instead, engineering professors usually ignore outside job proposals until their situation here is just bad enough or the salary in industry is just good enough to leave. So there is no warning; they just say good-bye. "Once you lose enough people to get worried, it's too late," Drucker explained. Combine this with the current financial struggles, and you have the right ingredients for an avalanche of faculty away from the University.

There is, however, hope that this situation may be avoided. Included in the University's FY 1984 budget request is a separate section called "Special Engineering Programs". The aim of this portion of the budget is for the state to allocate an additional $6 million to the engineering programs at the Urbana and Chicago campuses to achieve four major goals: ". . . 1) to enhance engineering faculty and graduate assistant salary levels to retain current faculty, and to aid in attracting top quality faculty and graduate assistants; 2) to add faculty to reduce student/faculty ratios so that enrollment levels may be maitained; 3) to replace outdated equipment; and 4) to modernize facilities.

The $6 million figure was reached by adding the requirements to achieve each of the above goals. The budget request estimated that a salary of $34,000 for new assistant professors would be needed to hire quality faculty. The budget requested a 12.5% ($1.5 million total) increase in faculty salary across the board to bring new faculty salaries up to par and to avoid salary compaction.

Student/faculty ratios have jumped 25% from 11.7 to 14.6 overall since 1974 according to the FY 1984 budget. To raise the ratio to its previously decent level, the budget estimated that $6 million would be needed for new faculty. Spreading this out over a three year period, it called for a $2 million increase in FY 1984.

For new equipment, the budget requested $1 million per year for the next two years based on a 1978 study by the Association of Independent Engineering Colleges. The remaining $1.5 million is to go to facilities remodeling.

University President Stanley Ikenberry has stated publicly that this program, known as the "special engineering initiative" has number one priority. According to Drucker, "We've shifted all our efforts to the special initiative." The fate of the college may not be so bleak if the initiative prevails and certain tax increases are passed by the state legislature.

But what if the initiative doesn't work? What if no more money comes into the college? Drucker indicated that there are "a variety of techniques we could use to carry us through for one year. It's not clear how it would work beyond that."

Are there more tuition increases in the works for the future? Probably, but the legislature is not likely to base all of the University operating expenses on tuition; that would create an unusually big burden on the students here, and enrollment would plummet, not exactly the desired end result.

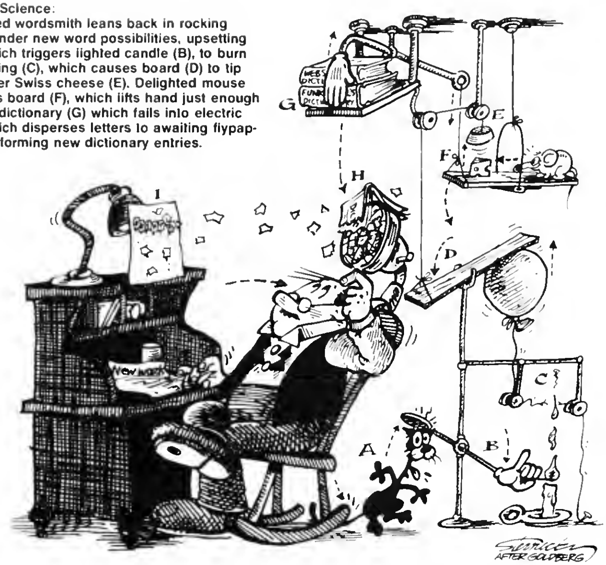
One can see then, that the future of the College of Engineering is tenuous at best. It rides on the decisions made by our legislators in the very near future. It is clear that a tax increase is imperative for the survival of this school and probably the State.

The article of two years ago ended on a somewhat happier note. The author cited good job opportunities for graduating engineers and urged them not to worry too much. Now, however, one cannot rely on an improved placement picture to brighten this story of the college. The average starting salary has risen from a monthly $1775 two years ago to about $2068 today, but those jobs are harder to find. The average number of plant trips has dropped from 3.8 to 3.5, and the job offers have fallen from an average of 3.2 to 2.5.

The national recession has taken its toll on the demand for engineers as well as on the quality of the college. ■

Larry Mallak

What Do Engineers Respond To?



Down to a Science:
Exasperated wordsmith leans back in rocking chair to ponder new word possibilities, upsetting cat (A), which triggers lighted candle (B), to burn balloon string (C), which causes board (D) to tip and uncover Swiss cheese (E). Delighted mouse imbalances board (F), which lifts hand just enough to release dictionary (G) which falls into electric fan (H), which disperses letters to awaiting flypaper (I), thus forming new dictionary entries.

Engineers respond to society's problems. But so do politicians, doctors, economists and a host of other experts. I must take an aside here to define the word expert: since X is usually a symbol used to denote an unknown, and a spurt is a drip under pressure, then logically an expert is an unknown drip under pressure. This is an example of an engineer responding to language, which is one of society's problems.

As an engineer, I will now describe a methodology which will lead to the solution of the ever-present English language problem. First step is to eliminate language. This has been successful in only a select few of our population—the deaf-blind-mute.

However, natural selective (Darwinian) pressures could provide an easy solution to our problem if language would de-evolve back to the days of cave drawings and earlier. This theory has been touted by notables such as DEVO as the theory of de-evolution. Are we not men? Sorry, that's another essay.

Since total elimination of language is not feasible, perhaps we could streamline and cut the excess out. I mean, really, when's the last time someone called you uxorious? Uxorious means "foolishly fond of one's wife." Is there a similar word for women who are foolishly fond of their husbands? Better yet, are there any women who are foolishly fond of their husbands?

All those extraneous words get in the way of the one you want to look up and should be eliminated (or at least abbreviated). Chances are, though, that the dictionary will continue to expand as technical words are invented to cover new engineering marvels. So, like, we're responsible for making the dictionary bigger? Right. Here's where we've got to make the exceptions: for example, if one of your engineering buddies swallows a computer chip, we need a word to put this all together—*engastrochipation*.

Many other words have need to be invented to describe life's marvels and perils. The student who finds out he is the only one of his clique not going to Florida for spring break is in a state of "nobeechformee".

Now that I have gotten thoroughly sidetracked on the engineer's response to language, one can see that there is much work to be done in this area. We need linguistics engineers to work in two capacities: 1) those who can develop highly technical words to describe things which engineers do so that the layman can't read our reports without a dictionary, a CRC Handbook, and the latest issue of Scientific American, and 2) those who can eliminate words which are no longer needed or too easily understood by the layman.

What is needed is to regress to the simplistic, yet mind-boggling sentences of earlier thinkers. Some French guy with a lady's name (I'll call him 'René') summed it all up when he said, "I think, therefore I am ⟨confused⟩." If all would follow this fellow's logic, we would all be confused and have no time to develop engineering marvels and perils and wouldn't have to make up words to describe things the laymen who are mystified by our seemingly endless knowledge. By being confused, language would have little meaning and would no longer be one of our problems. ■

Knight Time

The King, rather, the Saint, has knighted fourteen new Knights this year. They were chosen from about 1500 total engineers here at UIUC, and they all fulfill the requirements. All Knights of Saint Pat must have exhibited outstanding leadership and participation in student activities which pertain to engineering. The new Knights are: Yannis S. Arvanitis, CompE; Keith E. Brandau, CE; Kathryn Cation, Civil; Daryl L. Farley, EE; Lynne Gignac, CerE; Luis Blas Gonzalez, EE; Jeanette S. Harms, GE; Constance A. Kus, IE; George C. Mejicano, CerE; Daniel J. Talken, ME; Donald L. Tappendorf, CE; Kathryn R. Wilson, Eng. Mechanics; Carol Lynn Winte, ChemE; and Andrew J. Wisniewski, CS. Congratulations to them all. They were knighted at the Saint Pat's Ball, last March 5 after EOH '83.

Very Awarding

What do Grace Wilson and Julie Mae Schoenung have in common? Well, Ms. Wilson is a University alumnus who was on the General Engineering Faculty from 1946 to 1973, and Julie Schoenung has received the honor of becoming the eleventh Grace Wilson Award recipient. The award is given annually by the Champaign County chapter of the Illinois Society of Professional Engineers Ladies Auxiliary, and the award winner must be an "outstanding graduating woman engineer." Ms. Schoenung has received several previous awards, and has been the president of Keramos. She will be graduating from the ceramic engineering department.

Professor Charles A. Wert was named as a fellow of the Metallurgical Society last March at the Society's annual meeting. He is one of five such fellows that were named this year, which is quite an honor considering there can never be more than 100 active fellows at once. Professor Wert is the head of the metallurgy and mining engineering department, and his research is in the changing of metal properties by using gases, and also in the structure and chemical make-up of high-sulfur content coal in Illinois.

Lots of Bits and Pieces

Can you imagine trying to write down as many as 100,000 pieces of information, or even entering them into a computer, fast enough so as to continually monitor an event as fast as a particle splitting? Thanks to University physics and EE professor R.M. Brown and senior research physicist Robert W. Downing, the problem is solved. FASTBUS is the new information retrieval system they are perfecting, and it can grab information as fast as one billion bits per second.

In actuality, FASTBUS is a bundle of components that are put together to form data retrieval networks. The package rests between the experiment hardware, where the information is picked up, and the computer or data storage bank. The network takes information from up to 100,000 sources and extracts only the data that is relevant to the experimenters' needs. Once this is accomplished, FASTBUS ships it super-fast to the storage area.

This system is faster and more usable than any other data retrieval network that currently exists, and a big reason for this is that it is installed very close to the action. This way, the piles of information will not overwhelm the scientists. FASTBUS underwent its initial test last October, with four segments (each of which sent data at a billion bits per second) and three computers. Two of the segments were made at the European Organization for Nuclear Research, and two were created at the University.

The tests demonstrated the immense capabilities and flexibilities of FASTBUS. The network system was built and designed by physicists to help them in their research, but FASTBUS can also be used in other areas. A good example of this is the real-time simulation of human blood circulation, due to both the speed and number of sensors which FASTBUS can use. The system also saves money, since some experiment equipment is quite expensive; particle beam accelerators can cost up to $50,000 an hour.

The University of Illinois has been in the field of high-speed data retrieval since the 1950's, when it introduced NIM, the Nuclear Instrumentation Module, to the world.

Changing of the Guard

Illinois Technograph has chosen its staff for the 1983-1984 school year. The following people will bring you the magazine in the future:

Editor: *Larry Mallak*
Production Editor: *Langdon Alger*
Business Manager: *Raymond Hightower*
Copy Editor: *Laura Kasper*
Asst. Copy Editor: *Robert Ekblaw*
Photo Editor: *Jane Fiala*
Features Editor: *Jim O'Hagan*
Design: *Beth Beauvais*
Assistant Design: *Karen Peters*

Langdon Alger

Andrew Saporoschenko

A Futuristic Parable

This story takes place far in the future, in a society as far removed from our age and thinking as we are removed from the primitive cave-rumblings of Neanderthal society. How this story was conveyed to the author is beyond the scope of his understanding. He only knows that one day, the story appeared in his mind.

This futuristic society enjoyed all the fruits of thousands of years of development. The science of urban planning had created a shimmering metallic skyline, mixed with lushly verdant parks, and dotted with many small, self-sustaining living areas. Thousands of years of experimentation with the futility of war, and the beautiful quiet of protracted peace had resulted in the extinction of all war several years ago.

Agricultural engineering had created an abundant supply of food for everyone, in all varieties. The citizens of this utopian society could dine on luscious fruits, better than those that had tempted Eve in the Garden of Eden; on dainty pastries of wicked sweetness, with no added calories; and on thick, juicy, protein meats, which no animal had given his life for, since the meats were artificially produced in laboratories from mutated protein cells.

All sorts of entertainment were provided for the citizens. There were many huge game parlors and amusement parks in each neighborhood, run entirely by machines. Many spell-binding shows were put on. Home entertainment centers, with several options, were available in each home. There were many types of entertainment, but everyone had enough leisure time to try them all.

Gentic engineering and medical science had created perfect human bodies. By our standards, each had an exquisitely beautiful physical appearance. Every person, though, for all his beauty, looked almost like every other.

The wonders of technology kept everybody clothed, fed, and adequately sheltered. In fact, technology had reached such a peak that the minds of the people did not have to function creatively to design new technologies, to solve pressing problems, or to help man define and substantiate his existence. And that was exactly what happened.

No longer were tortured eloquies written on the frailty of the human soul, nor were long tomes, delving into the meaning and betterment of society. No longer did sharply sculpted, or well-acted films appear on the screen. New symphonic wonders did not come to fruition because there were no composers to write them, and no one willing to spend the many years of practice to become an accomplished musician. The mental soul had withered, though the ability was still there, as the physical body had grown in appearance.

The sad fact was that this society was not happy in its utopian world, for everyone was literally "bored out of his mind." They had played every game, seen every show, been to every amusement park many times. Everybody wore the same styles so no one could take pride in having the "latest"; every new style was just a slight variation of an oft repeated standard. Never had anyone felt the sting of bitter cold, so no one could take pleasure in warmth. They had never gone hungry or thirsty so satiation held no joys. They had become so accustomed to living off their machines, in a state of ennui, that they could not find a way out of their predicament.

Then one day, by some freak accident, providence, or by the law of probability, if you believe in such laws, a terribly ugly baby was born to one of the citizens of the society. This baby was ugly by our standards, but to those of the utopian society, she was something immensely freakish. They, nor their forefathers for at least several thousand years, had never known anything but a "perfect" birth.

The birth, of course, caught the attention of the entire society. At first, there were trepidations concerning the baby. Would she cause disruptions in the balance of things? Who would mate with her, since everybody had a perfect mate in this society? But nobody was able or willing to think too deeply about any possible problems, so the baby was allowed to grow into a child, and few people visited her after the initial excitement.

As the child grew up, subtle changes took place, partly because while the child had a freakish face and body, her mind was also beautifully freakish. On her own, in her isolation, the child began to create beautifully lyrical haikus. Later, as she grew older, she wrote longer, and fairly complex pieces. She tried to interest others in her writings, but no one could see any usefulness in the concentration it would take to read even a simple haiku. Finally, she interested one intrepid youth, who found a strange satisfaction from one of her short poems. Slowly her writings spread among almost the entire society. The males of the society, bored with the perfect sameness of all the other females, found a beauty in the uniqueness of her looks, and she had no lack of possible mates.

The mind of this child was the catalyst for the beginning of a new renaissance in creativity. A slow, and primitive renaissance but an awakening nonetheless, for this society had rediscovered an ancient proverb, "beauty is in the eye of the beholder." ■

Technovations

Bread & Board

Here's a product that is exceptionally useful for both the University and the students themselves. E&L Instruments Incorporated, from Derby, Conn., has combined a power supply, control switches, logic monitor lamps, a signal generator, input/output connectors, and breadboarding sockets into one convenient desk top unit. This means that you can build and test just about any TTL, linear, and CMOS circuit you can design without solder (or mess!), and in much less time than ever before.

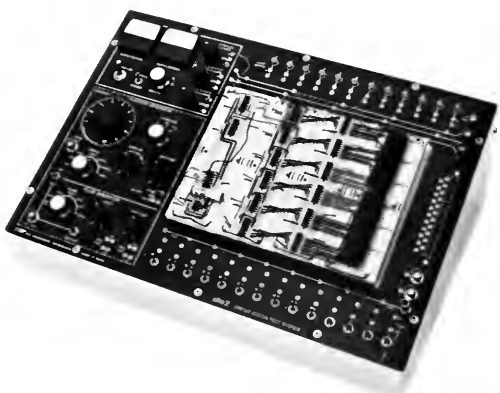
The four identical breadboard sockets will accept any wire, circuit, component, or IC leads from 20 to 26 gauge. All the power, control, signal, and indicator components built-in will take your average 22 gauge solid wire. There is absolutely no need for patch cords or soldering. Oh yes, it is called The Elite 2 Circuit Design Test Instrument.

My HERO

Did you happen to see that funny gray thing running around the second floor of EEB during EOH? Well, it is a kit available from Heathkit/Zenith, and the basic unit (without the arm and voice) costs only $1000. The HERO 1 is programmable, and it can do an endless list of tasks.

The robot has three wheels, with steering and drive all on one wheel, which allows it to run around in any direction, and turn in a one foot radius. You can program it through a keyboard on its "head," or by using either a remote-control unit or a pre-recorded tape. One tape can store up to 1000 individual steps. The HERO 1 has a 6808 microprocessor inside of it, so it is "intelligent" too. The basic model has a control panel, a light sensor beam which can detect any spectra of light down to one part in 256, an "omnidirectional sound sensor" which hears frequencies from 200 to 5000 Hertz, with the same 1/256 resolution, and twin ultrasonic beams which detect movement up to 15 feet away, and which figure out an object's distance up to 8 feet away. It also has a "sleep" mode, where it conserves power (which comes from 4 rechargeable batteries) until it sees intruders (or its master, I suppose), when it wakes up and warns them that it exists. There are two optional accessories, also: a voice and an arm. The voice is a Phoneme Speech Synthesizer which has four levels of inflection, and can speak full sentences. The arm rotates up to 250 degrees, and the wrist rotates 180 degrees. The hand can hold up to a full pound.

Since the HERO 1 is from Heathkit/Zenith, you can build it yourself, thus learning quite a bit about it. You can also buy it fully assembled. It is designed in part as a teaching aide, and will withstand a student's curiosity.



The Elite 2 Circuit Design Test Instrument allows quick and clean circuit testing.

Scribe it the Fast Way

Tired of the conventional lettering techniques? If you do any drafting, the answer is probably yes. Ozalid Corporation has the answer; it is Datascribe IV, a portable computerized lettering system.

Basically, it consists of a keyboard, a LCD display, a microcassete data recorder, and the 18x30 inch plotting area. All you do is plop the system on top of your drawing, type up what you want printed, and the plotter will print it out on your draft with wet-ink technical pens, felt-tip markers, or broad-tip pens in letters from one-sixteenth to 3-1/8 inches high. The system has an 8000 keystroke working memory, and one microcassete can hold up to 50,000 keystrokes in memory storage. The display is eighty characters long, plus it also gives liquid crystal prompting commands. This way, the user may view and edit the copy before finally printing it. Datascribe IV can rotate the letters and symbols a full 360°, in one degree increments. There are all kinds of character and symbol sets already, and Ozalid Corporation can design a custom set for you, too, including your company logo. The system weighs only 29 pounds, and supposedly you can letter and symbol up to ten times faster with this system than with conventional methods. The only problem, for all you GE 103 students, is the price tag: $8500 apiece, available immediately.

Langdon Alger

from page 3

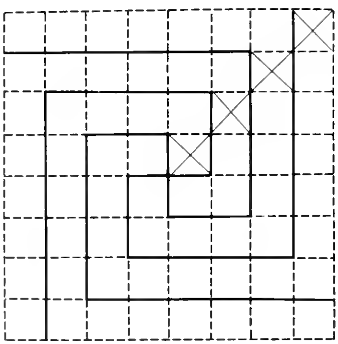
Tech Teasers Answers

1. 9642 × 87531 = 843,973,902.

2. The answer is (92.5 + 71.3 + 95 + 63.4)% − (4 − 1) × 100% = 22.2%.

3. Never. Think about it.

4. The solid lines represent the lines that divide the board into the four equal pieces.



Jim Stubbins graduated from the University of Michigan in 1970 with a B.S. in Nuclear Engineering. From there he moved to the University of Cincinnatti to complete his M.S. in Nuclear Engineering, and by 1975 he had earned his Ph.D. in Metallurgy and Materials Science.

Alan M. Nathan receieved his B.S in physics from the University of Maryland in 1968. Before graduate school, he served in the army for two years. Nathan received his M.S. and Ph.D. from Princeton University.

Roger Yoerger began his college career at age 16 at Iowa State University where he eventually earned his PhD. He was on the teaching staff there for seven years before coming to the University to instruct power and machinery classes.

Jim Stubbins In 1976, Stubbins began working in Karlsruhe, West Germany at the Kernforschungszentrum (nuclear research center). The center is the equivalent of a privately run American national laboratory. While at the center, he studied irradiation damage in materials.

Stubbins moved on to Oxford University in England in 1977, where he held a position as a researcher in the Department of Metallurgy and Science. At Oxford, Stubbins continued his work on the effects of radiation on materials.

In the fall of 1980, he returned to the Midwest to take a job as an assistant professor with the Nuclear Engineering Department here. Stubbins is currently teaching NE 347, and has taught, among other classes, NE 290M over the electronic blackboard to the people of Illinois Power at the Clinton Nuclear Power Plant construction site.

In his rare free time, Stubbins plays the role of the American Nuclear Society and Alpha Nu Sigma faculty advisor. He also serves as the chairman of the Nuclear Engineering Undergraduate Committee. *Kevin Wenzel*

Alan Nathan After leaving Princeton, Nathan worked as an experimental nuclear physicist at Brookhaven National Laboratory, until 1977, when he joined the University faculty.

For the past two years, Nathan has been involved in writing proposals to the National Science Foundation for grants to build a new electron accelerator. The new accelerator would accelerate electrons to 750 MeV, almost ten times the power of the present accelerator.

Currently, Nathan is associated with the Nuclear Physics Laboratory, where he is researching nuclear structure, mainly by scattering high energy gamma rays from nuclei. Next August, Nathan will be on sabbatical in Saclay, France.

When not playing with sub-atomic particles, Nathan collects baseball cards. His collection of cards dates back to 1928. *Jane Fiala*

Roger R. Yoerger Since 1978 Roger R. Yoerger has been a professor and head of the Agricultural Engineering Department. He is also involved in research on noise and vibration reduction of machine operators.

Yoerger enjoys working his farm in southern Champaign County and travelling with his wife. They have a lot of opportunities to travel since Yoerger is the Director of Fellowship of Phi Kappa Phi Honorary. He is also a member of Sigma Xi, Alpha Epsilon, and Gamma Sigma Delta, and is listed in Who's Who.

Yoerger feels that although technical aspects learned in class are essential, it is important to be able to accept responsibility and interact with your peers. He also feels that Ag Engineering will continue to be an important part of society as long as people continue to eat.

Randy Stukenberg

I F · Y O U · C A N · D R E A M · I T · Y O U · C A N · D O · I T

Expand the mind of the microchip.

Remember when electronic calculators were considered a luxury? Well, consider this sign seen recently outside a gasoline station in Schenectady, New York: "Free calculator with an oil change."

That's just one sign of the enormous impact microchips have had on the way we do everything — from banking to game-playing.

But how will we use microchips that are smarter, faster, more reliable, and less expensive to design? How will these new microchips be used to improve systems, products, and processes? As one GE engineer puts it, "The sky's the limit!"

That sky is replete with a number of integrated circuit concepts that GE is applying right now.

There's the custom IC, a chip that performs highly specialized functions. Traditionally, creating this chip has been an expensive, time-consuming job. So we're working on ways to cut design time and cost.

We're using computer-aided design (CAD) to design and simulate chips right on computer screens. We're also developing gate arrays, a system that allows you to build inexpensive prototype chips that can be "played" in systems before the final design is fixed.

Another area that GE is developing is VLSI (Very Large Scale Integrated) circuits. These ICs will eventually squeeze one million transistors onto a single chip.

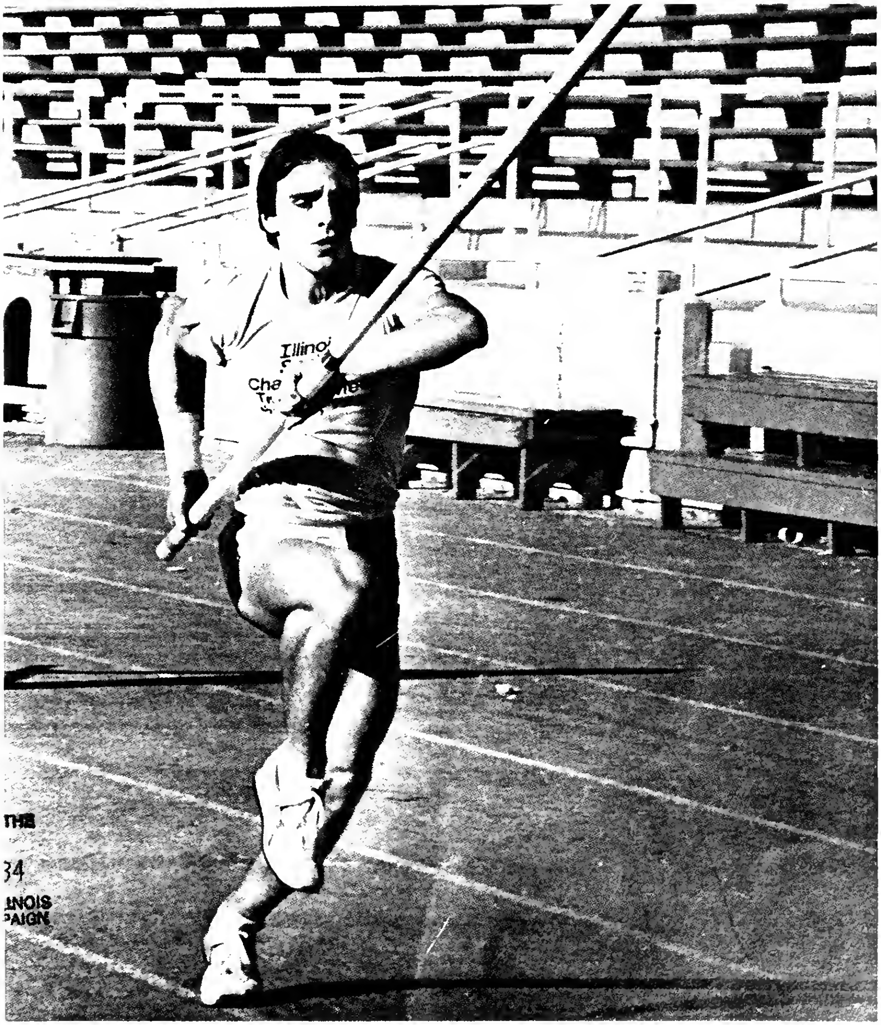
Where will all this super electronic power be applied? GE engineering manager Don Paterson sees it this way:

"At GE you can innovate from the system down to the chip to create . . . whatever ignites your imagination."

In other words, you can dream it . . . and do it.

WE BRING GOOD THINGS TO LIFE

An equal opportunity employer



Sports simulation

Illinois Technograph

October 1983 Volume 99, Issue 1

6 **Engineering Placement Report** *Mary Kay Flick*
The records of our 1983 graduates tell the story for the future.

8 **Engineering Family Album** *Jim O'Hagan*
Looking for something to do? In this College, there is a society for you.

10 **Athletic Optimization** *Larry Mallak*
Biomechanics analysis takes a swing at fixing that nasty slice.

16 **The Freshman Tutorial** *Kevin Wenzel*
This is the authoritative guide for the freshman engineer.

Departments

Editorial 5, Tech Teasers 5, Technovisions 12, Technotes 15, Technovations 21, Tech Profiles 23

On the cover: Jim Russell, UI pole vaulter, prepares to perform his feat. Computer simulation of pole vaulting and other sports is becoming the trend in athletic training. (photo by Jane Fiala)

Illinois Technograph
(USPS 258-760)
Vol 99 No 1 October 1983

Illinois Technograph is published five times during the academic year at the University of Illinois at Urbana-Champaign

Published by Illini Publishing Co., 620 East John St., Champaign, Illinois, 61820 Editorial and Business offices of the Illinois Technograph Room 302 Engineering Hall, Urbana Illinois, 61801, phone (217) 333-3730

Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001, 221 N. LaSalle Street, Chicago, IL., 60601

Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879

Illinois Technograph is a member of Engineering College Magazines Associated

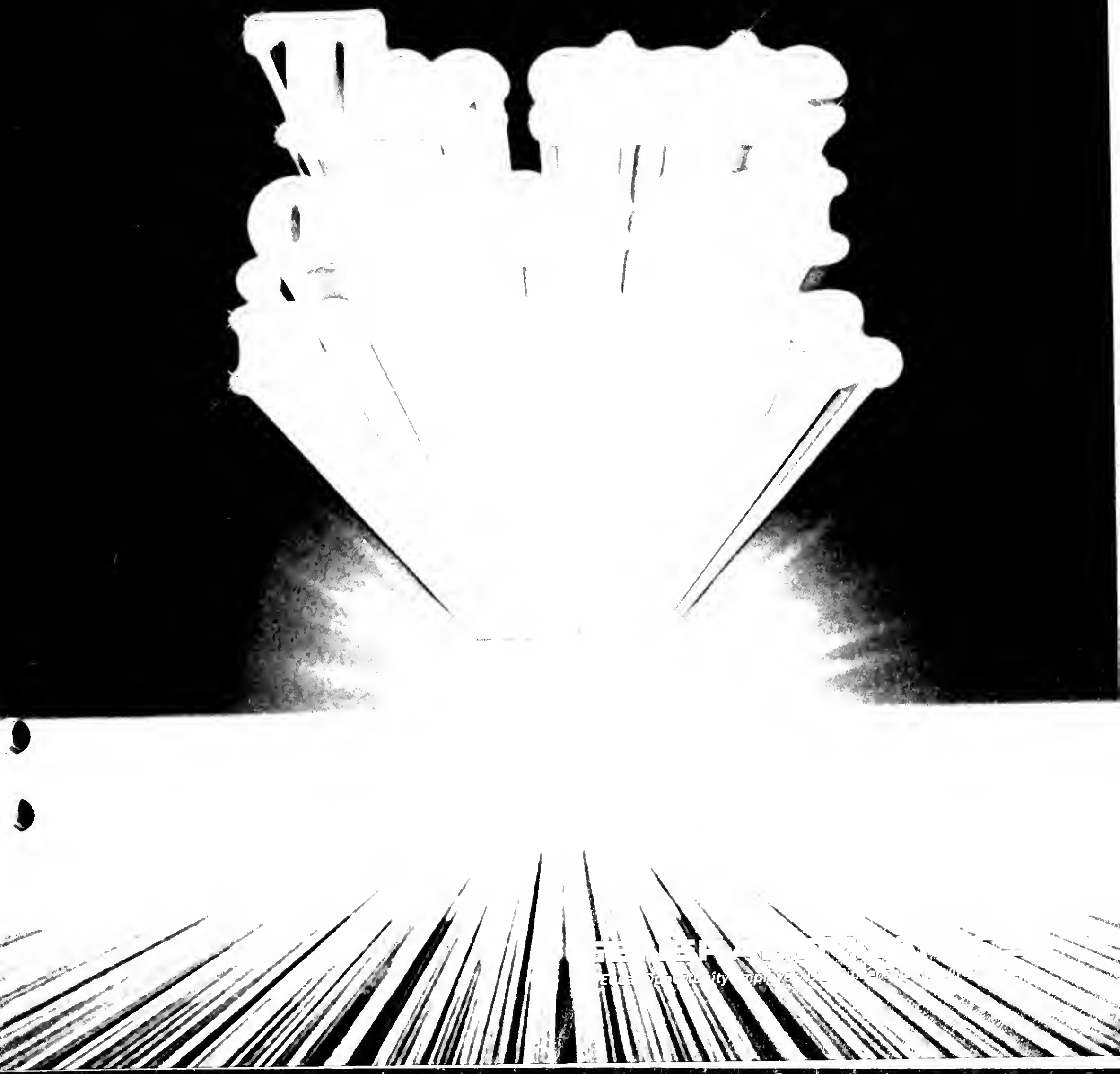
At General Dynamics, we design careers the same way we design our products: for success.

Today, many college graduates, particularly in the fields of Engineering and Computer Science, are playing a crucial role in this success.

If you are qualified, we offer a spectrum of opportunities in aerodynamics, advanced signal processing, radar systems, embedded software, lasers and electro-optics, composite structures, VLSI, non-linear structural analysis, robotics, CAD/CAM and other state-of-the-art technologies.

Working at General Dynamics, you will learn to integrate these technologies into new and existing programs in aerospace, electronics, shipbuilding, military land vehicles, computer systems and many other areas. You will be working with professionals who are recognized leaders in their fields. The most advanced tools of technology will be at your disposal. And to help you remain current in your chosen field, formal training and tuition refund programs are available.

To learn more about a state-of-the-art career at General Dynamics, see your Placement Office for a campus interview.



Tech Teasers

1. While playing in EE lab one day, a student found he had connected 11 instruments in a convex figure. Quickly connecting leads so current could flow between any 2 instruments along only 1 lead, he soon realized that no 3 leads crossed at any 1 point. Here are the questions: a) find the current in each loop, and b) determine how many triangles he made.

2. After several years of failure, the Chicago Cubs feel they've finally found a winning combination. Armed with only 8 clones of Mel Hall and 6 clones of Leon Durham, how many possible 9-man teams can the club field if Durham is not allowed to play at second base, third base, or shortstop?

3. When Steven Spider spied Sally Spider, it was love at first sight. In a 8x20 foot room with an 8 foot ceiling, Steven is one foot above the floor in the middle of the end wall, while Sally is one foot below the ceiling on the opposite wall. What is the shortest path Steven can take to reach his love?

answers on page 18

Editorial

A Journey in Progress

I had just gotten my fifty bucks out of the 24-hour teller machine that Friday afternoon, stuffed the bills and magic money card into my wallet, and I was ready. My backpack was secured to the passenger seat by a twin bungee cord, and the gas tank was filled. I slid the helmet over my head, strapped it, mounted my Yamaha Seca and brought it to life. A final check of my handwritten map was all that was needed to initiate the four-hour journey from Champaign to Carbondale. Soon, I was southbound on Interstate 57, with nothing but semis, sunset, and sweltering heat.

These moments of initial escape soon wore off and my mind casually wandered to reflective thought on the interactions between engineering, laws and regulations, and the consumer. The money in my wallet had been obtained with no human contact: I had requested money from a machine. Soon, I would be able to carry out my financial transactions in the comfort of my own home through a computer network, thereby eliminating the weekly encounter with the local teller.

As I sensed the thick white line used for overhead radar checks, the needle on my speedometer pointed to 65. Had I been riding one of the new cycles with computerized instrumentation, an LCD or LED readout would indicate 65 as well as telling me which gear the cycle was in, as if I didn't know.

The heat had begun to yield to the night air as the sun kissed the horizon. An onslaught of tiny flying creatures began crashing blindly into my face shield.

Earlier that week, the phone service at my new residence was installed. A multitude of services and equipment options availed themselves following the divesture of the phone giant. I still opted to rent my phone, but Ma Bell misunderstood and billed me $60. Doesn't she know that I can get a "lay-on-the-table-but-hope-it-doesn't-fall-off" model for ten bucks? The designs range from the above mentioned simplicity to the obviously commercial "Darth Vader" phone ("make every phone call a contact with Darth").

Engineers want to use computers to make all aspects of life more efficient, including the generation of new ideas through the use of artificial intelligence. The general public fears the implications this efficiency will bring. Restructuring of the labor force and resulting short-term unemployment are the major costs of this most recent technological revolution; however, the benefits afforded to the society as a whole will ideally be redistributed as higher living standards, though not equally. Progress has always had its problems. Would you rather be washing your clothes on rocks and hunting your dinner?

I swept the last curve and came to a halt in a gravel parking lot. A tired seat, a slap of sunburn, and a thousand dead insects affirmed my arrival. Journeys always have their tolls. Would I rather be sitting at home watching the ten-o'clock news?

Illinois Technograph invites letters in response to its articles and editorials, or any other item of interest to our readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.

Engineering Placement Report

by Mary Kay Flick

Getting through college is only half the battle in the preparation for a successful career. In today's fiercely competitive job market, an equally frustrating battle awaits new graduates. Statistics tell the story of last spring's graduates.

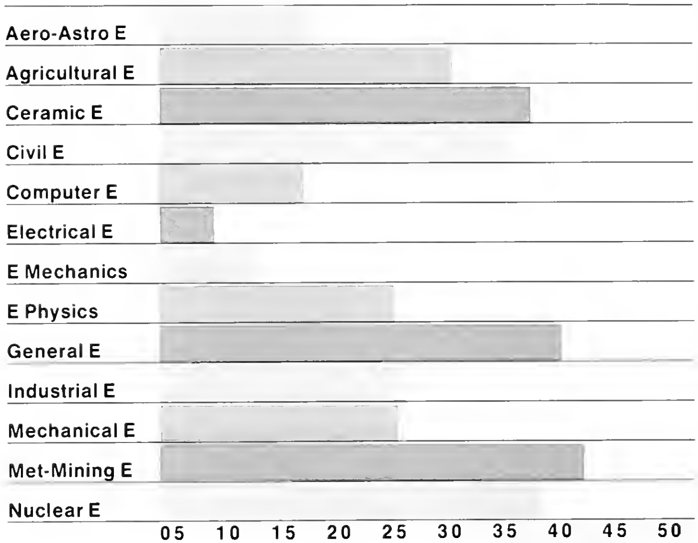
As far as employment security, engineering has recently seemed like an area where immediate employment was practically guaranteed. But in the past couple of years it has become increasingly difficult for grads to find jobs. Due to the downturn in the economy, production slowed, hence decreasing the demand for engineers. If last year is any indication of this year's job market, the future does not look promising. However, officials project a brighter picture, claiming that the trough of the cycle has passed.

But, what exactly was the hiring situation of last spring? Who did the hiring? Who was hired? Where did they go? Why did they go there? What kind of money did they make?

For B.S. graduates, last year was one of the worst years for job hunting. Out of the graduating class of 1983, 846 B.S. grads, 186 (22%) could not find jobs and 170 of them reported no offers. Separated by disciplines, 42% of metallurgical engineers, 40.3% of general engineers, 38.9% of nuclear engineers, and 37.5% of ceramic engineers could not find jobs.

Well, then, how many were hired? Overall, 46.1% of B.S. grads in 1983 were hired. The remainder went on to graduate school or other alternatives. A total of 22.4% went to grad school, mostly grads from engineering mechanics (75%), and ceramic engineering (50%). Among those who did find employment, the largest percentages of those hired came from computer engineering (61.1%), electrical engineering (60%), computer science (54%), mechanical engineering (51.2%), and industrial engineering (50%). Electrical, mechanical, civil, and general engineers, and computer science majors comprise the largest quantity of engineers.

Available for Employment
(in percents)

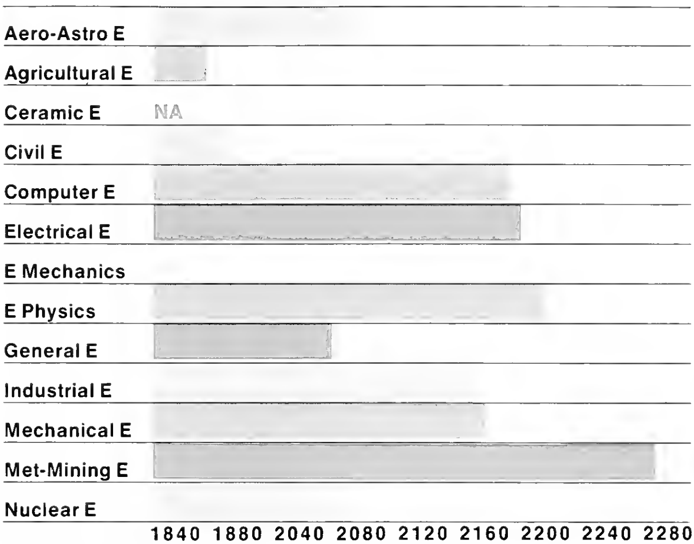


Source: Placement Office, University of Illinois at Urbana-Champaign   Figures current as of July 11, 1983

What types of companies hired grads? By far the largest groups were aerospace/electrical/instruments companies hiring 190 grads. Next came public utilities, automotive/mechanical equipment companies, and reasearch/consulting organizations.

Top individual employers in spring 1983 were Motorola with 42 grads, McDonnell-Douglas with 24, and IBM with 13. Commonwealth Edison and Sargent-Lundy both hired eleven graduates. When representatives from these companies were asked why they hired so many grads, their reasons were similiar. Officials from both Motorola and McDonnell-Douglas said they hire large numbers of grads from the University because of its good reputation. Another reason for hiring a large number of new grads is the location of their plants. Relocating to St. Louis (McDonnell-Douglas) or to the Chicago area (Motorola) is easier and more attractive for recent grads since most are from Illinois. New employees are able to

Average Salary per Month
(in dollars)



Source: Placement Office, University of Illinois at Urbana-Champaign NA:Not Applicable

stay closer to their family and friends.

The average salary offered was $2106 per month. The highest paid engineers were a mechanical and computer engineer getting $2492 per month, followed by an electrical engineer getting $2460 per month, and metallurgical engineer receiving $2383 a month. The lowest paid grad was an agricultural engineer getting $958 per month. Low salaries varied from a computer engineer receiving $1383 a month and a computer scientist receiving $1417 per month.

It appears that academics have a small bearing on the salary a graduate receives. There is a fairly proportional relationship between grades and salary which holds true statistically, but the ranges within the deciles are high. The average salary of the highest grade decile (4.758-5.000) was $2257. This gradually fell to the average salary in the lowest decile (3.000-3.454) of $1985.

Although average salaries seemed to follow this course, the individual high and low salaries people received did not. A person in the 4.219-4.373 decile received one of the highest salaries while a person in the 4.374-4.582 decile received one of the lowest.

With these kinds of salaries available, how much choice was available between companies? Overall, the average number of interviews per student was 10.5 while the average number of salary offers was 2.7. Mechanical (15.8), electrical (15.6), and computer engineers (15.0) had the largest average number of interviews with engineering physics (5.0), civil (5.6), and agricultural engineers (6.0) had the fewest. The highest average number of offers were received by computer engineers (3.0), electrical engineers (3.0), metallurgical engineers (2.5), and nuclear engineers (2.5). The fewest average number of offers were received by civil engineers (1.3), ag engineers (1.4) and engineering physics grads (1.7).

Geographically, were did the graduates go when they accepted their jobs? The greatest majority stayed in Illinois (41.5%) with smaller numbers going to California (11%) and Missouri (7.9%). The rest were scattered all over the country. Of those who remained in Illinois, many went to Chicago and its suburbs, with 31% in Chicago and 16.7% in Schaumburg. Outside of Chicago, 9% stayed right here in Champaign.

But what was the real reason the grads took their jobs? Primary reasons included type of work, location and the fact that it was their sole offer. The most frequently given second reasons were location, money/salary, and people/job atmosphere. Third reasons given were money/salary, location, and company reputation. Overall, the biggest reasons for selecting a job were type of work, location, and salary.

When asked what they were expecting in prospective employees, a representative of Motorola indicated that they were looking for students from a top school who demonstrated technical ability through hobbies and related work experience, in addition to class performance. They were also looking for people with good communication skills as well as the

continued on page 18

by James O'Hagan

Engineering Family Album

A major aspect of the extra-curricular, professional, and learning program of the College of Engineering at the University is found in student chapters of professional engineering societies. They broaden exposure to particular fields of engineering, while providing excellent educational and social opportunities.

American Academy of Mechanics (AAM)

The study of statics, dynamics, materials science, solid mechanics, fluid dynamics, and applied mathematics is the love of this organization. Laboratory tours, industrial and academic speakers, and the improvement of student-faculty relations are common activities. Membership is open to anyone interested in mechanics. Those interested should call Kay Wilson at 367-6148.

American Institute of Chemical Engineering (AIChE)

AIChE is a society for chemical engineers which offers monthly meetings with speakers from employers and schools plus a variety of social events. By providing its members with information on chemical engineering academically as well industrially, AIChE can be a major help to students in Chemical Engineering. Call Mark White at 352-5864 for more information.

American Institute of Industrial Engineers (AIIE)

AIIE is a professional society for industrial engineering students, geared toward informing students about the industrial engineering field and the opportunities it holds. Guest speakers at monthly meetings help to achieve this goal, while fireside chats and picnics help promote student-faculty interaction. Potential members should call Rich Dlesk at 328-7046.

American Nuclear Society (ANS)

The national organization of ANS offers many opportunities to University students by allowing contact with all technical and industrial facets of the nuclear community. A national newsletter, scholarships, a placement center, and a career guide also aid members in achieving their career goals. The local ANS chapter adds to these opportunities with social activities ranging from a fall picnic to sport teams and racquetball tournaments. Interested students should call Javier Sanchez at 356-7624.

American Society of Agricultural Engineers (ASAE)

ASAE provides opportunities for learning and experience in agricultural engineering. Society member Joe Lehman explains, "It's a professional society. We help develop leadership among the members, and give them a chance to get involved in philanthropic acts." Numerous social events, field trips, and lectures have made this one of the top 3 student ASAE societies in the nation for 12 of the past 15 years. For information call Jeff Kates at 384-6342.

American Society of Civil Engineers (ASCE)

To increase the students' awareness of the civil engineering profession, and to increase their opportunity to meet others in the field are the purposes of ASCE. Monthly meetings, social get-togethers, service projects, professor directed seminars, and national concrete canoe races keep members busy throughout the year. Stop by 308 Engineering Hall for further information.

Associated General Contractors (AGC)

Field trips to sites under construction, industrial speakers, and community service projects help the members of AGC become acquainted with various aspects of the construction industry. This society gives students a better understanding of theories and teachings studied in engineering or architecture curricula, and a more detailed look at industrial construction techniques. If interested in joining, call Chuck Stenzel at 356-7461.

Association for Computing Machinery (ACM)

The official student organization for all computer science students, ACM includes graduate and undergraduate students, as well as faculty members. At regular meetings, guest speakers lecture on topics ranging from new technologies and research in computer science to campus computing facilities. All interested students should see Larry Newman in 222 DCL.

Nearly all engineering societies have exhibits at Open House. Here, a student puts the final touches to his project.

Association of Minority Students in Engineering (AMSiE)

"All minority students in engineering are automatically members (of AMSiE)," explains Vice-President Michelle Bridges, "it's just up to them if they want to become active. Activities are many and varied for minority students. We have speakers from IBM, the CIA, Kodak, and Illinois Bell come and talk about job opportunities. We sponsor many social events, and participate in Engineering Council," explained Bridges. Interested minority students should call John Hill at 337-6062.

Illinois Society of General Engineers (ISGE)

ISGE, a professional and academic organization, continuously encourages student interaction with professors and other students. A monthly "Meet the Prof" meeting where a professor shares his interests and experiences with students helps achieve this goal, as does a myriad of other social events. ISGE also invites speakers from industry and various engineering fields to share their experiences with students.

Institute of Electrical and Electronics Engineers (IEEE)

University of Illinois student chapter of IEEE is one of the largest branches of IEEE in the country with nearly 600 members. IEEE sponsors a lab equipment seminar and a computer explanation display at EOH for the benefit of all students. For members, everything from formal dinners to sports activities are sponsored by the society. Interested students should call Ray Prill at 384-2080.

Institute of Transportation Engineers (ITE)

ITE is an organization consisting of members interested in various areas of transportation, including everything from research to design to economics to consultation. Field trips to airports and transit systems provide further exposure to the important field of transportation. Interested persons should call Jeanette Hair at 351-9246.

Metallurgical Society (UIMS)

The University extension of the American Institute of Mining, Metallurgy, and Petroleum Engineers sponsors a department pig roast, volleyball and football tournaments, and several plant trips to help students meet others and learn more about their diverse field. Interested students should contact Tom Little.

Physics Society

Every aspect of engineering has a relationship to physics, and the Physics Society exists to acquaint interested people with areas such as low temperature physics, high energy physics, astrophysics and biophysics through trips to Fermi Accelerator Labs, Argonne, Bell Labs, and the Danville Radio Telescope. Physics students wanting to join the society should call John McCown at 384-4261.

Society of Cooperative Engineers (COOPS)

To publicize the work study cooperative program of the College of Engineering and to give aid to present and future co-op students during their enrollment in the cooperative program is the purpose of the Society of Cooperative Engineers. Presentation of a mock interview, publication of a survival program for co-op students, and a variety of social programs are sponsored by the society each year, allowing students to gain valuable experience in leadership, working and socializing with others, and communication skills. Interested students should contact Jeff Donofrio at 332-4229.

Society of Women Engineers (SWE)

Through monthly meetings, conferences, banquets, plant trips, social functions, a resumé book, and newsletters, SWE informs and encourages women interested in engineering. A professional, non-profit, educational service organization of student and graduate engineers, SWE has 150 student sections nationwide. Further information can be obtained in 300 Engineering Hall or by calling president Patty Feit at 332-4399.

Student Branch of the American Ceramic Society (SBACS)

SBACS hosts several events each year to inform its members and the public about the profession of ceramic engineering. Guest speakers from ceramic industry and research are featured in monthly meetings. Engineering Open House displays are presented, and social events and sport teams are organized. A yearbook of University ceramics students is also put together by the group. Call Eugene Ylo at 332-1733 to join SBACS.

Tau Beta Pi

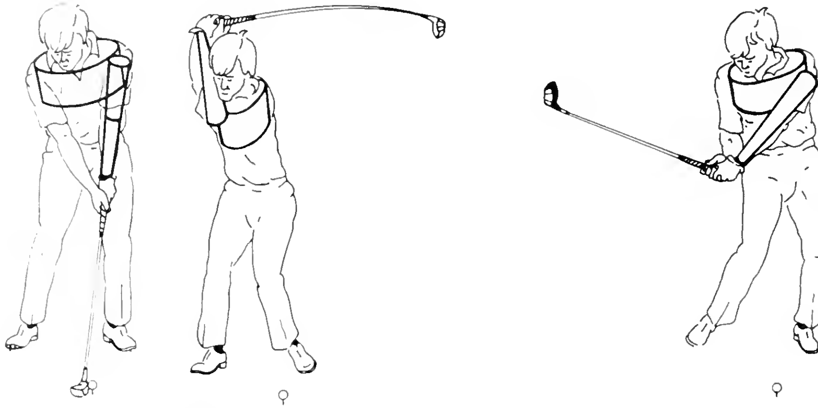
Tau Beta Pi is a national engineering honor society open to engineering students displaying optimum scholastic ability and outstanding character. Each year Tau Beta Pi conducts several major programs to help all engineering students learn more about their curriculum and their community. TBП's Robbie Rubik, a robot who solves Rubik's Cube was unveiled at EOH 1982 made headlines worldwide. Interested students should call Kurt Vanden at 337-7511.

Technograph

Technograph has been reporting on the engineering campus and modern technology since 1885. The student magazine is published five times a year, by the Illinois Publishing Company, which also owns the Daily Illini, WPGU radio, and Illio yearbook. Technograph is organized by engineering students who provide all writing, photography, editing, advertising, and production. The Engineering College Magazines Associated, composed of over 70 member magazines, has chosen Technograph as the best all-around magazine in 3 of the last 4 years. Distribution is free to all engineering students and faculty, as well as to all Illinois high schools. To join, fill out an application at the IPC office, corner of John and Wright streets, in the basement of Illini Hall, or call the office at 333-3558. ■

by Larry Mallak

Athletic Optimization



Pete McGinnis and Kevin Campbell are combining physical education and engineering to improve athletic performance. Soon their efforts will add the personal computer to the conventional training equipment.

Physical education (PE) as an academic curriculum is not limited to the basic classes taken to fill in one's schedule and take in one's waistline. Two gentlemen from the University have proven this in their separate, but related, analyses of sports activities using rigorous models. Kevin Campbell, now director of the biomechanics laboratory in the Department of Exercise Science at the University of Massachusetts at Amherst, started with getting his bachelor's degree in physical education at Penn State in 1976. He then entered the master's program in PE here at the University and soon will be granted his doctorate. Campbell's research was based on developing an optimal control model of human movement, as applied to the golf swing.

Pete McGinnis, now holding a joint appointment with the University of Oregon and a privately-owned biomechanic research company, BioDynamics, is an engineer by degree, having entered the doctorate program here in 1978 after spending two years working as a structural engineer. However, his PhD was not in engineering; McGinnis also earned his doctorate in physical education. His choice to receive his physical degree evolved from his status as a professional pole vaulter, combined with his structural engineering background.

Many engineers have analyzed structures of all sorts, but the structure of the human body has become increasingly popular in research. On the PE side, human motion had been described and analyzed, but not in such detail as would be characteristic of an engineering analysis. The common method of training has been to film world class athletes, or "elite athletes," as Olympic trainers refer to them. Then, the athlete trainee carefully studies the movements of the elite athlete for the purpose of learning how to adapt his movements to match those of the elite athlete, in hopes of achieving greater success.

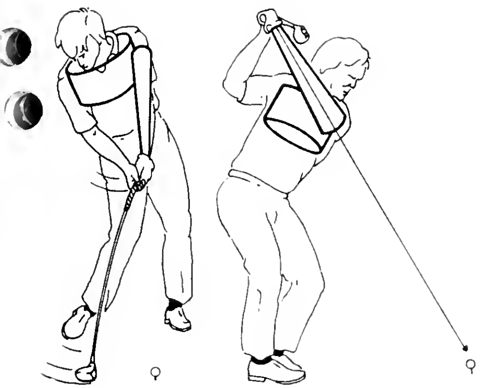
This method does not account for the differences in the physical structures of the athletes. What is needed is a model of the sport where the physical parameters of the athlete are considered and optimal movements are provided. The thrust of Campbell and McGinnis' research is that the athlete's movements should be modified to suit individual physical variables and not to match those of proven athletes.

Professor Larry Bergman of the Theoretical and Applied Mechanics (TAM) department remembers being approached by Campbell and McGinnis. The duo asked Bergman what would be needed to develop their models. He gave them a list of various statics, dynamics, and advanced dynamics courses.

The two PE doctoral candidates left the professor's office. Bergman, thinking he had cooled the jets of two dreamy minds, soon saw McGinnis' face in his advanced dynamics class. He now realized the serious pursuits of the two, and took McGinnis as one of his students. Campbell went to work on his golf swing, under Professor Robin Reid of the ME department.

Modeling the Golf Swing

Campbell modeled the golf swing with three goals in mind: 1)the ball would travel 250 yards, 2)clubhead velocity



From left to right: three link model at address, at initiation of downswing, at mid downswing, at impact; plane of motion of model. (graphics by Steve Lustig)

would be maximized, and 3)the mechanical work done by the system would be a minimum. Optimal control theory is used to develop the model. In his thesis, Campbell states that the objective of optimal control theory is "to determine the control (or input) signals that will cause a process to satisfy the physical constraints on the system and at the same time minimize (or maximize) some performance criterion."

The golf swing has been traditionally analyzed using a rigid two-link model, with the arm and shoulder forming one link and the club forming the other. In Campbell's three-link model, the upper body forms the first link, the left arm forms the second, and the club forms the third link. The right arm is not included as a link since it is not used to power the golf swing; modern golf theory states that it merely guides the club. In the analysis, forces exerted by the right arm are considered as external forces to the left arm. The model assumes that the club motion lies in a plane, which is approximately correct in real life.

The first step in the model is to write force equations for the three-link model. Films of golfers are then used to determine displacement and time data. The displacement as a function of time is integrated once to calculate the velocities, and integrated once again to find the accelerations. Torques may now be computed for each joint of the model, and the result is called a torque history.

The key to finding the characteristics of the optimal golf swing is to vary the torque histories. However, there are an infinite combination of torque histories available. Torques must be constrained to the human capabilities. Solutions lying outside the realm of human potential are not acceptable, but can result if constraints are not defined. A computer search utilizing the first order gradient method of calculus finds the optimal combination of torques from the constrained set.

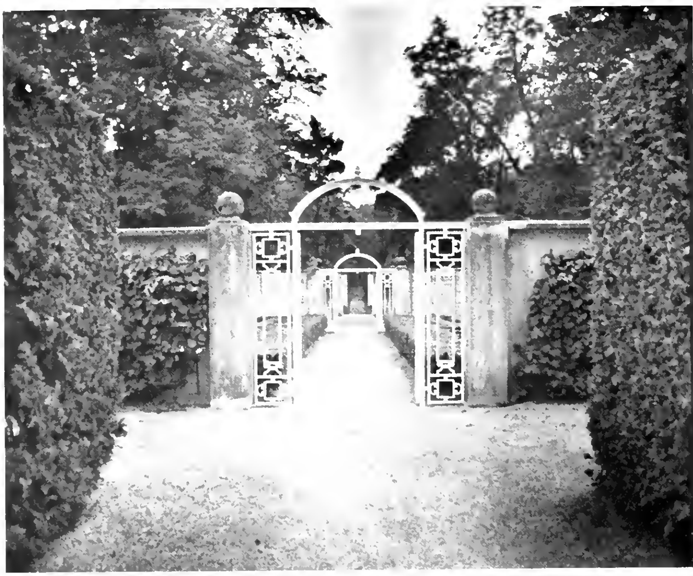
Before Campbell added constraints, the optimal clubhead velocity was infinite, and theoretically shattered the golfer's wrist. The path of the clubhead had to be constrained since optimal solutions were being obtained which required the club to dig through the ground before hitting the ball. One does not need to know the game of golf to realize that this is a waste of energy.

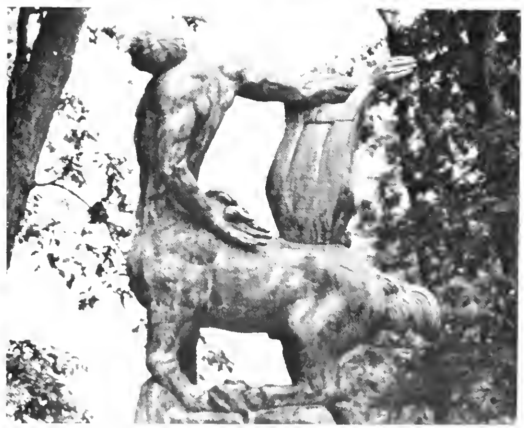
Measuring the torques is accomplished through the Cybex machine, which is commonly found in athletic training facilities. For a predetermined velocity, the Cybex will provide position, torque, and velocities of links. Multiple regression is used to get force equations and to predict maximum torque as a function of position and velocity. The position of the joint and the velocity will determine the maximum torque at the joint. Maximum tension in the muscle is dependent on the length of the muscle fibers and their rate of contraction.

Muscle tension was assumed constant throughout the experiment, since only one subject was used because of funding policies. High demand of computer time and its expense were the reasons for denying Campbell more subjects. A common run of his model on the Cyber 175 took 1800 sec of CPU time. In comparison, a typical FORTRAN program

continued on page 14

Formal gardens as well as natural forests of Allerton Park are the perfect setting for Robert Allerton's international collection of statues. Allerton donated his mansion and 1500 acres of park land to the University in 1947, along with 3700 acres of farm land, whose income supports the park. Robert Allerton's son, John Greg Allerton, a University graduate in architecture, designed many of the gardens which today provide a perfect retreat for University students and area residents.





continued from page 11

written for a CS 101 class generally takes between .1 and 1.0 sec.

Using regular golf techniques, the test subject drove the ball 250 yards with a clubhead velocity of 69.2 meters sec and total mechanical work of 441 newton-meters.. Using derived optimal techniques the ball was driven 366 yards with a clubhead velocity between 52 and 55 meters sec and total mechanical work of 357 newton-meters. Therefore, it now took less energy to drive the ball further. Motion initiation occurred at the upper segment of the body for maximum transfer of energy from the human link mechanism to the ball. A computer simulation of the model yielded almost perfect transfer of energy through the link mechanism.

Campbell's results also show that for maximum energy transfer, all links should be stationary at impact except for the club. Experimental data showed that 90% of the system energy was from the torques produced at the wrist.

Modeling the Pole Vault

The modeling of pole vaulting is based on the assumption that the human is a rigid body. When related to the flexibile nature of the pole, this seems to be a viable assumption. Equations of motion are written for each joint used in the analysis, which involve most of the body. Unlike Campbell, McGinnis has many more than three links. Shoulders, elbows, knees, ankles, pelvis and more are incorporated into his model, making it a very complex and difficult problem.

Armed with these equations of motion, the high-speed cameras are packed and taken to national competitions involving record-holding pole vaulters. McGinnis did this most recently at the Mobil/TAC Championship held in June, 1983, where Jeff Buckingham, Billy Olson, Mike Tully, and Earl Bell were filmed.

The films were then digitized back in the lab, to get velocity and acceleration at every joint. These quantities were substituted into the equations of motion and the torques at the joints could then be computed. To verify the model, the vault was reconstructed using a finite element model to account for the pole deformation. Derived torques are used and the expected height of the vault is calculated. The accuracy of the model is measured by comparing the calculated height to the actual height.

Now, it is possible to alter the input paramters, such as approach velocity or angle of pole plant, and calculate the expected vault height. As a result, small changes in the vaulter's style might give another inch of height.

Application of this model requires that one know the torques available at each joint in the athlete. Here also, the Cybex is used to measure the torques in the joints, and these values are then used with approach velocity, angle of plant, and other data to predict the vault height.

Present Plans

Both Campbell and McGinnis serve on the U.S. Olympic Committee's Elite Athlete Project, volunteering their time and research to advise athletes on improving their performance. Says McGinnis, "Telling a world (pole vault) record holder such as Billy Olson that he's got room for improvement is a tough game." Holding a world record is little incentive to be worrying about improving one's performance.

The beauty of these models lay in the fact that one need not risk experimentation in new techniques while in competition. The model has been developed in such detail that the athletes can be reasonably sure that recommended changes will result in better performance.

Future Plans

Campbell and McGinnis each have compiled a program to predict optimal solutions to their respective problems. These models may now be used as training tools to speed the learning of the best moves. Instead of trial-and-error, the answer is known beforehand. Prosthetics will benefit from this research in that recipients of artificial limbs can be trained how to use the limb with the least amount of effort. Proper lifting techniques in the industrial setting can be readily synthesized using the biomechanic models.

Revisions and Refinements

The models discussed provide analysis in minute detail, but the degree of accuracy in human posture, coupled with the high cost of computer time needed for the lengthy, recursive calculations leads to the demand for a program which can be run on a microcomputer. Both gentlemen are currently developing simplified versions which will yield solutions close to optimal, yet can be run on easily accessible and relatively inexpensive personal computers.

Besides simplifying, Campbell wishes to further develop his model by taking into account the intricate nature of muscles. Presentation of results will be studied to determine which information will aid in rapid learning.

The application of engineering techniques to the human physique is not new. However, the simulations described in this article are on the forefront of athletic training technology. No longer will athletes mimic actions of the pros; they will be able to have their own physical characteristics analyzed for peak performance. Pete McGinnis and Kevin Campbell have determined that the future of athletic prowess is a whole new game.■

Charter Fellows Honored

The American Society for Engineering Education has named three University faculty members, Daniel C. Drucker, Ross J. Martin, and William L. Everitt, as charter fellows. Illinois was the only institution to have more than one member among the 49 honored nationwide.

Drucker is dean of the college and immediate past president of ASEE; Martin is associate dean of the college and director of the Engineering Experiment Station; and Everitt is dean emeritus of the college and president of ASEE in 1956 and 1957.

The honor is conferred by the ASEE board of directors based on nominations by one or more members of the society. The ASEE established the distinction to recognize a greater number if its dedicated active members.

Shuttle Carried UI Momentos

The world's smallest holes traveled into the boundless domain of outer space.

On the August 30 mission of the space shuttle Challenger, astronaut Dale A. Gardner carried specimens containing the world's smallest permanent holes, drilled by University scientists using a tiny electron beam. Gardner, a lieutenant commander in the Navy, is a 1970 graduate of the University. He is a mission specialist assigned to perform a variety of duties on the shuttle.

The alumina specimens, two of the three items Gardner carried as momentos of his years as an engineering physics student at the University, included the words "USA" and "Illinois," also drilled by the beam.

The third item was a small rod of the superconducting material niobium, chosen to symbolize the research at the University on superconductivity led by physics and electrical engineering professor John Bardeen. The niobium rod is part of a system that monitors the accelerator during operation. The one Gardner carried was made for the University's accelerator.

Gardner called the University early this summer and asked for momentos to

take along on the Challenger mission. They were sent in July to the Johnson Space Center, Houston, to be packaged for the flight.

The two alumina films carried by Gardner were mounted on copper grids, each about ⅛ inch in diameter. The holes drilled into them are so small that if one were drilled into a penny and the penny expanded so the hole became 1 inch in diameter, the coin would stretch nearly 160 miles across. The niobium rod was made for use as a probe in the University's superconduccting linear accelerator. It measures about 1/16 inch in diameter and about 1 ¾ inches long.

New Director Named

Professor Robert J. Mosborg has been appointed director of placement and an assistant dean in the College of Engineering. A member of the civil engineering faculty since 1949, Mosborg will assume the placement duties of Assistant Dean David A. Opperman. Opperman has been named the coordinator of cooperative education.

"I'm not a miracle worker or a magician. Right now the economy is down and the number of employers coming to campus is less than it has been in many years. Coupled with the fact that the number of undergraduate students is at a historical high, it's a very competitive situation as far as students are concerned." Nevertheless, Mosborg is optimistic and expects this year's job market to be more favorable than last year's market.

Drucker Honored Again

Daniel C. Drucker, dean of the College of Engineering, won the William Prager Medal of the Society of Engineering Science.

Drucker is the first recipient of the medal, awarded by the society for "outstanding research contributions in the mechanics of solids."

A member of the National Academy of Engineering and the American Academy of Arts and Sciences, Drucker joined the University as dean in 1968. He is president of the International Union of Theoretical and Applied Mechanics, and a former president of the American Society of Mechanical Engineers, American Society for Engineering Education, Society of Experimental Stress Analysis and American Academy of Mechanics.

IBM for UIUC

The grant of a state-of-the-art International Business Machines Corporation computer system is a major boost to the University's College of Engineering, officials say. IBM officials announced this summer that Illinois is one of twenty universities selected to receive a gift of an IBM 4341 computer system. The computer system includes a computer-aided design/computer-aided manufacturing (CAD/CAM) system that will enable engineering students to learn first-hand about the latest technology in manufacturing systems.

"The addition of the IBM 4341 CAD/CAM system is a major boost to the college," said Jerry S. Dobrovolny, head of the General Engineering department. "It will be used primarily for teaching but will also have research applications."

James O'Hagan

by Kevin Wenzel

The Freshman Tutorial

It's easy to get caught up in the excitement of your first year at one of the finest tech schools in the country. There are secrets, however, that only upperclassmen know how to use.

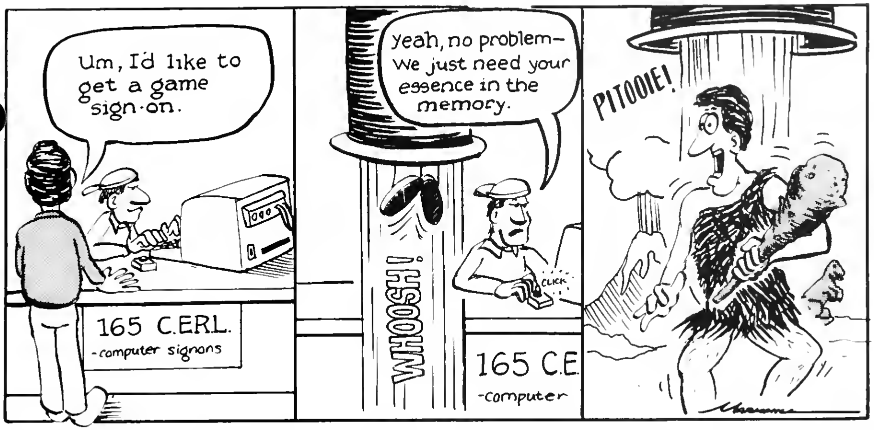
So you've arrived on campus. Most freshmen arrive on campus with incredible delusions of grandeur. They forsee four years of major parties, a few homework sets, plenty of panty (or jock) raids, and all the good times one can physically endure, which culminates in graduation to a good job with an absurdly high salary. The two major goals of students are partying and graduating. Since the former preceeds the latter, and therefore the latter follows the former, one must clearly party before graduating. However, these objectives can be (and often are) mutually exclusive. The first word to learn is moderation. Can you say that? It is a little difficult, but learn it. Moderation is partying to the point where you can just barely graduate.

Upon graduation, the great job search begins. The main tool used in this search is the resumé. The resumé levels personalities and puts all unemployed engineers on an equally low plane. What does it take for a good resumé? Three things are required: good academic performance, work experience, and extracurricular activities.

Good grades are not the easiest thing in the world to accomplish, though. Remember the College of Engineering admissions requirements are stiff; competition here is accordingly nasty. Forget the fact that most people here are relatively intelligent; students' minds must be pushed, pulled, or folded in order to squeeze into the famous bell-shaped curve. Of course, you could eliminate the smartest people in all your classes, but working for the state throughout the duration of your lifetime is not appealing. There are many other ways to get good grades.

One way is sheer hard work, but since nobody wants to do homework on Friday or Saturday nights (a sin in most student handbooks), one must search for other alternatives. The biggest asset at the University is people. Get to know your peers, teaching assistants, professors, and a dean or two. Peers come in handy, because if they've taken a class, they usually have old homework solutions. Don't worry about learning the material because friends usually have old tests too, and tests don't change much. Teaching assistants come in handy since they usually like to drink beer. For only a few dollars a student can learn the answer to any impending quiz question. Get friendly with professors, friendly enough to know where they keep their keys to the office. Professors usually write the tests, and having a copy before you take it never hurts.

A real killer when it comes to grades is a lousy teacher, be they a graduate student or full-fledged professor. If there is any hint that the teacher standing at the front of the room is boring, inept, or just doesn't speak English, get out! It's not that difficult to change sections. Speaking of changing sections, advanced enrollment is a waste of your time. The chances are very good that the schedule the computer spits out is miles from that requested. The easiest way to fix this is to attend the classes on the requested schedule. After a couple of days, go to the department office and switch sections. Bingo, you're back to the original ideal schedule. If you have a bad teacher for a required course



in your major with only one section, the only answer is to switch sections.

Work experience is the second most important thing on the resumé. The problem is that students are here to learn how to do the jobs they want to have. Who wants to hire a plebian freshman engineering student? Nobody but McDonald's, of course. No problem, the creative person can relate even the most remedial job to engineering. For example, the old vita could read, "McDonald's, summer 1983, determining the mean flight time for a flipped burger." This tactic should only be used in desperation. There are companies looking to brainwash freshmen early; the best place to find out about them is in the Engineering Placement Ofice, 109 Engineering Hall.

Next in importance after work is extracurricular activities. This campus is full of diverse organizations whose names you can put on your resumé. For example, one of the best outlets for the creative engineering student is Illinois Technograph, a student-run engineering magazine which looks something like the one you are reading now. There are lots of other engineering organizations (see Engineering Family Album, this issue), but they're not important. One of the worst things to do is limit involvement to engineering societies only. Recruiters look not only for interest in your chosen career, but also for marked leadership skills. A good way to show this is to start your own organization; all it takes are three officers, a faculty advisor, and a registration filed with the office of student organizations in the Student Services Building.

There is a lot more to school then the resumé; occasionally one must kick back and relax. The best time to let go of reality is on weekends. During extremely busy weeks, Wednesday isn't bad, or whenever the bars have good specials. Bars offer the best place on campus to relax. Where else do students converge by the thousands to be pushed, trampled, bombarded by music too loud to hear themselves think, and, if lucky, regurgitated upon by other students having too much of a good thing. What could be better? Caution must be practiced when choosing a bar, as some cater to particular ethnic or sexually oriented groups. If you do go someplace you would rather not be, forget apprehension, just enjoy.

Another way to escape from physics, chemistry, and math is to read. Don't read physics, chemistry, or math; that would be really dumb. Newspapers are good since they are timely, sometimes humorous, and usually tell of people in much worse condition, so cheer up. The Daily Illini is best for campus news, but for real gut-wrenching, around-the-world news read the New York Times. Novels can then provide escape from the news. The University has the third largest publications collection of any university in the country, so you can find anything you never thought about reading. The Champaign and Urbana public libraries are also

continued on page 20

continued from page 7

ability to cooperate within a group. A representative of McDonnell-Douglas indicated that the company was looking for a mix of good grades and work experience. Strong technical background and good training in a student's particular specialty were also important. Both companies indicated that they were planning to hire a large number of University grads this year.

How do these statistics compare with those of M.S. and Ph.D. graduates? Educators are often worried that those people who become qualified to teach at the college level will be lured away to industry by high salaries and better benefits. Placement data may validate these fears. Among masters graduates for spring 1983, 42% became employed while 24% continued graduate school. The rest went into military service, returned home (foreign students), or miscellaneous alternatives. No information was received from 21% of the grads.

The highest placed groups of employed M.S. grads are computer scientists (71%), mechanical engineers (62%), and electrical engineers (49%), who received an average salary of $2362 per month. IBM, Bell Telephone Labs, and Sargent-Lundy Engineers were among the companies who hired the most M.S. grads. The unemployment rate among masters grads is a scant 4%, but the civil rate is 13%. Most of those who continued their education were engineering physics grads (82%) and electrical engineers (29%).

Doctorate graduates fared equally as well with an unemployment rate of less than 2% (there was no information on 16% of Ph.D. graduates). Sixty-four percent of spring Ph.D. grads were placed. An encouraging 100% of engineering mechanics grads were hired, while 90% of electrical engineers and 71% of computer scientists were employed. Another 9% received post-doctoral appointments.

The average salaries of doctoral grads must be broken down into three categories. The average industrial salary was $3062 per month while the government salary average was $2595 per month, and the average salary for a university nine month teaching/research position was $2621 per month. Computer scientists received the highest average salary of $3418 per month.

Overall, things look promising for engineers this year. Thankfully, employment possibilities are not expected to get any worse. This year's engineers will know a little bit more about what to expect year by examining last year's statistics. To any future grad: Good Luck! ■

from page 5

Tech Teasers Answers

1. a. No current flows because no instruments were turned on.

b. 11!/6!5! plus 11(10!)/4!6! plus 11(9!)/2!7! plus 11!/3!8! = 3333

2. 5!/5!0! plus 5!/4!1! plus 5!/3!2! plus 5!/2!3! plus 5!/1!4! = 31

3. Down the wall, across the floor, up a side wall, across the ceiling, and down the end wall to Sally will mean a trip of 27 feet 2 inches for the lovesick spider.

Statement of Ownership
Illinois Technograph

Editor-in-Chief of the Illinois Technograph is Larry Mallak 620 E John St, Champaign, IL 61820 General Manager of the Illini Publishing Company is E Mayer Maloney Jr, 704 Harmon, Urbana, IL 61801 Business Manager of the Illinois Technograph is Raymond Hightower III, 620 E John St, Champaign, IL 61820

The Illini Publishing Company is a not-for-profit organization established in the State of Illinois in 1911

Average number of copies of each issue during the preceding 12 months 4400 Annual subscription rate $5.00 Paid circulaton through dealers and carriers none Average mail subscriptions preceding 12 months 1085 Free distribution preceding 12 months 3215 No copies distributed to news agents Total distribution preceding 12 months 4300 Office copies preceding 12 months 100 Total average distribution 4400 No paid circulation throught dealers or carriers Actual April mail subscription 1088 Free distribution at the Engineering campus of the University of Illinois nearest to filing date 2912 Total distribution nearest filing date 4100 Actual number of office copies nearest to filing date 100 I certify that the statements made above by me are correct and complete E Mayer Maloney, Jr, Publisher

continued from page 17

good resources. They are off-campus, have no stacks in which to get lost, and even lend popular records for a dime per week. The Browsing Room, located on the first floor of the Union, offers another escape for between-class reading. If you time it right, you'll never have to open a text book again.

A good way to relax is "gaming." Gaming is playing games on PLATO, the educational computer system. To play, you must sign up with the operators in Room 165 CERL. There are also games on the CYBER computer. For a free student sign-on, go to 1208 W. Springfield (U); then ask a computer science major how to get the games file. For students with computer phobia, there are plenty of video games scattered about campus to eat quarters and absorb brain cells.

The sports scene at the University is just as diverse. Students can participate in any sport from basketball to water polo through the Intramural Sports program run by the Division of Campus Recreation. See the people in 172 Intramural Physical Education (IMPE) Building for more information. The Illini Union also offers bowling and billiards in the basement. Bowling provides a great substitute for going to class. Billiards is a great lunchtime activity, because then one can meet a lot of math professors, who could come in handy later. These games also take a lot less concentration than sitting in lectures.

Armchair coaches and cheerleaders also have plenty of opportunity here. Of course there are the big draws, varsity football in the fall, and basketball in the spring. Everyone should also know about the less renowned sports such as lacrosse, soccer, and women's volleyball. And watch out for javelins flying at the north end of the stadium.

A spectator sport with no fixed schedule occurs several times every week right on the Quad. Carrying the "Word of God," people appear with names like Jed or Max to save us from our sins. The arguments erupting between these evangelists and the students provide prime entertainment. On the mellower side there are the Hare Krishnas (Hare Krishna, Hare Krishna, Krishna Krishna, Hare Hare . . .), who play good music.

In order to take advantage of all these activities, one must be able to transport his body from one point to another. Walking is by far the most popular means of transportation. Ambulating across the Quad on a nice day produces certain feelings of euphoria. That may be from the strange smoke floating over that circle of people. However, walking is slow. The best way to alleviate this problem is to find shortcuts. For instance, few students ever discover the tunnels between Chem Annex and Noyes Lab, or from Huff Gym to the Armory. The second most popular transport mode is by bicycle. Bikes are faster but more dangerous, especially for pedestrians and other little animals walking in front of bikes. Seriously, there are about 10,000 people riding around like maniacs on bicycles, so follow these two rules: register your bike with the University Police, and ride on the bike paths. If you do hit something, make sure it is dead so it cannot report you. Automobiles provide another form of transportation for longer hauls and trips to the grocery store, laundromat, etc. The Champaign-Urbana Mass Transit District will carry you all over town for only 50 cents; it's a good deal. Just remember, you'll probably get where you are going sometime.

Presumably students have chosen their dwelling for the year, but there is always the future to consider. The dorms are probably the best deal. Lots of money will buy you a furnished closet, a community bathroom reeking from weekend activities, and a meal ticket straight to indigestion. There is hope. You can gain exemptions from the housing requirement for religious, ethical (conscientious objector to dorm status), or academic reasons by going to the housing office with an explanation and a note from Mom. Fraternities and sororities provide more private communal living.

For a little more money, an apartment can be had. The resident of an apartment can also more easily live on marshmallow ripple ice cream if he is so inclined. However, one must be wary of unsavory landlords. One should never lease from his professor, as by the end of the year you will both hate each other, which is not good for grades, and insures kissing your damage deposit bye bye. Consult the Tenant Union on the second floor of the Illini Union before renting anything. The best living would be in a tent on the Quad, but since the University Police will evict you forcefully, don't try it.

Once you choose a place to live, it is time to leave. The University offers several programs for studying out of the country. When you get tired of school here and want to go to Europe for a while, talk to the people in Room 3024 Foreign Languages Building for details on the best way to do it.

As a final bit of advice, remember that engineers are the brunt of copious jokes and insults. Don't support them by wearing a calculator on your belt or a T-square sticking out of your backpack. There are lockers in the basement of the Union to keep those in until they are needed. ■

Hot Stuff

Westinghouse Electric Corporation has opened a new facility to develop "superhot" plasma torch systems for a wide variety of future industrial applications. These plasma torches can generate extremely high temperatures by passing compressed gases through a high-power rotating electric arc. This technology can be applied to many processes that now use fossil fuel.

The plasma torch needs only electricity to produce working temperatures up to 10,000°F. By comparison, normal combustion processes using fossil fuels achieve temperatures no higher than 3600°F.

The patented torch is a small device containing electrodes and a cylindrical nozzle from which the glowing gas exits. An electric arc rotates within the torch at high speeds. A pressurized process gas—virtually any gas—is infected between the arc electrodes, creating the ultrahot ionized gas, or plasma. Through this 75 to 90 percent efficient system, process temperatures can be readily controlled by varying the arc current.

The near-term potential for plasma systems, Baker explained, is in Canada, Brazil and other countries that have abundant, inexpensive hydroelectric power and want to develop highly efficient metal and chemical industries. Later, as the cost of fossil fuels such as coke continues to increase in relation to the cost of electricity, it will become economical to retrofit plasma systems to existing conventional iron and steelmaking facilities. Conversions can be readily carried out as soon as high energy cost ratios warrant them.

With a capability of 20,000 kilowatts, the Westinghouse Plasma Center may become the world's most powerful industrial plasma facility. It is available to firms that are interested in testing, developing, and evaluating processes using ultrahigh temperatures. It has two torch test stations and four thyristor controlled

William Junk, an electronics technician at Westinghouse's new Plasma Center near Pittsburgh, peers through a welding eye shield to watch the test firing of a 10,000 F plasma.

DC power supplies, rated 5000 kilowatts each, that can be placed in parallel or in series to total 20,000 kilowatts.

What's Up Dock?

The $700 million Louisiana Offshore Oil Port (LOOP) in the Gulf of Mexico is the first major U.S. facility designed to handle super oil tankers. The LOOP, recently completed after nine years of construction, consists of a marine terminal with platforms and single point mooring buoys, a large diameter pipeline for bringing the oil to shore, and an on-shore oil storage facility capable of holding up to 30 million barrels.

LOOP is an exceptional construction project not only due to sheer size, but also its location. Over 18 miles off the coast of Louisiana, it is constructed in water up to 115 feet deep, making it capable of handling the largest deep draft supertankers afloat.

Its location also offers the U.S. considerable economic benefits since LOOP can be easily connected to a pipeline system serving 30% of the nation's refining capacity in Louisiana, the Midwest, and as far into the Northeast as New York. Handling up to 1.4 million barrels daily, it is a major boost to the effort to increase America's oil supplies.

As an engineering accomplishment, LOOP has many outstanding features. The marine terminal has platforms able to withstand greater wind and wave forces than normally considered in designs of off-shore platforms: mooring buoys are large enough to handle crude oil tankers up to 700,000 deadweight tons, pipelines and pumps can unload oil at rates up to 100,000 barrels per hour, and storage caverns are perfectly engineered to handle the enormous flow rate. In addition, the use of mini-computers gives personnel greater control over maintenance and operations.

Exceptional planning was also needed. Many of the structures and machinery used in construction were assembled at numerous facilities around the world and then brought to the job site, fitted together, and put in operation.

A Rosy World

Tektronix has come to the rescue of weary, bloodshot eyes due to long hours in front of an oscilloscope, CAD system, or VDT. At last, a solution better than eyedrops. Called a π switch, the device fits over a monochromate (one-color) CRT and converts it to a red, green, and yellow display.

The CRT is made with a single phosphor applied in a continuous coating, as in most monochrome tubes. The major difference in the CRT is in the selection and mixing of an innovative phosphor that emits light in both the green and the red portions of the visible spectrum.

The π switch has proven to be more rugged, more precise, and no more expensive than that which the current shadow mask CRT's use to provide a splash of color on similar devices. Tektronix's research group is still pushing the present limits of the π switch for a three color device that will bring full color operation.

James O'Hagan

Daniel Hang graduated from the University of Illinois with a bachelor's degree in Electrical Engineering in 1941. After working for General Electric for 5 years, the University offered him a teaching position, and by 1949 he completed his master's degree and then became a member of the Electrical Engineering faculty.

In 1970, while working for Commonwealth Edison, Hang helped revise a computer code used in economics. In the summer of 1970, he and John Hughes, a student, began working on a better code to be used by Commonwealth Edison to determine the economics of plutonium recycling. By 1973, the code called GEM 1 resided at the Argonne Code Center.

Five years later, Hang, Hughes and three associates formed the corporation HTH Associates Inc., with Hang as president, to market their codes and economic services. The company is growing, and should soon diversify.

Aside from his academic and commercial responsibilities, Hang serves as the faculty advisor for Tau Beta Pi, the secretary of the Illinois Professional Engineering Exam Committee, and is a member of both the National Counsel of Engineering Examiners and the Illinois Atomic Energy Commission.

Kevin Wenzel

Michael Faiman came to the United States to work on Illiac. The early 1960's was the exciting time of the Illiac II computer, and it was happening at the University of Illinois. Faiman was interested in computers and held a bachelor's degree in math and physics from Cambridge. In 1964, he obtained his master's degree in physics from the University, and his Ph.D. in physics in 1966. Professor Faiman then became an assistant professor, being promoted to associate professor in 1971.

Since being on the Computer Science faculty here at the University, Professor Faiman has pioneered the department's first digital logic laboratory in 1971, and the first microcomputer laboratory in 1978.

Favoring academics over industrial positions for the freedom to work as one pleases, Professor Faiman specializes in computer hardware, digital logic design, microcomputers, and networking. While overseeing six graduate students pursuing their advanced degrees, working on his research projects, and teaching, Professor Faiman is an avid amateur photographer and listener of classical music. He says that tomorrow's CS majors will be in most every field of endeavor and they must be prepared to meet the challenges.

James Lee

Ibrahim N. Hajj came to the University of Illinois' Electrical Engineering Department in 1978 after having been on the faculty of the University of Waterloo in Waterloo, Canada, and the Lebanese University in Beirut, Lebanon. He obtained his bachelor's degree in EE from the University of Beirut in 1964, his master's degree from the University of Mexico in 1966, and his Ph.D. from the University of California in 1970. He was promoted to the rank of associate professor of EE in 1982.

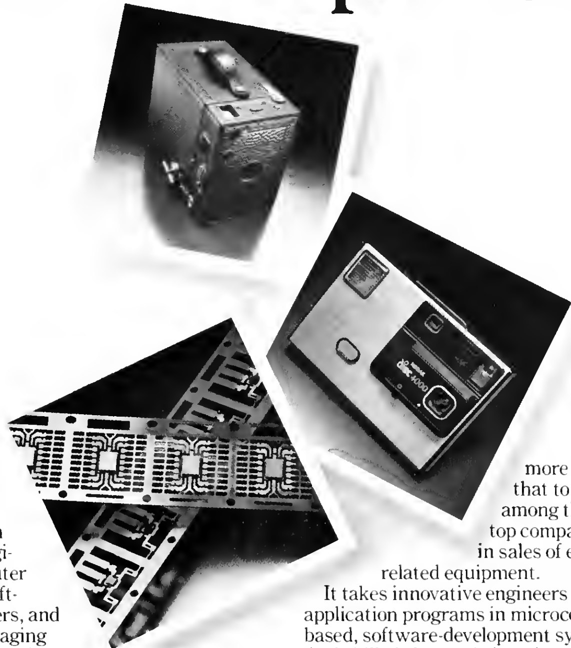
Professor Hajj played an active part in the computer-aided design of VLSI (Very Large Scale Integration) circuits. These circuits are now on the magnitude of 20,000 transistors on a single silicon wafer. Future hopes are on the order of 500,000 transistors on the same chip. With grants from IBM, the Joint Service Electrical Program, and SRC, he oversees four graduate students in their pursuit of advanced EE degrees.

Teaching is his primary enjoyment in academics because of the independent thinking, and freedom it offers not found in industry. Outside the academic world, Professor Hajj is busy with two young sons, aged six and three, and enjoys travelling, hiking, and camping.

James Lee

(c) Eastman Kodak Company, 1983

Electronics at Kodak. Putting good things in small packages is one of our specialties.



Kodak has entered a new era. One in which electrical engineers, computer scientists, software engineers, and electronic-imaging specialists interface to expand our considerable expertise in a wide variety of technologies.

Already, this blending of skills and talents has produced the Kodak disc camera—a camera in which integrated circuits make the decisions, automatically, at the touch of a button, and which incorporates Kodak advances in optical design.

Today, integrated electronic components designed and fabricated at Kodak are built into many of our products. But it takes more than that to keep us among the nation's top companies in sales of electronics-related equipment.

It takes innovative engineers to debug application programs in microcomputer-based, software-development systems. And skilled electronic-imaging professionals to design digital and analog signal-processing devices, and develop software for complex electromechanical hardware.

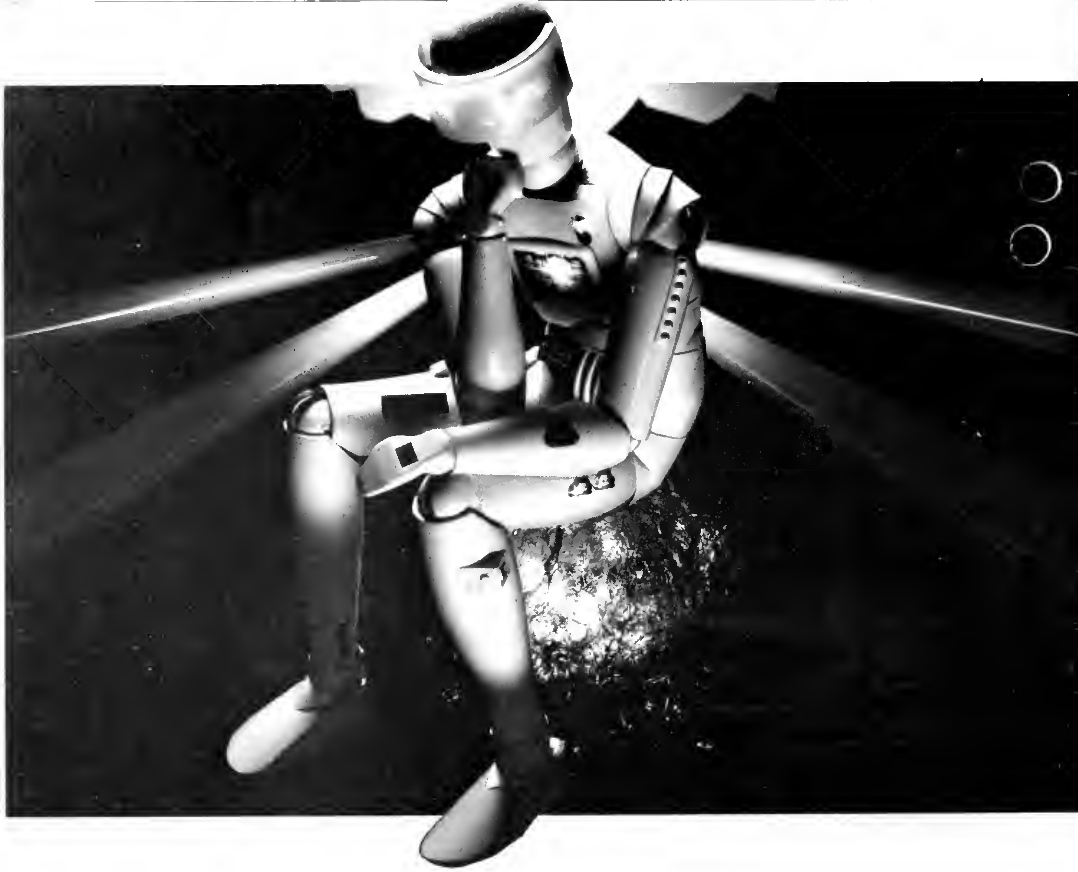
If you're interested in the challenge, diversity, and career advancement you'll find at Kodak, see a Kodak recruiter on your campus. Or send your resume to:
Personnel Resources,
Eastman Kodak Company,
Dept. DECM,
Rochester, NY 14650.

Kodak

Kodak. The right place. The right time.

An equal opportunity employer manufacturing photographic products, fibers, plastics, chemicals, and electronic equipment. Plants in Rochester, N.Y.; Kingsport, Tenn.; Windsor, Colo.; Longview, Tex.; Columbia, S.C.; Batesville, Ark.; and a sales force all over the U.S.

I F · Y O U · C A N · D R E A M · I T · Y O U · C A N · D O · I T



Create computers that capture the mysteries of common sense.

The brain does it naturally. It wonders. It thinks with spontaneity—advantages we haven't been able to give computers. We've made them "smart," able to make sophisticated calculations at very fast speeds. But we have yet to get them to act with insight, instinct, and intuition.

But what if we could devise ways to probe into the inner nature of human thought? So computers could follow the same rationale and reach the same conclusions a person would. What if we could actually design computers to capture the mysteries of common sense?

At GE, we've already begun to implement advances in knowledge engineering. We are codifying the knowledge, intuition and experience of expert engineers and technicians into computer algorithms for diagnostic troubleshooting. At present, we are applying this breakthrough to diesel electric locomotive systems to reduce the number of engine teardowns for factory repair as well as adapting this technology to affect savings in other areas of manufacturing.

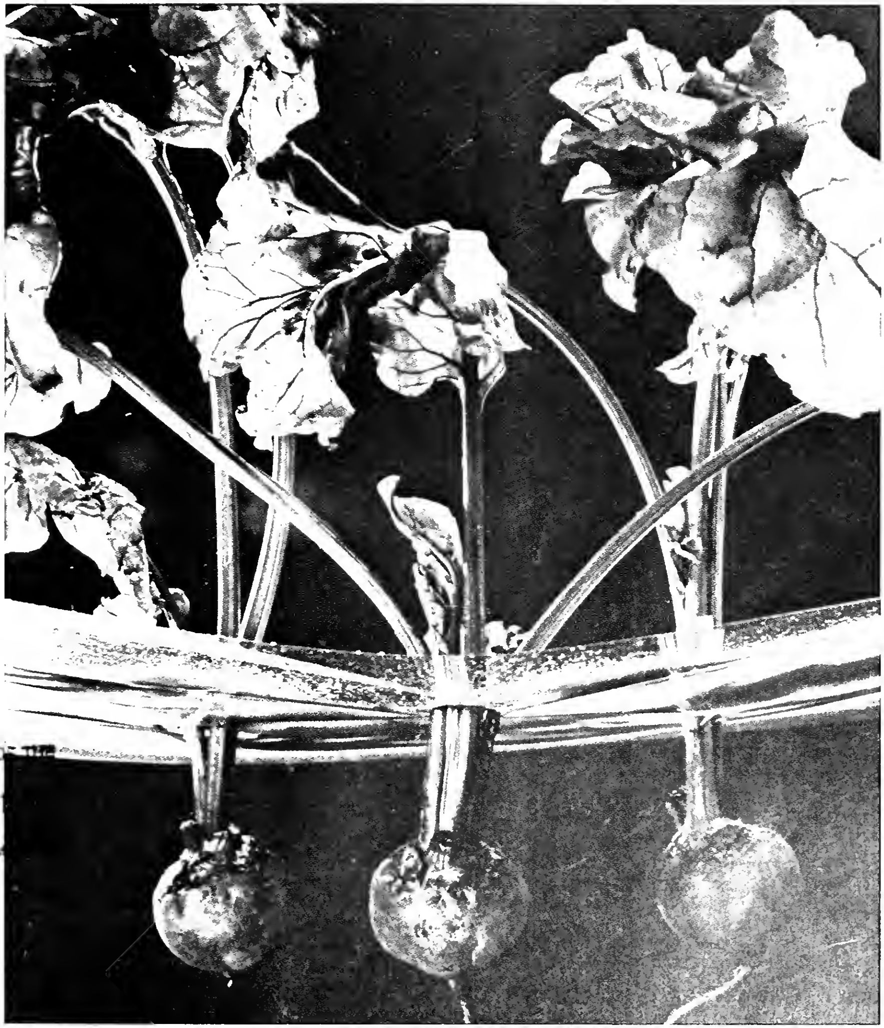
We are also looking at parallel processing, a method that divides problems into parts and attacks them simultaneously, rather than sequentially, the way the human brain might.

While extending technology and application of computer systems is important, the real excitement and the challenge of knowledge engineering is its conception. At the heart of all expert systems are master engineers and technicians, preserving their knowledge and experience, questioning their logic and dissecting their dreams. As one young employee said, "At GE, we're not just shaping machines and technology. We're shaping opportunity."

Thinking about the possibilities is the first step to making things happen. And it all starts with an eagerness to dream, a willingness to dare and the determination to make visions reality.

An equal opportunity employer

If you can dream it, you can do it.



Artificial Growing

The Illuminated Vortex

Understanding how the in-cylinder flow of the fuel-air mixture is influenced by chamber geometry provides a key to improving engine performance. By applying a laser measurement technique, a researcher at the General Motors Research Laboratories has gained new insight into the behavior of the flow.

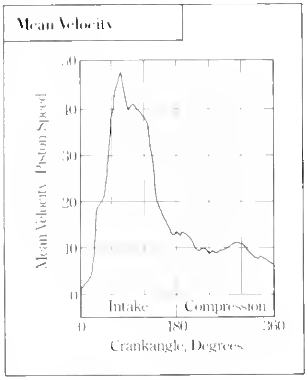


Figure 1. History of mean velocity at a single engine location.

THE FLUID motions inside engine cylinders have considerable influence over the progress of combustion. Mixing of air and fuel, combustion rate, and heat losses from the cylinder are all important transport processes strongly dependent on fluid motions. The motion inside the cylinder has two components. Mean velocity influences the transport of momentum, energy, and species on a cylinder-wide scale, while the turbulence component influences the same phenomena on a local basis. The in-cylinder flow field depends primarily on the geometry of the cylinder and inlet port. Hence, decisions made in the engine design stage exert a controlling influence over the flow. But before questions about how different geometrical features affect the flow field can be answered, the problem of how to measure the flow must be solved. By applying Laser Doppler Anemometry (LDA), Dr. Rodney Rask, a researcher at the General Motors Research Laboratories, has obtained detailed measurements of the flow field.

LDA is a technique in which two focused laser beams pass into the cylinder through a quartz window. In the minute measuring region where the laser beams cross, a regular pattern of interference fringes is created. As the 1-micron particles, which have been added to the engine inlet flow, cross the measurement region, they scatter light in the bright fringes. In Dr. Rask's LDA system, the scattered light is collected by the same lenses used to focus the laser beam, and measured by a photomultiplier tube. The resulting signal is processed electronically to determine the time it takes a particle to traverse a fixed number of fringes. Since the fringe spacing is a known function of the laser beam crossing angle, this transit time provides a direct measure of velocity.

During operation of the LDA, measurements of velocity as a function of engine rotation (crankangle) are made at a number of locations within the cylinder. The instantaneous velocity at each point must then be separated into mean and turbulence components. The simplest technique is to declare that the mean velocities for all cycles are identical and ensemble average the data. However, this approach ignores the cyclic variation in the mean velocity. Another technique looks at individual cycles and uses a variety of methods, including sophisticated filtering, to split the instantaneous velocity into its components. This

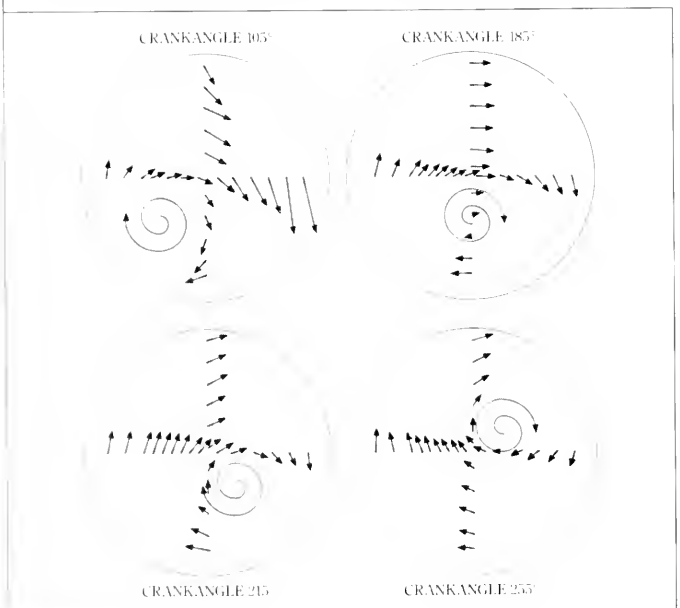


Figure 2. Panoramic view of engine flow patterns. With changing crankangle, the center of rotation precesses from the cylinder's lower left quadrant to its upper right quadrant.

approach is consistent with the LDA measurements, which clearly show that the mean velocity does not repeat exactly from one engine cycle to the next.

Differences in the flow field from one cycle to the next can seriously compromise engine efficiency. Near the end of the compression stroke, it is important to maintain a consistent velocity at key cylinder locations (e.g., at a spark plug). Dr. Rask's LDA measurements have identified design features that control cyclic variability.

FIGURE 1 shows mean velocity measured at a single location during an engine cycle. High velocity exists during the intake stroke when the inlet flow is rushing through the narrow valve opening. This jet-like flow into the cylinder causes large velocity differences between adjacent cylinder locations and produces strong turbulence. As the end of the intake stroke is approached (180 degrees in Figure 1), the levels of both mean velocity and turbulence drop rapidly. This decrease is a result of the changing boundary conditions for the cylinder—from strong inflow to no inflow. During the compression stroke the flow field evolves, but it undergoes no drastic changes. However, in a high-squish chamber, where the flow is forced into a small bowl in the piston or cylinder head, considerable turbulence is generated near the end of the compression stroke.

Measurements from many cylinder locations are necessary to make the flow field understandable. Figure 2 shows four flow patterns covering a period from near the end of intake into the compression stroke. Note the strong vertical flow, with the center of the vortex away from the cylinder center and precessing with changing crankangle.

By experimenting with geometrical variables, Dr. Rask has gained new understanding of phenomena observed in operating engines. The resulting knowledge has guided the design and development of new engines with a minimum of trial-and-error testing. The LDA findings are also being used to validate and calibrate engine flow computer models under development.

"From our measurements," Dr. Rask states, "we have been able to deduce how changes in the geometry of the port and combustion chamber modify the velocity field. These flow field effects are now being used to help designers tailor engine combustion for optimum performance."

THE MAN BEHIND THE WORK

Dr. Rodney Rask is a Senior Staff Research Engineer in the Fluid Mechanics Department at the General Motors Research Laboratories.

Dr. Rask received his undergraduate and graduate degrees in mechanical engineering from the University of Minnesota. His Ph.D. thesis concerned the Coanda effect.

Prior to joining General Motors in 1973, Dr. Rask worked on the design of nuclear reactors at the Knoll's Atomic Power Laboratories. In addition to further refinements in LDA measurement techniques, his current research interests include computer simulation of engine systems, with special emphasis on the intake manifold.

Illinois **Technograph**

November 1983 Volume 99, Issue 2

6 **Digital Audio** *Eric Guarin*
Bit by bit, new methods of music reproduction are capturing the hearts of audiophiles.

8 **Electromagnetic Pulse Shielding** *Kirt Nakagawa*
Nationwide pandemonium can be prevented by the shielding of semiconductors from outerspace disturbances.

10 **Hydroponics** *Mary Kay Flick*
Those vegetables in the produce section may have never seen the light of day.

16 **Trends in the College** *Jeff Donofrio*
The College of Engineering has always changed with the times. . . and always will.

18 **Synthetic Fuels** *James Yun*
Supplementing the energy supply with artificially produced fuels is one alternative to drilling for oil and gas. Can this practice continue?

Departments
Editorial 5, Tech Teasers 5, Technovisions 12, Technotes 15, Technovations 21, Tech Profiles 23

On the cover: Beets are illustrated growing in an unnatural medium. The field of hydroponics is discovering media other than soil in which plants may grow. (photo by Dave Colburn)

Illinois Technograph
(USPS 258-760)
Vol.99 No.2 November 1983

Illinois Technograph is published five times during the academic year at the University of Illinois at Urbana-Champaign.

Published by Illini Publishing Co., 620 East John St., Champaign, Illinois, 61820. Editorial and Business offices of the Illinois Technograph: Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3730.

Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001; 221 N. LaSalle Street, Chicago, IL., 60601.

Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879.

Illinois Technograph is a member of Engineering College Magazines Associated.

SCIENCE/SCOPE

A Very High Speed Integrated Circuit chip has been produced at Hughes Aircraft Company, marking a significant step toward the use of advanced semiconductor technology in military systems. The chip, built after less than two years of development, contains 72,000 transistors in an area the size of a thumb tack. The VHSIC program is being conducted by the U.S. Department of Defense to develop chips that will give military electronic systems a tenfold increase in signal processing capability. The high-speed, compact VHSIC chips will be more reliable and will require less power than integrated circuits now in use.

An advanced antenna farm designed with the aid of a computer will be carried into space by Intelsat VI communications satellites. The system will provide many different kinds of coverage -- beams transmitting to entire hemispheres, "global" beams, focused regional beams, and very narrow spot beams for broadcasting high-speed data. Hundreds of computer patterns were created to predict antenna performance. These studies led to the choice of transmit reflectors 3.2 meters in diameter instead of 4 meters. The larger size was rejected because it offered only slight improvement at the cost of being much heavier, larger, and more complex. Hughes heads an international team building Intelsat VI for the International Telecommunications Satellite Organization.

The F/A-18 Hornet's radar undergoes searing heat and piercing cold as part of its reliability tests. During one demonstration, two AN/APG-65 radars operated 149 hours without failure, the equivalent of almost five months of flight time. The units were run through repeated cycles consisting of 90 minutes at -65°F, then 90 minutes at -40°F, and six hours of continuous operation at temperatures up to 160°F. By comparison, the lowest and highest temperatures ever recorded in North America were -81°F in 1954 at Snag in Canada's Yukon Territory, and 134°F in 1913 in California's Death Valley. The APG-65 is the first multifunction radar for both air-to-air and air-to-surface missions. Hughes builds it under contract to McDonnell Douglas for the U.S. Navy and Marine Corps.

The new AMRAAM missile will be good at evading enemy detection through a clever improvement to its radar system. The improvement, now patent pending, is done simply and with only a little extra hardware. It greatly reduces inaccuracies caused when the missile jumps from one radar frequency to another en route to its target. Frequency hopping makes it extremely difficult for enemy radar-detection equipment to get a fix on the missile. Hughes designed and developed the Advanced Medium-Range Air-to-Air Missile for the U.S. Air Force and Navy.

More than 20 nations throughout the free world guard their skies against enemy attack with automated air defense systems developed by Hughes. Since pioneering the electronically scanned 3-D radar more than 20 years ago, Hughes has produced or managed systems for Japan, Switzerland, NATO countries, Spain, Canada, and the United States. Air Defense Ground Environment (ADGE) systems are comprised of air defense radars, computers, displays, and other electronic subsystems. Data links relay detections to data processing centers where computers identify, automatically track, and report the aircraft's speed, altitude, and course.

Guglielmo Marconi
1874-1937

Tech Teasers

1. Brilliant Bob visited Busey Bank one day to apply for a job. The interviewer asked him, "If a customer cashed a check for $63 and asked for his money in 6 bills, what would you hand him if you were out of $1 bills?"

Being brilliant, Bob busied his brain and brought forth his answer. What was it?

2. A strip of paper is .009 inches thick and 450 feet long. If it is rolled on to a cardboard cylinder 1 inch in diameter, what will be the final diameter of the roll?

3. Before Cuba took over Nicaragua, the anti-human Somoza regime issued 10 postage stamps dedicated to mathematical formulae as an obvious attack on the public's mental health. How many can you identify?

a. The elementary formula that ended imprecise totalling of possesions of exchange.

b. Einstein's formula for the conversion of matter to energy.

c. Pythagoras's formula for the relationship of the two sides and hypotenuse of a right triangle.

d. Konstantin Tsiolkovskii's equation giving the changing speed of a rocket as it burns the weight of its fuel.

e. James Maxwell's formula equating electricity and magnetism.

f. Archimedes' formula for the lever.

g. Louis de Broglie's equation for light as a form of energy.

h. Ludwig Boltzmann's equation for the behavior of gases.

i. John Naqier's logarithm formula, which provided a multiplication and division method simply by adding or subtracting the logarithms of numbers.

j. Sir Isaac Newton's formula for gravitation.

answers on page 20

Editorial

Wrong Numbers

Newspapers across the country have recently carried full-page ads for AT&T. These ads have been in the form of letters to members of Congress, AT&T shareholders and employees, and their customers. At the bottom of each of these pleas is the signature of AT&T Board Chairman C.I. Brown.

Brown claims that if two bills now in Congress, S1660 and HR4102, are passed into law, the deregulation and divestiture of the phone giant will be severely affected.

These bills, according to Brown, call for a continuation of massive subsidies, which is in opposition to the national policy favoring competition. Secondly, the bills would keep the pricing structure the same with respect to long-distance rates and local service charges. AT&T has a proposal before the FCC to reduce long-distance rates, while raising the monthly fee for local service. Brown states that long-distance rates have had a high profit margin, while local service had been provided at a loss.

Ma Bell has allowed herself to foster poor pricing schemes because of no previous outside pressure to do otherwise. Now MCI, Sprint, and a host of other long-distance services are available, which offer lower prices for many of Bell's customers. This new competition for long-distance customers will force the participating companies to operate more efficiently.

Brown contends that for most Bell customers, long-distance charges constitute a major portion of the phone bill. He uses this fact to support the "long-distance rate cut and local service increase package." But, Mr. Brown, will this stop AT&T's customers from subscribing to MCI and Sprint? Further, what would stop MCI and Sprint from offering local service by the following scheme: the local call is routed to an MCI or Sprint switching station where the call is relayed back to its origination area, thereby making it a local call? Economies of scale may make such a plan realistic, or it may be used as a "loss-leader" to receive initial subscribers, thereby providing competition at the local level.

Giving up monopolistic practices should not be used as an exploitation device to achieve increased profits. AT&T's rate increase proposal undoubtedly asks for rate hikes in local service which more than offset the revenue lost by the reduction in long-distance rates. This correction is the result of poor pricing on the part of AT&T. The FCC should not approve a package which allows for higher profits than those earned under the current structure.

Interference in this stage of AT&T's scheduled breakup will only hurt the consumer as the corporation would incur huge costs in changing its carefully designed strategy. These costs would be passed on to the consumer in the form of higher rates.

AT&T should be allowed to complete its divestiture and to engage in a newly found "free competition," free of hindrance from the Congress who originally legislated the breakup.

In Memoriam

The staff of Illinois Technograph would like to extend its sympathy to Associate Dean of Engineering, Howard Wakeland, on the loss of his wife Betty.

Missing Persons

Our apologies to computer scientists, who were inadvertently left out of the charts accompanying *Engineering Placement Report* in our October, 1983 issue.

by Eric Guarin

Digital Audio

Ever since the invention of sound, there have always been those who strive for perfect audio recording and playback. Until recently, their success has been limited to a combination of personal taste and the current technology. This is all changing with the advent of "perfect" sound reproduction.

A compact disc is loaded into the Sony CD digital audio player. (photo by Dave Colburn)

Ever since Thomas Edison first recorded sound onto a tin cylinder, researchers in the audio field have continually strived to perfect techniques for storing and reproducing sound. From tin cylinders the state of the art proceeded to phonograph records in a long progression, beginning with 78 rpm shellac records to more modem 33-1/3 rpm vinyl records and finally to today's superdisc audiophile records with their very high quality control standards.

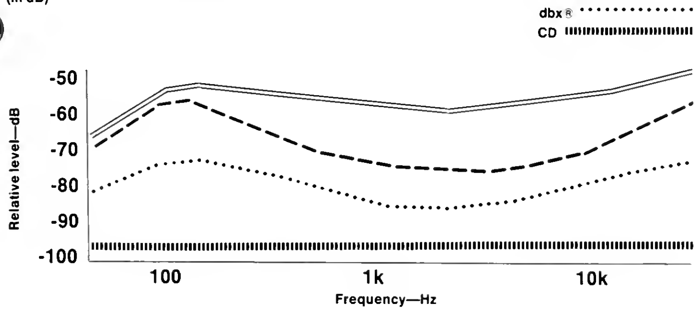
Tape recording also developed, growing as wire recorders were superseded by magnetic tape recorders: reel-to-reel, cassette, and eight-track tape. Tape mediums benefitted most from the inventions of various noise reduction systems designed to combat residual noise intrinsic to various recording media: Dolby A (for the studio) in 1967, Dolby B (for consumer applications) in 1969, followed by dbx®, Dolby C, DNR, and a host of other systems. Each system made a contribution to better sound fidelity in recording, yet problems and limitations still remained. Primary problems included the impermanence of recordings (wear), distortion, frequency response inaccuracies, and, ironically, incompatibility between the various forms of noise reduction sytems designed to combat these problems. In the late Seventies, portents of a new development appeared as audio engineers began working on a new form of recording altogether: digital audio, which may be to conventional analog recording what stereo was to mono in an earlier era.

The difference between conventional analog processing and digital processing lies in how the recorded signal is sampled and stored. On a basic level, analog recordings make a continous record of an occurrence whereas digital processing makes a periodic record of the occurrence. For example, a record of temperature variations during the day could be made using either approach. To make an analog record of the temperature, a pen-and-paper chart could make a continous graph of temperature versus time (an *analog* of temperature); a digital record would consist of spot checks of the temperature every hour. With the analog method, every minute variation in the measured variable is preserved; the digital method merely samples these variations. Such sampling and consequent loss of minute detail may not be so bad; however, hourly spot checks of the temperature might be useless for a detailed analysis of a particular day's temperature variations, but more than sufficient detail for analysis of monthly temperature trends.

Sound can be recorded via the same processes. The voltage of the music signal (in electronic form) can be recorded continuously or sampled periodically. When the music signal is sampled often enough, the digital recording will contain nearly as great a degree of fine detail as the analog recording; for a relatively high sampling rate, the digital recording will have sufficiently fine detail to recreate the original signal well enough so that the human ear cannot distinguish between the two. Thus, the basic difference between analog recording and digital recording is that analog recording stores a continuous function of the signal voltage, whereas the digital recording will store periodic samples of that voltage (or, in some cases, the change in signal voltage between samplings).

Digital recording, of course, has some inherent difficulties. One of these difficulties, at least in present consumer sytems, is that to properly recreate the original sound, frequencies above 20,000 hertz must be severely attenuated. As this is the upper limit of human hearing, this will not cause the high frequencies to be lost, but they will be slightly delayed with respect to lower frequencies due to the effects of filtering; this is known as phase shift. Very slight decreases in output near

Noise Relative to Maximum Output
(in dB)



Source: dbx® Inc., "Audio" Magazine Feb. 1982

20,000 hertz are also caused by this filtering, but this effect is humanly inaudible.

Digital recordings have also been accused of sounding artificial, but overall this has been unsubstantiated under controlled conditions. Conversely, many experts believe that digital sound is a magnitudinal improvement on the state of the art in recording. Digital recordings may reveal recording flaws to a greater degree than analog recordings—but this is a problem with the recording techniques employed, not the system. Overall, the improvement in sound quality made possible with digital recording renders these few flaws a comparatively minor problem.

Digital processing leads to enhanced sound quality not so much because of actual improved sound, but because factors detrimental to sound quality are sidestepped. Many problems are essentially eliminated in digital processing. Noise is reduced to nearly total inaudibility. Changing response as a function of recording level is no longer a problem, and variations in playback speed and pitch are undetectable by present technology. Other problems also become unimportant, especially the problems of software deterioration and distortion, both of which are greatly reduced. For example, compact discs, the digital equivalent of analog LP records, should last for decades with extremely minimal care and no noticeable deterioration in sound quality. All of the various improvements lead to reproduction quality which can be startlingly accurate.

These improvements occur due to the processing procedure itself. The process by which music is stored and recreated in a digital system is essentially simple in concept, although in practice quite complex. Musical signals being processed have their voltage level sampled at some 44.1 thousand times per second, in order to record the full frequency range of human hearing. The value for each sampled voltage level is stored numerically in binary code. Analog systems, in contrast, store voltage levels either physically (LP records) or magnetically (tapes). The digital code itself is composed of sixteen-bit numbers representing the voltage values. Sixteen-bit recording yields a maximum ratio of signal level to noise level of 96 decibels—this is much better than, say, Dolby B which has a typical signal-to-noise ratio of about 65 decibels (ten decibels represents a tenfold increase in power; three decibels is a small but noticeable increase in music volume).

Conversion of musical voltage levels into representative numbers is analog-to-digital conversion, a difficult task considering that over 44 thousand voltage levels must be sampled in the space of one second and converted into binary code. The binary code generated is then stored in some medium (tape, disc, and so forth). Upon playback, the code is fed into digital-to-analog converters, which turn the numerical voltage values into actual signal voltages, and smooth these distinct voltage values into one continuous music signal. Playback conversion is also quite difficult; the stored voltage levels must be analyzed and converted into any one of 65,536 distinct output voltage values. All this conversion and reconversion sounds like a lot of difficulty, but it creates a high degree of precision in storage and reproduction. Essentially, a highly complex musical signal becomes a stream of binary "ones" and "zeros" which are much easier to store without error than the original complex signal. In cases where errors do occur, extensive and sophisticated error detection and correction circuitry corrects these errors and the musical signal is reproduced with no audible flaws.

In theory, then, digital audio recording should be nearly flawless. In practice, the results seem to live up to the industry's expectations. The actual systems used to produce these results vary, but digital audio hardware generally falls into one of several formats.

One major digital audio format is digital cassettes, or, to be more precise, digital audio stored on videocassettes. Two approaches to digital audio in tape form are available to consumers. The more common approach involves a device

continued on page 14

by Kirt Nakagawa

Electromagnetic Pulse Shielding

One of the greatest offenses in a battle is total control of the enemy's society. Since Silicon Valley was founded, this control has been indirectly possible for any country that owns a nuclear device. This bizarre connection is, nonetheless, quite real and a current concern.

A key element in the defense network of any country is good communication between government officials, military leaders, and the troops. Without reliable and complete communications a war effort is certainly hindered, if at all possible.

Many of us take for granted that in the event of a war, the President may simply pick up a telephone, speak with his military advisors, and literally orchestrate the war over the phone. However, if an enemy nation could somehow disrupt communications, even temporarily, it could get the upper hand in a war. But how could the communications network be disrupted on so great a scale that even alternate systems are defeated?

The answer lies in the fact that today's communication systems rely a great deal on sensitive electronic devices such as integrated circuits and other solid state devices. Many of these devices are susceptible to damage from sudden voltage surges, or pulses. If one of these devices were to be connected to a large conductor, such as an antenna, a voltage surge could be caused by a strong burst of radio-frequency electromagnetic energy being received by the conductor. Such pulses are given off with exo-atmospheric (or outside of the atmosphere) nuclear explosions. A pulse of this type is called EMP, an acronym for electromagnetic pulse. The story of EMP and how it developed as a potential security threat dates back over twenty years, and begins in the Pacific ocean.

Limits of coverage for height of burst (HOB) at 50 and 120 miles located over the central United States.

Source: <u>EMP Radiation and Protective Techniques</u>

During a July evening in 1962, a small rocket lifted off from Johnson Atoll, a tiny island in the Pacific ocean. When the rocket attained an altitude of 248 miles above sea level, the 1.4 megaton hydrogen bomb it was carrying was detonated. While military engineers were making observations, 800 miles away in Hawaii a number of scattered and seemingly unrelated electrical malfunctions occured, all within one second of the blast: streetlights died out, burglar alarms went off and power lines went dead as circuit breakers were tripped. Some phones went dead but most kept working. The media blamed these occurences on a nuclear shock wave.

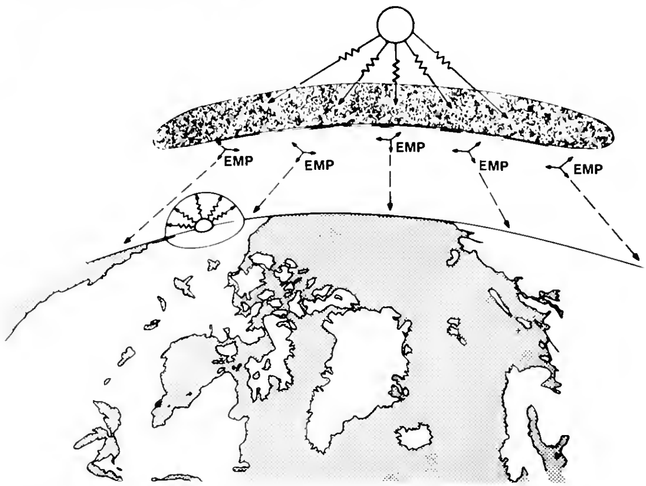
The effects were more accurately explained by military physicists in 1963, who attributed the malfunctions to a strong electromagnetic pulse which they called EMP. EMP was found to accompany nuclear explosions in the atmosphere and to be unrelated to the thermal, alpha, beta, gamma, and neutron radiations normally associated with nuclear explosions. EMP was declared harmless to human beings.

The military scientists discovered that EMP did not originate from the nuclear reaction which caused the explosion; it was realized to be a by-product of the reaction. EMP, they found, is propagated when gamma rays, X-rays, and other forms of high-energy radiation (which are released during the blast itself) react with the atmosphere in such a manner as to ionize the gas molecules of air. This produces free electrons and positive ions. The electrons, which acquire kinetic energy, spin down and around the lines of force of the earth's magnetic field. This flow of charge effectively constitutes a flow of current which transmits a brief but powerful burst of energy—EMP.

EMP is classified as a prompt effect. It occurs with the blast and is an immediate effect. EMP is vastly increased in the exo-atmosphere (as opposed to surface blasts) because, as Magnavox scientist L.W. Ricketts and IIT engineer J.E. Bridges put it,"The dense atmosphere near the earth's surface restricts the range of gamma rays." In the near airlessness of the exo-atmosphere, however, the gamma radiation is free to travel much greater distances before encountering a gas molecule of the atmosphere. Thus, not only is the effective EMP greater, but the area affected by the pulse is broader. In fact, at an altitude of 120 miles, a nuclear explosion would affect (to varying degrees) the entire continental United States. The pulse is brief, less than a millisecond in duration, but powerful, with peak field strength of 50,000 volts per meter.

However, the military scientists were not overly concerned about EMP in Hawaii. They felt reassured by the fact that the effects were not complete but

Near-surface and exo-atmospheric blasts.



Source: EMP Radiation and Protective Techniques

scattered. Also, at the time, most electronic and electrical systems employed vacuum tubes, which are resistant to voltage surges.

In the 1970's, a kind of semi-conductor revolution occurred as integrated circuits invaded the world of communications and control. As dependence on integrated circuits and other solid-state devices increased, greater attention was focused on the problem of EMP. It was soon discovered that these devices were more than a million times more likely to be destroyed by EMP than vacuum tubes. Massive disruption occurred in digital processing circuits upon absorption of EMP.

Burnout was associated with electronic devices connected with large antennas (radar, broadcast, etc.) receiving EMP. It became clear that research was needed to fully understand the effect of EMP. By 1971 the military was spending $250 million on EMP research with emphasis on hardening (or shielding) various electronic and electrical systems from the effects of EMP. In the late Seventies, the Air Force began to construct an EMP simulator at the Kirtland Air Force Base in New Mexico. Named Trestle, after the railroad structure it resembles, the simulator consists of two 5-million volt pulsers which discharge into wires surrounding a test area. The pulsers, wires, and test area lay atop an enormous wooden platform (easily large enough to hold a B-52 bomber). Any metal affects the pulse, so the entire platform, including the pegs which hold it together, is made of wood. In 1980, at a cost of $58 million, the Air Force began testing their airplanes for EMP hardness.

Today military scientists and engineers are tackling the problem of hardening communications and control networks used in and between the government and the military from the effects of EMP. A major concern of defense officials is the potential for a communications blackout between Washington, D.C. and the armed forces. An ideal step by an enemy nation attacking the United States would be to bathe the nation in EMP and attack during the ensuing confusion. There are a great deal of communication avenues between Washington and the military, but each has some degree of susceptibility to EMP.

Current research indicates that the use of vacuum tubes and the insulation of sensitive electronic devices from large conductors is a wise precautionary measure for important systems. Unfortunately this is often an impractical or unfeasible approach.

One solution relies on the use of fiber optics. Fiber optics involves the transmission of messages along thin glass fibres in the form of pulses of light. Unfortunately, this can only be used on a small scale (e.g., within a bomber) because a large system would require vulnerable switching centers and amplifiers filled with solid state devices.

Another solution engineers and scientists devised included taking one of the special Boeing 747's that serves as an airborne command post for the President and insulate the entire electrical system from the hull of the airplane. This provides, in the event of a war, one possible communication center between the government and the armed forces. The plane is considered reliably hard, but was built at a cost five times greater than a commercial 747. In addition, it is believed that the communications satellites the government depends on would be damaged or destroyed by EMP as well, thus reducing the range of communication at the disposal of the government and the military.

One of the greatest problems facing scientists is the fact that no simulation can be as widespread as necessary to test an entire communications network. Only an exo-atmospheric nuclear detonation itself would be an accurate test, but these have been banned since 1962. Testing and research will continue until scientists and engineers find an avenue free from the threat of EMP.■

Hydroponics

by Mary Kay Flick

It is not easy to tell the difference between a plant grown in soil and one nurtured inorganically. This is the secret behind the success of inert substance-grown vegetables and flowers, a success that can be shared by anyone with a greenhouse and a green thumb.

Growing garden vegetables in an Illinois winter sounds like an outrageous idea. Vegetable growing in Illinois is not economically feasible. Instead, consumers are forced to pay high prices for produce due to transportation costs from growers in the West and Southwest. Hydroponics offers an alternative to this and allows consumers to enjoy fresh garden vegetables all winter long.

The word "hydroponics" describes the method by which plants are grown in inert substances that do not hold water and nutrients as soil does. The water and nutrients are supplied via storage tanks and pumps. After passing through plant roots, the water is saved and later recirculated as needed. Primarily, lettuce, tomatoes, and cucumbers are grown in hydroponic greenhouses, however many houses grow flowering plants such as roses and carnations.

Hydroponic systems can be designed in countless ways. The conventional system consists of a tray that holds and supports the plants, a tank for the nutrient solution, a pump, a control system, and pipes to connect these. Many systems use a filtering method which removes fungi, bacteria and other plant debris. After the nutrient solution is pumped into the plant trays, it drains into the filter where it is pumped back into the storage tank and pumped again into the plant tray to repeat the cycle.

Hydroponic growing systems may be either static or flowing. Static systems require that air constantly be bubbled through the solution around the roots, supplying them with oxygen. A pump similar to an aquarium pump can be used to do this. In a flowing system, the nutrient solution provides aeration as it flows through the root systems of the plants.

Although plants are commonly grown only in water, other inert rooting media may be used. Gravel and sand are possible materials since they do not hold water and nutrients the same way as soil. Other substances which can be used are artificial soils such as peat-lite (consisting mostly of sphagnum peat), horticultural vermiculite, and inorganic sources of plant nutrients. Straw bales, rockwool (a European insulating material), sawdust, wood shavings, and bark have been used in Europe, but because these substances decompose easily they are useful for one crop only. In the United States, coal shale and volcanic ash have been used as an alternative hydroponic media.

When using inert growing media such as these, plants are often placed in plastic bags rather than trays. The bags retain the material while allowing the nut-

This field of lettuce grows in water and is harvested after thirty days. (photo by Jane Fiala)

rient solution to pass through. Otherwise, trays that allow large amounts of water to flow through are used.

Water can either be flooded to the roots of a plant, as with the tray system, or it can be sent to the roots using a trickle tube. This is common when gravel and sand systems are used. In some systems, the roots or the tops of plants are misted with nutrient-enriched water.

Good water is requisite for profitable crop production. The salt concentration is also important in the growth of the plant. The smaller the concentration, the greater the growth. In addition, there are certain basic nutrients neccesary for healthy plant growth. Calcium, postassium, nitrogen, phosphorus, and magnesium are considered major elements because plants need more of them, and a deficiency is readily noticeable. Copper, boron, iron, zinc, and molybdenum are considered trace elements since the plant uses very little of them. Usually there are sufficient amounts of trace elements in tap water to supply the plants with what they need. The major elements can be added to the water in the form of fertilizer salts such as magnesium nitrate, phosphoric acid, potassium monophosphate, calcium carbonate, and sodium nitrate as well as others.

In an open system (where the nutrient solution is circulated throughout the plants again and again) constant monitoring of the concentration levels of the salts is needed. After one or two weeks of use, a solution may be discarded and a fresh one made. This helps assure a purer solution and alleviates some nutritional problems.

Hydroponic greenhouses are built both privately and commercially. When built by novices as money-making ventures, profits often do not reach anticipated levels. It takes a large investment to start a greenhouse and keep it running. This includes the cost of the greenhouse and hydroponic equipment. The initial cost of hydroponic equipment depends upon how large and how elaborate a system the grower wants to use. Plastic greenhouses initially cost less than glass, but their maintenence costs are greater.

The operational expenses of a hydroponic greenhouse are considerable. Fuel, which is used to heat the house in winter and run the pumps, accounts for one of the largest outlays of funds. This will continue to be a large expense, since fuel costs are not decreasing. Other operational costs include material costs and repair (seed, nutrients, building repair, equipment repair), shipping and selling costs, and labor.

According to a survey done by the University in April of 1983, the average cost of labor plus management for a standard 24 by 130 foot greenhouse is $7608 per year. A greenhouse also takes an average of 40.5 hours of labor per week to run.

The survey also broke down the annual production costs as follows: materials and repair, $1130.50; labor, $7608.00; utilities, $398.00; selling, $850.00. Therefore, the average production cost per greenhouse was $13,568. Growers who borrow to start their businesses incur interest payments, in addition to these costs.

Potential net return depends on the yield and the market price of a crop. Hydroponic tomato producers need to sell 20,000 pounds of tomatoes per year at a minimum cost of 68 cents a pound to cover costs and receive a profit of $7000 per year, assuming all loans are paid.

Clearly, a small greenhouse operation is not highly profitable. As a hobby, this type of agriculture can be worthwhile and challenging. Growers can produce quality vegetables even though they may not make a large profit.

Although hydroponics is a speculative business on a small scale, it has achieved some success on a large commercial scale. The Archer Daniels Midland Company (ADM) in Decatur, Illinois has become successful in hydroponics from its unique use of by-products from its grain refining plant. The ADM Hydrofarm consists of 4.5 acres of greenhouse space used primarily for growing lettuce. What makes ADM unique is the fact that it uses waste heat from corn refining operations and excess carbon dioxide from power alcohol production for plant production. In this way, it is possible to reduce utility costs by 90% and increase plant yield by 20 to 40%.

At ADM, a lettuce seedling starts in a block of cotton where it is misted by tap water for five days. It is then put in a nutrient solution for another fourteen days. Then seedlings are transplanted into trays and placed in large greenhouses where they take another 25 to 35 days to mature in water containing 24 nutrients. This water is conserved through a continuous flow-through system. At maturity, conveyors take the lettuce to a picking area for packing and shipping. With 4.5 acres in full operation, ADM expects to produce two tons of lettuce each day.

ADM's greenhouses are regulated by a computer system. Probes sense temperature, humidity levels and nutrient concentrations. These probes feed the information into a computer for regulation. After packaging, most ADM lettuce is sold to large chain grocery stores in Illinois.

There are advantages and disadvantages to growing with hydroponics. Hydroponics provides a more controlled environment. However, good soil is forgiving of most mistakes. Someone recently stated, "The potential for greenhouse vegetable production has never been so great nor problems more critical." This statement sums up basic thoughts about hydroponics. It can be a viable alternative to soil grown vegetables, however the costs are significantly greater. The question of sufficient markets for higher priced vegetables must also be answered. Marketing is one key to success. Poor marketing has caused many growers to shut down.

Hydroponic growing has captured the imagination of many people. However, whether Illinois can become a major vegetable growing area is a question that only the future can answer. ■

200 Years of Flight

The Institute of Aviation recently celebrated 200 years of manned flight with the air pageant Flight 200. On display were aircraft depicting the entire history of aviation—gliders, World War II fighters, helicopters, and experimental ultralight planes, just to name a few. Stuntmen and aerobatic flyers thrilled spectators with their antics. The most spectacular show was the launching of the hot air ballons, an appropriate grand finale to commemorate mankind's flight which began with the Montgolifer hot air balloon, near Paris, France in November, 1783. *(photos by Jane Fiala)*

continued from page 7

which converts a videocassette recorder into a device capable of making digital audio tapes. This variation of the digital tape format was the first digital audio format available to consumers. A more aesthetic and convenient approach lies in the digital cassette deck, which functions much like a standard home cassette deck, but with two differences. First, videocassettes are used for taping. Second, recording is done in digital form (which implies the possibility of making virtually perfect copies). Of course, digital tape formats have the advantage of recording capabilities, which not all digital systems have.

The digital disc format is a system useable only for playback. Dubbed "Compact Discs" and standardized by the sheer marketplace clout of a Sony/Philips alliance, the Compact Disc (CD for short) has become the latest wonder in the audio world. At the heart of the system is the CD itself: 120 by 1.2 millimeters, stored in a box slightly larger, making the CD quite unobtrusive. In the center of the disc is a 15-millimeter hole, conveniently sized so that the disc can be slipped onto the little finger of the hand for handling purposes. This method of handling is not paramount, just convenient; the CD itself is impervious to wear and tear.

How the compact disc system works explains why the system is relatively impervious to all but extreme mishandling. The idea behind a compact disc somewhat resembles that of a conventional record. In both cases, information is stored in tracks spiraling between the center and the rim of the disc, but similarities between the two systems end there. The compact disc can store up to 75 minutes of music on its single playing side, more than the longest LP albums. A compact disc does not have grooves, it has tracks onto which pits are etched representing the digital encoding of the music. A highly sophisticated laser system scans the disc from the center outwards at a varying rate of speed, so that the same amount of track is scanned in the middle of the disc as at the rim. This laser system optically "reads" the encoded pit tracks and converts the readings into electrical signals.

The disc itself is made of two layers: a base layer into which the pit tracks are etched and a protective layer covering the tracks. The composition of these materials is such that the discs can withstand an extreme range of temperatures and will not warp under real-world conditions. For instance, due to the characteristics of the laser system, minor scratches on the disc surface will be out of focus as far as the laser is concerned, and will not affect the sound. Sturdy disc construction combines with the optical tracking system to yield an easy-to-handle source of high quality music.

An entirely different digital format has been developed by dbx®, inc., best known for dbx® tape noise reduction. To properly understand how this format works, it is first necessary to understand how the dbx® tape system processes musical signals.

The principle of dynamic range compression underlies dbx® tape noise reduction. Here, the difference in volume between the softest and loudest parts of the music is reduced by a fixed compression factor. For example, a symphony recording with a sixty-decibel variation in volume levels would be compressed to a thirty-decibel variation. The reduction of dynamic range makes it easier to accurately record the signal onto tape. When the music is played, the signal from the tape goes through circuitry to restore the sixty decibels of dynamic range present in the original music. Thus, dbx® systems "squeeze" the signal to facilitate accurate sound recording.

CPDM utilizes somewhat the same approach as the dbx® digital audio system. CPDM stands for Companded Predictive Delta Modulation, which explains what the system does. When a musical signal is to be recorded, the dynamic range of the music is reduced so as to simplify the digital processing. Then the digital processing itself begins, but not in the usual manner. Instead of recording signal voltage values at every sampling, this system stores the change in voltage level between successive samplings. On playback, the stored information is reconverted into compressed music, and expanded to regain the dynamic range present in the original. In addition to the usual low distortion, precise response of conventional digital systems, the CPDM can record an utterly incredible dynamic range of 110 decibels. Truly, this digital audio format could be described as state-of-the-art. However, with an 1983 price tag of $5000, this system is not for everyone.

What about the future state of the art in digital sound? Well, refinements in present technologies can be expected in the future; additionally, some very interesting new possibilities are under development. One is the development of a compact digital cassette of the same size as today's analog cassettes. Another possibility is compact disc car sound. Present players can negotiate moderate bumps in the road but cannot track the signal when travelling on bad road surfaces. Perhaps the most interesting possibility is that of bubble memory audio: sound stored in bubble memory packs connectable to a stereo system, to be played back and listened to with no moving parts involved. If audio engineers continue to apply their ingenuity to such problems, perhaps one day this idea will become a working reality and follow in the footsteps of the compact disc.■

Developing EOH today

They've built on dreams, seen technological magic, and responded to reality. This year, they will be "Developing Tomorrow Today." Planning for Engineering Open House (EOH) 1984 is

ENGINEERING OPEN HOUSE
EOH '84
DEVELOPING TOMORROW TODAY

already underway, although the actual event will not be until March 2 and 3, 1984.

Activities for EOH 1984 cover a broad range, explained chairman of Internal Publicity, Joe Lehman. "The second annual EOH Rat Race will once again give students a chance to compete in pseudo-athletic competition. The annual debates have been cancelled, but a new event will be substituted in its place. The Coordinated Project promises to be a first-class display of space colonizaton. Central Exhibit projects will reflect the theme 'Developing Today Yesterday' as projects show engineering developments from a historic viewpoint. Student-conducted exhibits will demonstrate student engineering expertise as the products of a great college."

Students interested in helping with EOH should contact any engineering society. Newsletters may be received free of charge by contacting Joe Lehman in 300 Engineering Hall.

An Awarding Experience

Tau Beta Pi recently hosted the 78th national Tau Beta Pi convention. Held here October 6-8, the convention was attended by 340 delegates and alternate delegates from over 185 Tau Beta Pi chapters in the United States and Puerto Rico.

Nearly 100 members had a hand in planning and executing the meetings. "It was a worthwhile experience for all of us," said Tom Resman, Chairman of Convention Arrangements. Resman began planning the event in January, arranging housing, meals, meeting rooms, souvenirs, a group phoptograph, campus tours, transportation on campus, and transportation to and from O'Hare Airport in Chicago.

One of the highlights of the convention was the awards ceremony. The local chapter was awarded a chapter projects award for its outstanding projects during the past year and a project grant of $400 for its current Wilbur Heights Playground Project.

Chapter President Howard Walther was "disappointed" that the Universtiy of Florida won the most outstanding chapter award. "I hope that the current group of officers can work together this year so that we win top honors next year at Arizona," said Walther.

Students wanting to become involved with Tau Beta Pi activities may contact Walther at 333-3558.

Well-Trained Engineers

The University will soon be the site of the Affiliated Laboratory for Railroad Research, according to William J. Harris, vice president in charge of research for the Association of American Railroads.

The association will donate at least $100,000 for each of the next 5 years to the new program, which will be administered through the College of Engineering by Ernest J. Barenberg, professor of civil engineering. Further funding will be sought from industry.

Barenberg said the program will interest competent faculty in the study of railroad-related problems by providing extensive support for their activities, and attract young engineers to the railroad industry by providing support for student research assistants to work on railroad-related issues. It will also assist the railroad industry in the solution of technical problems and keep the industry and interested faculty aware of the bearing on railroad-related problems of new and developing technologies. Although it will concentrate on railroad engineering problems, it will also address issues on materials, economics, and rail transportation systems.

"The affiliated labs program will now revitalize the University's interest in this area and attract students back into this field of engineering," Barenberg said.

Professor Honored

Daniel L. Slotnick, a university professor of computer science, has received the top prize of one of the computer field's principal professional organizatons.

The Computer Society of the Institute of Electrical and Electronics Engineers (IEEE) presented Slotnick with the 18th W. Wallace McDowell Award for "pioneering contributions to centrally controlled parallel computers and for his achievement in creating the parallel computer ILLIAC IV."

The award, established through a grant by International Business Machines Corp. in honor of a retired IBM vice president, is awarded annually to an individual "whose professional work has been outstanding in concepts, technology, programming, education or management in the computer field."

Slotnick joined the faculty in 1965, and until 1974 was director and principal investigator of the ILLIAC IV computer project. The world's fastest computer from its completion in 1972 until it was removed from service in 1982, ILLIAC IV was designed at the University, manufactured commercially and installed at the National Aeronautics and Space Administration's Ames Research Laboratory in California.

James O'Hagan

by Jeff Donofrio

Trends in the College

Engineering curricula changes are barely noticed during a student's residence. A retrospective glance and a predictive glimpse expose a progressive timeline.

It was a lot different back then.

March 2, 1868—less than three years after the conclusion of the Civil War—was the opening day for the newly formed "Illinois Industrial University." Only twenty engineering students enrolled that first year, guided by just one faculty member. The cost of a dorm room—$4 for the entire semester (that price did not include heating—students had to bring their own furnaces, and purchased coal from the University). Requirements differed radically from today's. In addition to English, students studied French and German, since virtually all textbooks were written in those languages. Some lucky students bought lecture notes blueprinted in English. During the early years, the College of Engineering required students to complete a thesis, and in addition, the University decreed that all students must perform manual labor five days a week—with the students receiving eight cents an hour for their work.

Even our past name sounds a bit strange today. We wouldn't be known as "The University of Illinois" until 1883. Reform institutions were then becoming known as "industrial schools," not a name with which the Illinois Industrial University wanted to be associated. In fact, the problem became so bad that some students were asked, "What were you sent up for?"

In sharp contrast to today's seventeen major curricula, the College of Engineering began with just four "schools," smaller sub-units of the college: Mechanical, Civil, Mining Engineering, and Architecture. Now it is obvious that there has been a tremendous amount of evolution in the engineering college in 115 years. But whatever happened to such inspiring majors as Sanitary Engineering and Railway Engineering? Where will the direction of the University's undergrad curriculum go in the future, given today's and tomorrow's technologies?

Much of the present College of Engineering formed at the end of the last century. The year 1889 saw the organization of the Physics department, and Theoretical and Applied Mechanics emerged the following year. That same year, 1890, the Department of Municipal and Sanitary Engineering developed. This department, devoted to the idea of building better sewers, never attracted a lot of attention by the student body. In 1926, the college dissolved the department, and Civil Engineering absorbed the department's remains.

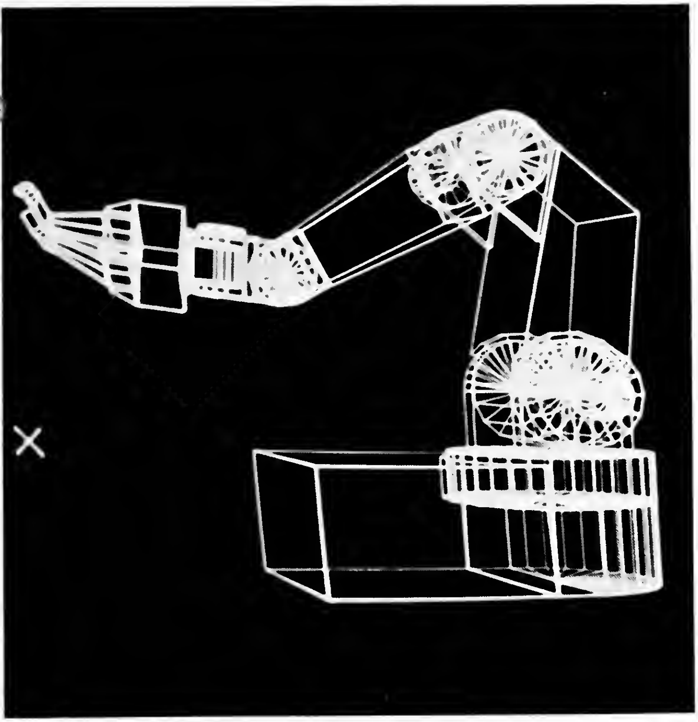
Not directly under the engineering college, the Division of Industrial Chemistry formed in 1891. Later, this division became the Department of Chemical Engineering, and remains to this day under the College of Liberal Arts and Science.

One of the four "originals," Mining Engineering, also suffered from a lack of undergraduate interest, so in 1893 the engineering college decided to abolish this department. Eighteen years later, the acting dean realized the need for the department, resurrected it, and Mining has been around ever since. Metallurgical Engineering, an option under Mining since 1916, eventually became a distinct offering in 1934.

Before the turn of the century, the Electrical Engineering department originated under the Physics department. After a preliminary "divorce" in 1892, the EE department finally permanently dissociated from Physics in the fall of 1898.

The University saw the emergence of another unusual department with the 1906 blossoming of the Department of Railway Engineering. Another "classic" department that didn't capture the affection of many students, the department suffered after several faculty members were called to serve in World War I, and in 1940, the department officially disbanded.

During the year 1915, the College of Science transferred their ceramic department to the College of Engineering, thus beginning Ceramic Engineering. General Engineering Physics (later just



At left: Professor Michael Pleck designs a robotic arm on the Evans and Sutherland PS 300 CAD/CAM system. Right: A closer look at the robotic arm design as displayed by the PS 300. (photos by Jane Fiala)

Engineering Physics) followed in 1917, with General Engineering tagging along in 1921. Agricultural Engineering congealed in 1931 under supervision of the engineering and agricultural colleges. That same year, the newly formed College of Fine and Applied Arts accepted the responsibility of the Architecture department, which was transferred out of engineering.

Surpisingly, the Civil Engineering department, in 1942, offered an option under an emerging technology of the day—Aeronautical Engineering. Even earlier, in 1916, the Mechanical Engineering department offered ME 33—"Aeronautic Engineering," and added another course in 1920. The Aeronautical Engineering department officially became a part of the college in 1944, and about fifteen years later, with spaceflight developing quickly, the department appended astronautical engineering aspects to its curriculum.

Industrial Engineering, originally an option under ME, became a separate major in the mid 1950's after strong interest by the student body. Another affiliation of ME, Bioengineering, officially created their undergraduate curriculum in 1972.

The Computer Science department, first available only to graduate students, later expanded by offering undergraduate degrees in 1971, and officially became a member of the College of Engineering in 1976. Another relatively new field, Computer Engineering, traces its roots back to 1971, but the newest engineering curriculum at the undergraduate level is Nuclear Engineering, first offered in 1975. Graduate level nuclear engineering dates back only 25 years.

That brings us to the present, and the future, where the University of Illinois will head in response to today's and tomorrow's challenges. No doubt, present engineering fields already offered will continue to evolve and develop—new alloys and ceramics, hypersonic and advanced spaceflight, artificial organs, powerful new computers, and satellite communications. But while these established curricula mature, many new multidisciplinary technologies, which may become the undergraduate studies of the future, are emerging. Some time will pass before these fields, heavily researched and sometimes available on the graduate level, filter down to the undergraduate ranks. But these future trends, and many others, while not guaranteed to become "mainstream" undergrad curricula at the University, will play a tremendous part in tomorrow's engineering.

Artificial Intelligence Also undergoing enormous growth, Artificial Intelligence (AI) involves hardware, software, and data bases necessary to allow computers to "think" and make inferences. MillerComm recently held a lecture series on

continued on page 22

by James Yun

Synthetic Fuels

The planet we live on cannot support human life forever, especially considering the way we consume its resources. Programs designed to bypass the use of naturally found fuels do exist, but their profitability depends on research; research that may be in danger of running out of funds.

For almost forty years after oil production first began in the U.S. in the 1930's, Americans lived complacently with a blasé attitude toward the seemingly endless supply of oil. It was not until the 1973-74 Arab oil embargo that the U.S. first became aware of its vulnerability to foreign oil suppliers. In response to the embargo, the U.S. Government instituted a synthetic fuel program in an attempt to decrease its dependence on foreign suppliers. But now, despite the fact that commercial production of synthetic fuels will most likely become vital to the security and the economy of the U.S., the program is in serious danger.

When the synthetic fuel program began, there were several processes under consideration. The most significant were coal gasification, coal liquefaction, extraction of oil from oil shale, and extraction of oil from tar sands.

The technology necessary for gasifying coal has existed for more than 150 years. The first commercial coal-gas plant went into operation in 1807 in Manchester, England. It was used for lighting homes and factories. Since then, various means of gasifying coal were introduced. In the U.S., the demand for synthetic gas declined first with Edison's invention and then, after World War II, with the construction of pipelines to transport natural gas from southern fields to the industrial centers of the Northeast.

Of the different methods available for gasifying coal, the one under the most serious consideration today is the Lurgi process, developed during 1927-35 by Lurgi Gesellschaft fur Warmetechik GmbH of Frankfurt (Main), Germany. In the Lurgi process, crushed coal is mixed with steam and oxygen under high pressure and temperature to produce a useable form of fuel called synthesis gas, which is a mixture of hydrogen and carbon monoxide (a recent modification of the process involves gasifying coal underground). Synthetic gas can be used directly to produce energy or as an intermediate in a process that produces methane, a major component of natural gas. A proposal by a number of U.S. gas transmission companies today calls for the use of synthetic gas in the production of synthetic methane. Synthetic gas can also be used to produce chemicals such as ammonia and methanol. Already, synthetic gas is being used to produce transportation fuels at the world's only commercial oil-from-coal plant, the SASOL complex, that has been in operation since 1955 near Johannesburg, South Africa.

Though extremely useful, coal gasification has its drawbacks. Coal boilers must be used to produce the tremendous amount of steam required by the Lurgi process, which results in the formation of air pollutants. Air filters and precipitators would have to be installed to remove 170 tons of fly ash per day. During the gas purification stages, sulfurous compounds, some of the most detrimental air pollutants known to man, are released. Here, steps would have to be taken to remove the pollutants. If the gas is not purified, any trace of impurity, such as hydrogen sulfide or carbon dioxide, would corrode the pipeline in the presence of moisture. Impure gas destined for power plants will not only corrode the pipelines and the blades of the gas turbine, but will also pollute the air with sulfur dioxide after combustion.

The development of coal liquefaction technology is recent; the complete liquefaction of coal was first achieved by Berthelot in 1896. Currently the process can be classified under the following categories: pyrolysis, direct liquefaction, and indirect liquefaction. Of the three methods, pyrolysis is the one least favored by U.S. companies. Pyrolysis uses coal in the presence of a fluidized bed (a catalyst), decomposing it into hot unreacted coke by heat. This coke is then hydrogenated under high pressure and temperature, a process somewhat similar to the Lurgi process. Pyrolysis is undesirable because of the low yield of liquid fuel and also because it restricts the range of types of coal that can be used.

In the Bergius direct coal liquefaction process, coal is converted to a liquid product through an interaction with molecular hydrogen at high temperature and pressure in the presence of an iron catalyst. A newer, improved method uses highly active catalysts, such as cobalt-molybdenum, to permit the use of lower temperature and pressure. The major disadvantages of the Bergius process are that it has a high hydrogen consumption and that it can use only certain types of coal to produce sufficient quantities of liquid fuel to have any economic benefit. Thus, the current aim of the U.S. companies is to provide a basis for an improved commercial direct coal liquefaction industry, with the basic technology based on the German developments.

Indirect coal liquefaction was first discovered in 1927, and is called the Fischer-Tropsch synthesis, in honor of the inventors. The process was developed in Germany and became an important source of synthetic fuels for that country during World War II. From about 1940 to 1950, further extensive research was carried out in the U.S., both by the government and the industry.

The production of synthetic gas through the Lurgi process is the first step in indirect coal liquefaction. Liquid fuels are then synthesized from the synthetic gas in the presence of a catalyst. In a major development, the Mobil Corporation recently developed a modified process in which methanol (derived from synthetic gas), in the presence of a synthetic shape-selective zeolite catalyst, is converted into high-octane gasoline, with no other products or major contaminants. Because the Fischer-Tropsch synthesis releases so

World reserves, annual production and consumption of fossil fuels, 1978.

Region	Crude Oil						Natural Gas				Coal	
	Proved reserves		Production		Consumption		Proved reserves		Consumption		Consumption	
	Gt	(%)	Mt	(%)	Mt	(%)	Gtoe	(%)	Mtoe	(%)	Mtoe	(%)
U.S.A.	4.4	(5.2)	487.8	(15.8)	887.9	(28.9)	4.8	(7.9)	504.2	(40.7)	355.0	(19.6)
Canada	1.1	(1.3)	74.4	(2.4)	86.9	(2.8)	2.0	(3.2)	47.3	(3.8)	19.2	(1.1)
Latin America	5.8	(6.4)	251.5	(8.1)	202.0	(6.6)	2.7	(4.5)	42.3	(3.4)	15.2	(0.8)
Western Europe including U.K.	3.3	(3.7)	89.7	(2.9)	714.6	(23.1)	3.4	(5.7)	178.9	(14.4)	198.4	(11.0)
U.K.	—	—	53.4	(1.7)	94.0	(3.1)	—	—	37.9	(3.1)	70.4	(3.9)
Middle East	50.3	(56.9)	1054.1	(34.1)	83.3	(2.7)	17.5	(29.0)	30.1	(2.4)	—	—
Africa	7.7	(8.9)	297.1	(9.8)	60.3	(2.0)	4.5	(7.4)	8.3	(0.7)	49.2	(2.7)
Sino/Soviet/E. Europe	12.8	(14.5)	689.0	(22.4)	597.9	(19.6)	22.7	(37.5)	387.0	(31.2)	985.0	(54.4)
Far East/Japan/Australia	2.7	(3.1)	140.4	(4.5)	443.0	(14.3)	2.9	(4.8)	42.4	(3.4)	189.3	(10.4)
Totals	88.1	(100.0)	3084.0	(100.0)	3075.9	(100.0)	60.5	(100.0)	1240.5	(100.0)	1811.3	(100.0)

Differences between production and consumption due to stock changes and unknown military liftings.
Gtoe = gigatons oil equivalent; Mtoe = megatons oil equivalent

Source: BP Statistical Review of the World Oil Industry

much heat, its temperature is very difficult to control. Presently, this is its major drawback.

The research into the extraction of oil from oil shale received serious attention only after the embargo, but even before the embargo, the Union Oil Company was involved in the oil shale research for more than fifty years. It has been estimated that U.S. oil shale offers a potential recoverable crude oil resource much larger than current U.S. petroleum reserves and comparable to those in the Middle East. The total potential crude oil resource from oil shale in the U.S., which also includes oil not recoverable with current technology, has been estimated to be four trillion barrels of oil.

The process of extracting shale oil favored by most companies at the present time is the In-Situ Extraction process. In this process, oil shale is either crushed or fractured underground and is heated in place either by hot gases or by combustion using a supply of air. An oil product is formed, which can then be mixed and pumped to the surface with water.

If the process is to have any chance of being economically competitive in terms of number of barrels of oil produced each day, tremendous amounts of water must be used. That is the heart of the problem associated with the process. For one thing, oil shale deposits are concentrated in Colorado, Utah, and Wyoming, where abundant supplies of water are not yet readily available. Hence, one of the present objectives of U.S. companies is to improve the oil extraction technology so that the water supply problem could be better dealt with.

Tar sands, which have been known to exist in Canada since around the year 1800, offer a real extraction challenge. Early Canadian efforts to recover oil from tar sands proved fruitless because, at the time, it was believed that bitumen (asphaltic residue) present in the tar sands was coming from a pool of oil deep beneath the surface. During those early efforts, between 1906 and 1917, about twenty-four wells were sunk without success.

In the 1920's, a scientist named Karl A. Clark, who was attached to the Alberta Research Council, developed a method of extracting oil from tar sands known as the Clark Hot Water process. The process was used by the first major producer of oil from tar sands, the Great Canadian Oil Sands Ltd. (now renamed the Suncor Inc.), which began plant construction in 1964 and started to produce oil in 1967. As of 1980, there were no serious plans to exploit tar sands deposits in the U.S., which contain about 27 billion barrels of recoverable oil. There are about 892 billion barrels of recoverable tar sands oil in

continued on page 20

continued from page 19

Canada and about 1050 billion barrels in Venezuela, the largest deposits in the world.

In the Clark Hot Water process, tar sand is added to hot water, caustic (to control alkalinity), and steam (to maintain the temperature). From the resultant product, called slurry, bitumen froth is separated by gravity. Besides bitumen, this froth may also contain water and mineral solids. Before bitumen can be refined into useful petroleum products, most of the water and solids must be removed from the froth. The major problem with the Clark process is that, as a by-product, it produces highly toxic wastes called tailings. Presently, tailings are contained in man-made lakes where they pose considerable hazard to man and wildlife. Research for better waste disposal is a constant, ongoing activity at the Canadian tar sands industry.

During the years following the embargo, the combination of conservation efforts, rising foreign oil prices, declining Government support and the recession have made the further development of the synthetic fuel technologies financially unattractive. In fact, most oil companies believe that there is no profitable option among the synthetic fuel technologies available. The synthetic fuel industry suffered demoralizing blows during recent years when such experienced companies as Ashland, Cities Service, Exxon, and Sohio abandoned their synthetic fuel projects.

Contrary to common opinion, the current level of oil imports can still have a cataclysmic effect on the U.S. economy. According to a recent study conducted by the American Gas Association, a world loss of Arab oil during the years 1986-87 would increase the U.S. unemployment level by 5 million and reduce the U.S. Gross National Product by $320 billion (in constant 1982 dollars) for each year the interruption continued. But the same study indicates that even if the synthetic fuel program began right now with a maximum effort, the unemployment level would still increase by 3 million and the GNP would decrease by $185 billion.

However, the synthetic fuel program should be supported because of concern for national security, not the national economy. The national security, in the broadest sense, would involve not only the military aspects, where transportation fuels are vital, but also the political aspects, where foreign policy options must be protected from such pressures as threatened oil embargoes. Paradoxically, while the current administration gives the national security top priority, it is not giving the synthetic fuel program the same treatment.

Certainly, there are many technical and environmental problems associated with the present methods for producing synthetic fuels. It is very costly to research these problems, but the industry does not have adequate financial resource to carry out all the necessary studies. According to the American Institute of Chemical Engineers, the government must start assisting the industry right now if it is to have a significant synthetic fuel option by the year 2000. ■

from page 5

Tech Teasers Answers

1. One $50 bill, one $5 bill, and four $2 bills.

2. $V = w[(.009)(450)(12) + \pi(.5)^2]$

$V = w\pi R^2$

where V is the volume of the roll of paper, w its width, and R its total radius.

Therefore, $R^2 = (.009)(450)(12 + \pi(.5)^2)/\pi$

and $R = 3.96$ inches, making $D = 7.92$ inches.

3. a. $1 + 1 = 2$.

b. $E = mc^2$.

c. $a^2 + b^2 = c^2$.

d. $V = V_e[ln(m_0/m_1)]$.

e. $V^2E = (K/e^2)\delta^2E/\delta t^2$.

f. $F_1x_1 = F_2x_2$.

g. $\lambda = h/(mv)$.

h. $S = k\,log\,w$.

i. $e^{lnN} = N$.

j. $F = (Gm_1m_2)/r_{12}^2$.

Riding On Air

Magnetic levitation trains, already in use in Germany and Japan, may soon be destined for the United States. "Bechtel is now studying a maglev system for a Los Angeles to Las Vegas route," said Hydro and Community Facilities Vice President, John Asmus. "It's quite possible that we may be in a position to install the first maglev system in North America."

The transportation system would hold a vehicle above a rail by magnetic attraction and could push rail speeds over 200 miles per hour by the year 2000. This would make the trains more efficient and could cut down travel times to the point of replacing airplanes on shorter routes.

A Crushing Blow

NASA's Jet Propulsion Laboratory has developed a new crash barrier relying on beer cans. The barrier holds empty cans in a tear-resistant cloth bag encased in a collapsible container made of plywood and steel. The bag is flame-retardant and weather-resistant. Cans in the front part of the barrier bag are randomly oriented, and cans in the rear are oriented parallel to the direction of a head-on collision. When a car strikes the barrier, it starts to collapse the plywood-and-steel container, which in turn compresses the cans. The energy of the car is absorbed by the buckling metal of the cans and by the air within them.

Experiments have shown that the lightweight barrier is effective in protecting vehicle occupants from collisions with trees or poles in both head-on and other angle collisions, even at speeds of 40 miles per hour.

Whoops!

For that rare moment when engineers make mistakes, a new electric eraser can save their day. The recently developed Koh-I-Noor 2800 electric eraser is a system which removes both graphite and ink from drawing paper and coated drafting film. Special cleats hold white vinyl eraser strips to remove lead from drafting paper, and drafting film can be cleaned up with newly developed Koh-I-Noor yellow vinyl eraser strips. These yellow strips contain tiny drops of erasing fluid which actually dissolve ink. Erasing with the Koh-I-Noor 2800 leaves no shadows or marring on the drafting film.

Zap!

The discovery of a new photochemical process at the IBM Thomas J. Watson Research Center now makes it possible to use lasers for etching organic polymers and biological materials without the occurrence of heating effects. Called ablative photodecomposition by its discoverer, R. Srinivasan, the process has potential for application in the photolithographic creation of integrated circuits as well as in the precise removal of biological material for medical and dental purposes.

The process works by using a well-designed beam of laser light. Radiation of short (less than 200 nanometers) wavelengths is strongly absorbed by almost all organic materials—more than 95 percent through a depth of only a fraction of a micrometer. At a high enough intensity, numerous small molecules are suddenly ejected from the material, but the high intensity of the radiation is not itself directly responsible for this etching effect. Instead, believes Srinivasan, the absorbed radiation has a high probability for breaking chemical bonds between atoms in the organic material, thus producing smaller molecules that vaporize at relatively low temperatures and carrying away excess energy imparted by the laser pulse.

This chemiluminescent glow is a result of a single laser pulse lasting only 12 billionths of a second. Although a loud pop accompanied this mini-explosion, the subject registered no sensation. (photo courtesy of IBM)

Because past methods often result in unwanted heating effects, the new ablative photodecomposition can be used for exceptionally clean removal of biological material in medicine. Other recent experiments have already shown that ultraviolet radiation from excimer lasers might be a key to economical submicron lithography.

James O'Hagan

continued from page 17

this topic. This curriculum would likely spawn from the CS, EE, CompE, and Psychology departments.

CAD/CAM/CAE Standing for computer-aided design, manufacturing, and engineering, this area involves the utilization of computers to assist in virtually all engineering related processes. The College of Engineering's expanding CAD/CAM lab, housed in Transportation Building, includes a $90,000 PS300 computer graphics system built and donated by Evans and Sutherland, and equipment purchased through a $50,000 donation from General Motors. The latest addition to the new lab, part of a nationwide $50 million IBM grant, is a new IBM 4341 CAD/CAM system. Four departments (GE, AAE, CE, and ME) will share this new system.

Controlled Fusion/Plasma Plasma (high-temperature, ionized gas) and controlled fusion both occupy the Engineering Physics, LAS Physics, and Nuclear Engineering departments. It remains to be seen if these technologies dissociate from the other departments and are offered at the undergraduate level.

Energy Engineering/Resources Engineering Although currently overlooked because of the present oil glut, energy remains an extremely important issue—one that will occupy many future engineers. Such areas as photovoltaics, hydrogen fuel, solar, synthetic fuel, ocean, wind, and geothermal energy will continue to play vital roles in the future. Probable sources of this future department would include the EE, AAE, MinE, and ChemE departments.

Genetic Engineering/Biotechnologies Genetic Engineering deals primarily with rearrangement, development, and understanding of nucleic acids in plants and animals in ways to benefit man. From genetically manipulated bacteria that create insulin, absorb an oil spill at sea, or produce interferon (a possible virus fighting serum), to development of high yield crops, Genetic Engineering is expanding rapidly. A curriculum of this nature would blend facets of the Genetics and Development, Microbiology, and Bioengineering departments.

Lasers/Optics/Holography/Directed Energy/Particle Beam This very wide range of topics, presently under heavy research, will certainly develop in the near future, primarily in defense related areas. Possibly a future defense to offensive nuclear weapons, short- and long-wavelength chemical lasers and directed energy instruments such as particle beam weapons are under intensive study by the Department of Defense and by industry. On this campus, the EE, LAS Physics, and Engineering Physics departments conduct research in this area.

Microelectronics With the introduction of FAB II, the EE department's new semiconductor fabrication lab (see Technograph, April 1983, p. 4), the college has already taken a major step in this direction. The thrust of future electronics will continue to be miniaturization.

Particle Physics The fundamentals of subatomic physics, involving leptons, baryons, quarks, and a bizarre assortment of other particles, will be understood to a much greater degree in the future. While a long way from future engineering applications, particle physics' future remains certain.

Robotics/Artificial Vision Robotics today is close to where the level of automobile technology was in the early 1900's. At both the research and industrial levels, robotics continually attracts more interest, and will affect future manufacturing. This new trend merges various parts of current fields of IE, ME, EE, CompE, and CS.

Synthetic Materials/Composites Short fiber-reinforced polymeric material, generating a great deal of interest in industry, will progress to a more advanced state than today. The Materials Engineering Lab presently studies this direction.

The future of engineering remains certain. Many new technologies, while being researched today, remain invisible to the majority of undergraduates. When these new fields will finally be absorbed at the undergraduate level, perhaps ten, fifty, or a hundred years from now, is uncertain. But one thing is sure—when technology advances, so will the College of Engineering.■

Reference.

Baker, Ira O. and King, Everett E. *A History of the College of Engineering at the University of Illinois, 1868-1945, Parts I and II*. Urbana, Illinois. June 1947.

William Ferguson, Associate Professor of Mathematics, says being the Executive Secretary of the Mathematics Department is much like being the Executive Officer under a Commanding Officer in the Navy.

Successful in terms of managing people and resources, Professor Ferguson served as the Big 10 faculty representative from 1976 to 1981, as well as other campus committees. An avid fan of Illini football and basketball, he also enjoys bridge games, following major league baseball, and Dixieland music.

From his many years of evaluating the math competency of incoming students, Professor Ferguson remarks that persons taking the Advanced Placement exams are mainly from the metropolitan areas and that basic calculus is rapidly becoming general education for everyone.

Seeing a slow, but steady growth to a greater level of math aptitude in the U.S. today, Professor Ferguson hopes that more people will develop the math aptitude needed to challenge the problems of tomorrow. Why did Professor Ferguson get interested in math? Mathematicians have no labs.

James Lee

Robert E. Miller has been a member of the Theoretical and Applied Mechanics department since 1954. However, this is not the full extent of his affiliation with the University. Miller received a bachelor's degree in Aeronautical Engineering in 1954 from the University, and stayed in Champaign-Urbana to enter the TAM department. It was there that he received his master's and Ph.D. degrees from the University in 1955 and 1959, respectively.

Miller's main research area involves the analysis of finite element methods for problems in solid mechanics and dynamics. He has been the author of various technological journal articles on this and other subjects of mechanics. Miller has done consulting work for the U.S. Army and various midwest industries. In addition, he has been an adviser for more than 20 doctoral students and is a member of the Stability Commitee for the American Society of Civil Engineers.

During his free time, Miller doesn't abandon his vast knowledge of aerodynamics and structures. He enjoys the construction and flying of remote control gliders.

Joseph Wyse

H. G. Friedman, Associate Professor of Computer Science, has never had a formal course in computers. He received his original education in chemistry.

Finding out that chemistry was not an interest, Professor Friedman came to the University of Illinois in 1965 as an assistant professor and programmer in computer science. With a self-taught background, he became proficient in computer-aided instruction (CAI), operating systems, and other software.

"Today, CS is the thing to be logically thinking about, and the field to get into. The job market is tremendous, especially for our graduates," Friedman commented. The University's department is producing well-rounded computer scientists in terms of numerical analysis, hardware, computational theory, and software programming. This is more comprehensive than other institutions.

Being interested in rail and transit, Professor Friedman serves as the Vice-Chairman of the MTD (Mass Transit District) Board and is a certified street car operator. His interest originated in the antique streetcars operating in New Orleans while he was attending Loyola.

James Lee

· AN · DREAM · IT · YOU · CAN · DO · IT

Dream things that never were and say, "Why not?"

Let your imagination go as far as it can. Then give it a real workout.

Press a button and watch your integrated circuit design light up a computer screen. Touch another button and see a cross-sectional view of your heart.

You're just scratching the surface. Keep on going.

Make that imagination squeeze one million functions onto a single microchip.

Let it loose on appliances that can think for themselves.

Unleash it on computers that can speak the human language.

Turn it on to robots that can see, hear, think, and feel.

If you can dream it, you can do it. And if you're bright, talented, energetic, creative, and determined enough, you can do it with us.

You can put your mind to work on anything from materials research to computer-aided design and robotics.

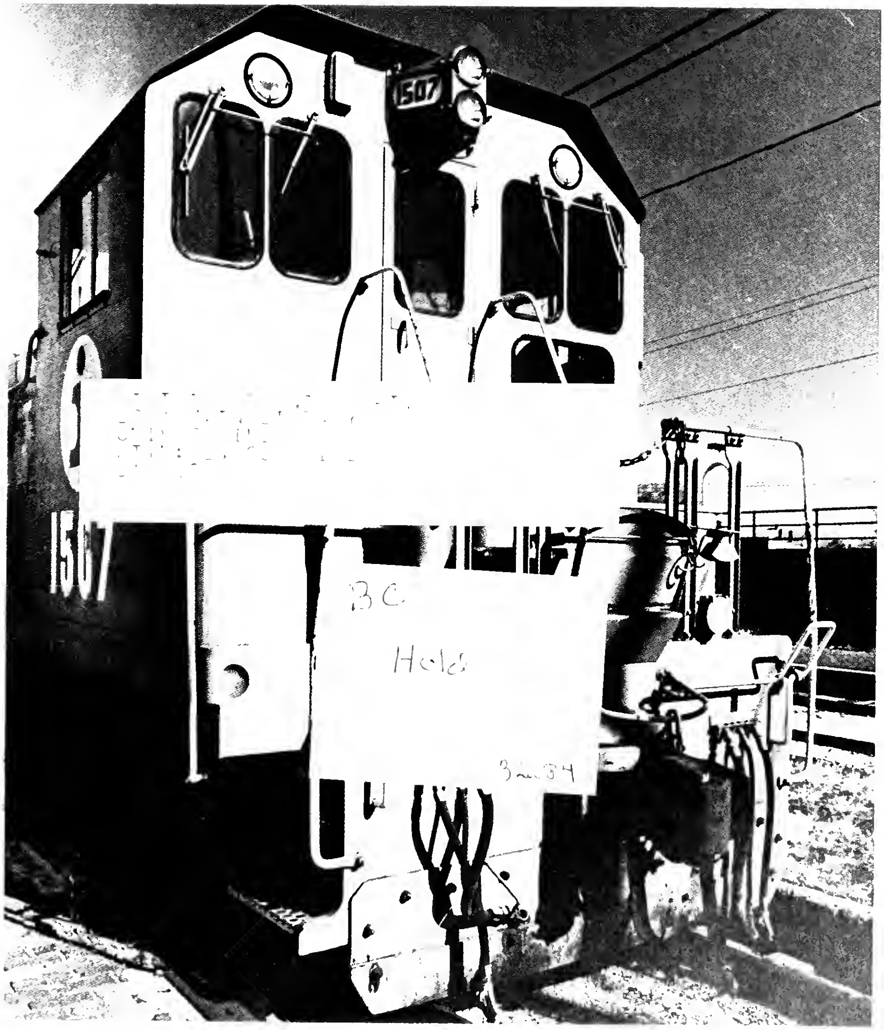
You can bring your ideas to life in just about every area of life—from the office to outer space, the laboratory to the living room.

There's never been a better time to be an engineer. You've got the tools—the technology—to take your ideas and run with them. To make tomorrow happen faster than ever before—starting right now.

And GE? We've got enough resources, diversity, and imagination to keep you asking, "Why not?" for the rest of your life.

An equal opportunity employer

If you can dream it, you can do it.



Backtracking

ENGINEERING MAJORS HAVE ENOUGH STRESS WITHOUT HAVING TO WORRY ABOUT TUITION.

If one of the angles you've been studying lately is a way to pay your tuition costs, Army ROTC would like to offer some sound advice.

Apply for an Army ROTC scholarship.

Recently, we set aside hundreds of scholarships solely for engineering majors like yourself.

Each one covers full tuition, books and other supplies, and pays you up to $1,000 each school year it's in effect.

So if the stress of worrying about tuition is bending you out of shape, get some financial support. Apply for an Army ROTC scholarship today.

For more information, contact your Professor of Military Science.

ARMY ROTC.
BE ALL YOU CAN BE.

University of Illinois
217-333-1550

Illinois

Technograph

December 1983 Volume 99, Issue 3

4 **Colossal Computers** *Rob Busse*
The latest machines from the supercomputer companies are executing programs much faster than their prototypes. This kind of technology creates new problems that must be overcome.

6 **Railway History** *James O'Hagan*
For those people searching for nostalgia, a paradise exists in Union, Illinois. The Illinois Railway Museum offers a look at the past for both kinds of engineers.

10 **Write a Thesis: Receive a Degree** *Tushar Chande*
Nearly all graduate programs culminate in the publication of a specialized paper. This process is understandably mysterious, owing to the small percentage of PhD's in the country.

Departments
Editorial 3, Tech Teasers 3, Technovisions 8, Technotes 12, Technovations 13, Tech Profiles 15

On the cover: This Illinois Central Gulf locomotive hauls tons of materials across the Midwest. Rail transportation has progressed since the days of steam power, and rail museums display these historical machines.(photo by Jane Fiala)

Illinois Technograph
(USPS 258-760)
Vol 99 No 2 November 1983

Illinois Technograph is published five times during the academic year at the University of Illinois at Urbana-Champaign

Published by Illini Publishing Co., 620 East John St., Champaign, Illinois, 61820. Editorial and Business offices of the Illinois Technograph, Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3730

Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N Y, 10001, 221 N LaSalle Street, Chicago, IL., 60601.

Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879

Illinois Technograph is a member of Engineering College Magazines Associated

Tech Teasers

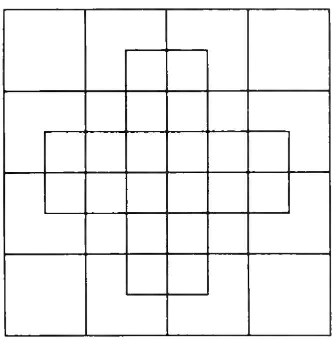
1. The number 324 is unusual not only because it is a perfect square ($18 \times 18 = 324$) but also because its digits are consecutive integers. What perfect cube is comprised of consecutive integers?

2. One day Mrs. Adams visited Farmer Brown's vegetable stand to purchase some corn. After buying n ears for m dollars, Farmer Brown declared, "If you buy 10 more ears of corn, I'll give you all the corn for two dollars, and you'll save 80¢ per dozen!"

Find the integers n and m.

3. In some artificial intelligence applications, two pictures are compared using needle statistics to see how closely they are alike. If an image consists of a series of equally spaced parallel lines, where the distance between lines is a, and the needle is of length l ($\leq a$), what is the probability that the needle, if dropped randomly on the image, will touch a line?

4. How many squares appear in the figure below?



answers on page 14

Editorial

Mind Over Body

At press time, the Fighting Illini were ranked sixth nationally (UPI), and held the top spot in the Big Ten. This has almost promised Mike White's boys a trip to the Rose Bowl.

Who are the Fighting Illini? They're our classmates, of course. But we engineers probably won't find them in our classes. Chances are, our mates south of Green won't see much of them either.

The national publicity and local fervor surrounding the mighty Orange and Blue men has spawned a new wave of support for revenue sports. Not only are the crowds packing Memorial Stadium, but their dollars are stuffing the coffers of the Athletic Association.

The recent rage of goalpost toppling has meant no dent in the AA's funds. But the Erlenmeyer flask you dropped in Chem Lab last week will be tacked on to your student account. Why the difference?

The AA has a regular battalion of contributors who receive preferential treatment for their "charity." They are provided with tickets, parking spaces close to the stadium, and even dinner with the team. Academia is not so fortunate; a major portion of contributed funds must be solicited. To motivate the potential contributors, the University must sell the educational quality of its programs. Often, this is difficult since the supporters are lured by the AA with promises of tickets and the like.

One clearly receives a quicker and more entertaining return from a donation to the AA. Endowments to academics rely on the long-term social benefits afforded through the fostering of higher education. That's a far cry from beers and cheers.

While a donation to revenue sports may help a team rise to the limelight, thereby bringing recognition to the whole institution, I ask that in 1993 those contributors check the status of the athletes they have supported in 1983. Then check the status of several high-caliber engineering graduates of 1983. Some of the athletes may be lucky enough to be doing Lite beer commercials; most will have been punted into obscurity. I predict that the engineers will have introduced several new applications of technology which will affect most segments of the population.

These engineers will have progressed without being pampered by an abundant stack of dollar bills. Imagine what they could have done if more dollars had been stacked in their favor.

Companies and foundations are beginning to strengthen their support for engineering education. Among the donations this year are personal computers from the National Science Foundation and CAD CAM equipment from IBM.

Engineering education must not be allowed to fall as the goalposts have. Money can replace the goalposts to their original stature, but not higher. However, our body of knowledge is incremented by each contribution to education; this body of knowledge is forward-chaining and must receive continuing support.

Illinois Technograph invites letters in response to its articles and editorials, or any other item of interest to our readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.

by Rob Busse

Colossal Computers

"The computers I design are very simple. My computers just add, divide, multiply and subtract."

—Seymour R. Cray
Computer Design, Dec. 1982

Technological advancements have created problems in dealing with the large number of calculations required for solving many engineering problems. The complexity of some problems has increased to the point where several billion arithmetic calculations are required to solve them. Only twenty years ago, this type of calculating power was science fiction.

Today, powerful high-speed computers have been developed which give the engineer and scientist an incredible amount of computing power. These supercomputers, of which only about a hundred exist in the entire world, incorporate advances in microelectronics and computer architecture which were unheard of when Sperry Univac delivered the first commercial computer to the bureau of the census in 1951.

To comprehend the need for the more than 100 million arithmetic operations per second, one must first understand the types of problems on which these supercomputers work. Supercomputers are not like the IBM's or Burroughs computers that sit in the back rooms of banks all day and keep records of deposits and withdrawals. At 100 million operations per second, a supercomputer could process the bank transactions for a given month of every person in the United States in well under an hour. Instead, supercomputers are used in the simulation of physical phenomena, which require an astronomical amount of calculations.

A typical problem involves modeling of the flow of a fluid around an object. This problem is important in aerodynamics when the behavior of air around an airfoil or rocket body is under study. A simulation requires the solution to a system of partial differential equations which describes the fluid flow. The mathematician can prove that a solution exists, but to obtain the solution within a reasonable time period requires a numerical approximation which only a supercomputer can perform.

To solve a fluid flow problem, a set of three-dimensional grid points around the body is established. Then, to each of these points, the system of partial differential equations is applied to calculate the value at every grid point. Through a series of successive approximations, the values at the grid points are calculated until they solve the system of equations to a specified degree of accuracy.

A simulation of the airflow around a rocket body was performed on the Illiac IV in the late Seventies. The Illiac IV, the first computer capable of performing over 20 million operations per second, was designed by a team led by D. L. Slotnick at the University. The computations consisted of the plot of a quarter of a million grid points which described the airflow. Each iteration of a data point required between 10 and 500 operations to arrive at the new data value. The final solution required 10^{11} arithmetic operations and took the Illiac IV only eighteen hours of computing time to complete.

There are currently two major companies which make supercomputers. Control Data Corporation manufactures the Cyber 205 which is capable of 200 million operations per second with a central memory of four million 64-bit words. Cray Research makes the Cray-XMP, capable of 200 million to 400 million operations per second with the same amount of memory. Both the Cray-XMP and the Cyber 205 cost between $10 million and $20 million.

IBM, Sperry Univac, Adahl, and a few others make computers which exceed the current criteria of over 20 million operations per second required of a supercomputer, but they are not as advanced as the Cray-XMP or the Cyber 205. The Illiac IV was installed at the Ames Research Center of the National Aeronautics and Space Administration in 1972 and is still considered the fastest computer for certain calculations, even though it was dismantled over two years ago.

The high speeds of supercomputers have been obtained in part through advances in microelectronic technology. The first primitive computers of the 1950's were slow machines with gate delays of 10,000 nanoseconds. With the invention of the transistor, this time was cut to under 100 nanoseconds and new developments in integrated circuits have decreased the time of a gate delay to under 10 nanoseconds, and, in some instances, as for emitter coupled logic (ECL), to under 1 nanosecond. Advances in gallium arsenide technology promise even shorter gate delays since electrons, the main carriers of electronic signals in most computer microelectronics, move three to ten times faster in gallium arsenide than in silicon.

When gate delays are decreased below one nanosecond, the propagation time between chips becomes important. Light travels at a speed of 0.3 to 0.9 feet per second in wire, so the difference in propagation times between a three foot and a one foot wire can affect the overall speed of the computer. In the Cray-1, the wire lengths were kept to less than four feet and in the newest Cray computer, the Cray-2, they will be not be any longer than 16 inches.

Off-chip propagation delay is also shortened by packing many devices on one chip to keep chip interconnections to a minimum. Concentrating a large number of chips into a small area results in a problem with power dissipation. A typical fast bipolar chip can generate about five watts per chip. The Cray-1 contained over 300,000 chips in a volume of less than 100 cubic feet. To dissipate the large amounts of power, coolants are pumped through supercomputers. The Illiac IV was cooled by pumping refrigerated air through it. The Cray-XMP and the Cyber 205 are cooled with a freon refrigerant. In the Cray, the printed circuit boards are held between slabs of aluminum with freon flowing in them, while the Cyber 205 uses tubing clamped to the chips to contain the coolant.

To make supercomputers even faster, new types of computer architecture are used which allow the computers to process data in faster and more efficient

CRAY X-MP Computer System (toreground) and CRAY-1 Computer system (photo courtesy of Cray Research, Inc.)

ways. One of these methods is known as pipelining. Pipelining is analogous to an assembly line where all parts of the system are working on individual parts of the overall task. A pipelined adder, for instance, breaks up the addition process into segments, each of which processes a piece of the overall addition. The data being added moves through the pipeline one segment at a time at every clock pulse. After an initial start-up time equal to the time it takes for one sweep to propagate through the entire pipeline, data will appear at the output of the adder at a rate equal to the clock pulse.

The architecture of the Illiac IV used a different type of processing, called multiprocessing, in which the memory was partitioned into 64 divisions, each controlled by its own data processor. This allowed the computer to operate sixty-four times faster than a standard single processor machine. These innovations led to a total price of $40 million.

In either multiprocessing or pipelining, data in a processor or a pipeline cannot be called on for other calculations. Several calculations can be performed simultaneously as long as the required data is outside of the processing unit. This puts a constraint on the speed of some types of calculations, but performance is still better than that of computers which can handle only one operation at a time.

To support high speed calculations, a supercomputer must have large amounts of data, which entails large amounts of memory. The speed at which data can be transferred between memory and the processing unit then becomes a limiting factor. The Cray-1, the Cray-XMP and the Cyber 205 are designed so that the processing unit directly accesses a fast central memory, which contained the program and data for immediate calculations. Magnetic discs store the rest of the data which is sent to the central memory when it is needed.

This transfer of data needs to be very fast to make sure the central processor has enough data at all times. Since large amounts of data require wide bandwidths in order to be transmitted, the speed of data transmission is limited by the available bandwidth. The Illiac IV fed data individually to each of its partitioned memories. This was accomplished by using sixty-four separate read-write heads on the disc drives—one read-write head for each section of memory. Since the Cray computers and the Cyber 205 do not use this type of data transfer, the Illiac IV was faster for problems involving flow of large amounts of data between central and disc memory.

The current record holder for computing speed is held by the Cray-XMP at 200 million to 400 million operations per second. This is a phenomenal speed when compared to the 17 million operations per second for the Cyber's 174 and 175 on campus and a few hundred operations per second for personal computers. The engineers at Cray research and Control Data, however, have not completed their quest for faster speeds. Cray Research is already at work on the Cray-2, which is estimated to be six to twelve times faster than the Cray-1, putting it in the area of one billion operations per second. Faster electronics and architecture will be used to reach this speed. A new method of cooling the computer will be implemented in which the whole computer will be submerged in a liquid fluorocarbon, similar to the one found in blood plasma. This liquid will not only carry away heat more efficiently than freon or forced air, but it will also be in direct contact with the electronic components, allowing for a very efficient transfer of energy.

Kepler had to fill volumes with hand calculations to finally arrive at his discovery of elliptical planetary motion. Now, supercomputers are able to perform the same number of calculations in a fraction of a second. Modern scientists and engineers use these machines to delve into the intricacies of aerodynamics, nuclear physics and mechanics. The speed of these supercomputers will lead to a better understanding of the physical world. ■

by James O'Hagan

Railway History

Engineers are trained during their college years to build for the future. The past, however, can teach us a lot about designing products for the times to come. There is a place that offers such a service, while also providing aesthetic diversion.

The railroad industry has come a long way since the days of steam power. Here, a modern derivation of the old Silver Zephyr pulls into Champaign. (photo by Jane Fiala)

More than any other technology, railroading has drawn together the boundaries of the United States. Rail service has been an inexpensive, effective, and reliable source of transportation for delivering minerals, hauling livestock, or transporting commuters.

The impact of railroads is evident in all levels of American society. From handicraft and fashion to economics and politics, the history of railroading mirrors the history of the American society in which it was raised—a history which is now being re-enacted in northern Illinois.

The Illinois Railway Museum in Union, Illinois, is a non-profit educational corporation. Funded by contributions and run by volunteers, the museum is a display of operational cars and locomotives that played important parts in the development of the midwestern United States. Frank Sirinek, Restoration foreman of the car department and former general manager of the museum, explained, "The museum began in 1953 with one car and $100 in Chicago. In 1964, they moved here [to Union]." Now the museum has over 175 cars and locomotives.

The main emphasis of the museum is to restore all cars and locomotives to operating condition. "Most of the work we do here is on things you can't see," said Sirinek. Mechanical work on motors, wiring, wheels and brakes accounts for most of the restoration time and expense and is necessary only because the museum is an operational museum. Visitors can ride all restored trains, creating an atmosphere much different from traditional hands-off museums. "We try to collect regional pieces," Sirinek stated. "People come from Chicago to see the cars they remember."

Because of its functional nature, the expansion of railroading over the years is readily apparent. The Frisco 1630, a steam locomotive built for Russia in 1918, is coal operated. "They have to clean the oven and put in a new bed of coals every weekend," explained Dwayne Tudor, head of Diesel Operations. "It takes 3 to 4 hours of preparation to get running. You can see why the diesel engine was so important to the railroad industry."

"The plates have to be emptied periodically. A lever dumps ashes into a tray under the cab, then new coal is shoveled into the boiler on top of the coals," explained another member, Brad Wujcik. "As the exhaust leaves and moves up the stack, it creates a draft, pulling more air into the fire and making it burn better."

In time, the diesel-powered locomotive grew in popularity due to the long maintenance hours and poor visibility common in early steam engines. One of the first diesel engines built was used on the Milwaukee Road for the Chicago area. "The diesel engine is not connected to the wheels," explained Sirinek. "It just runs an electric engine which moves the wheels. It works the same way on modern engines."

Later, more extravagant diesel trains were developed. The Silver Zephyr was built by General Motors and run by the Burlington Railroad in the 1940's and 50's. "It had a top speed of over 100 miles per hour," explained Sirinek, and "it was the first train with roller bearings." A diesel generator provided steam, power, and the air conditioning which serviced all seven cars. "The Zephyr was essentially a coach; it was ultra-modern—had no sleeping facilities. It was typical of trains in the late 1930's and 40's," he explained.

Electric motors gave rise to trains and streetcars that ran entirely on electric current. One such train, the Electroliner, was used by the Chicago North Shore Milwaukee Railway. "To make an electric train look like the Zephyr was their goal," noted Sirinek. The car's sides curved to the middle, narrowing the train and restricting it to the elevated system. Also, all the cars were permanently coupled with the trucks between cars. "This low profile made the train look very sleek, very streamlined—like a bullet," said Sirinek. This appearance was a definite advantage to the railroad, explained museum member Jim Nicholas of the Chicago Transit Authority (CTA) communications department. "The North Shore was running into problems and wanted something to 'run with the wind.' This train had a free running speed of 85 miles per hour and was capable of 95."

Although trains were important in developing American society, single cars played an important role as well. These streetcars, or trolleys, carried passengers across town or to nearby cities.

The Red Rocket is a famous car which carried seven million passengers per day in Chicago. "The Red Rocket is the most readily-recognized piece in the museum—the car people come out to see," stated Sirinek. "It is a double-ended car. The street cars had large platforms on the back where everyone would be ushered on. Then the car would be kept moving while the passengers paid their fares and moved into the seating secton."

Another car that was not as popular as the Red Rocket was a car from the Aurora Elgin line that ran on an elevated trussel over what is now Chicago's Eisenhower Expressway. "This was an important commuter line which went under because of the city of Chicago and Mayor Daley," said Sirinek. "Within eight hours the city refused to allow the Aurora Elgin into the city. It had to stop at Des Plaines Avenue. Thousands of commuters who had ridden into the city on the Aurora Elgin had no way to get home and were stranded."

Other cars served more specific purposes for the railroads. One such car was similar to today's snow plows. "With 4800 trolleys at rush hour, they needed equipment to clean the tracks," explained Sirinek. Manufactured by McGuire-Cummings, the snow sweeper was powered by electricity and swept snow off the rails onto the cars below. A metal plow on the side extended laterally and would demolish cars if they were in the way. "That's from back in the days when the automobile took its place below the streetcars," Sirinek noted.

Another car has proven useful to the museum's expansion efforts. "We have a special electric-powered wire car which unreels miles of cable from large rolls. It's hot when they unroll it," allowing the car to tap the wire for energy as it is installed. A hot wire is one that has an electric current running through it. "The workers are on an insulated platform as they install the wire so if they brush against it, grab it, hammer it, or bang on it, it's just as if I did this," said Sirinek, harmlessly grabbing a nearby rail.

Trains cannot run without tracks, and the development of the museum's track has demanded extra effort. Sirinek said, "We spent five years constructing this streetcar track," a two-and-a-half mile loop of track with tight turns over which electric streetcars and inter-urban cars navigate. "The hot potential is the wire," said Sirinek pointing to the cable running nearly 30 feet above the tracks. "The current travels from the wire, through the car, then through the wheels and back along the track to the power source." The rail connections are bonded with copper wire to ensure a complete circuit.

In keeping with the idea of an operating museum, even the overhead power line resembles that of a city electric railway. "The wire work is typical of the city," noted Sirinek. "Even the poles are of the type that was used in Chicago along the lake shore and beaches in the 1930's. New sodium vapor lamps will add to that appearance."

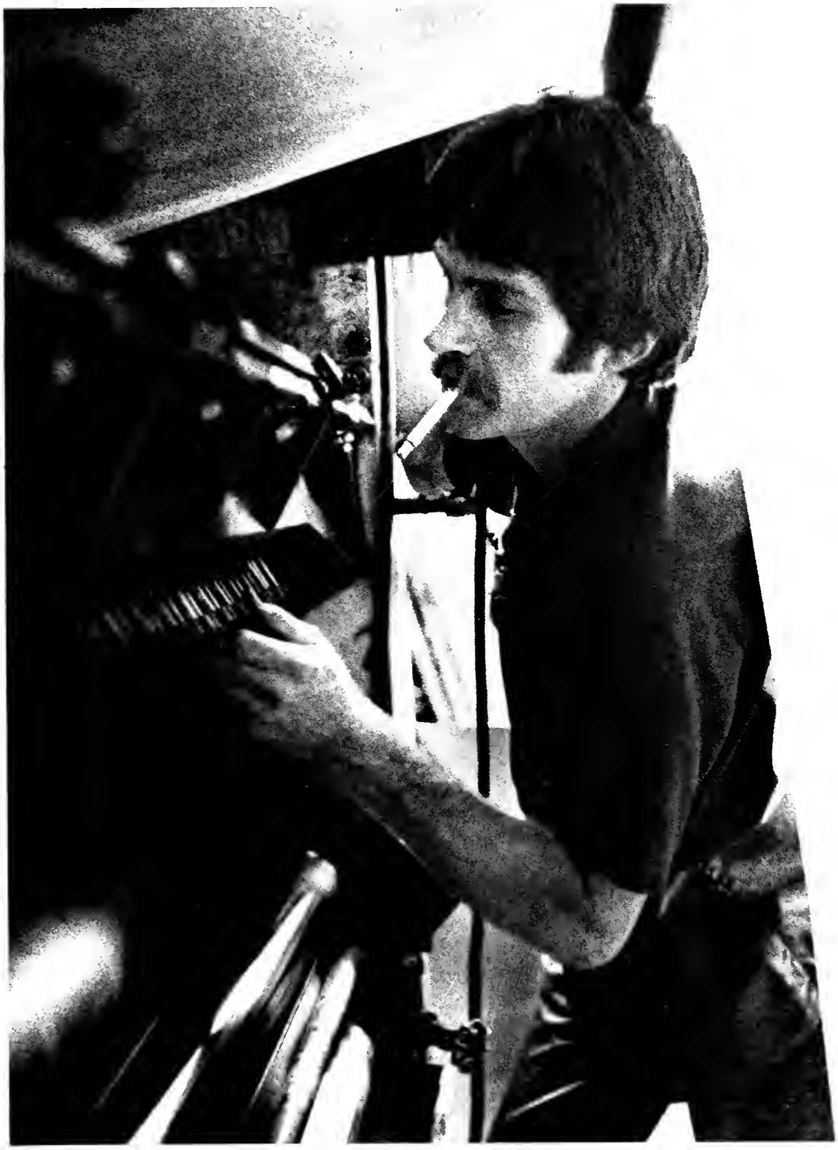
Sharp turns in the rails create additional problems. "With these tight turns," explained Sirinek, "there is a great amount of pressure on the flanges and sliding of the wheels. If we just constantly ran the cars one way around the track, we'd have to replace the wheels after every season. So we do two things: we reverse the wheels after every winter, and we paid $5000 for this wheel lubricator to keep them from wearing out." The greaser is triggered by the weight of the train. When a car reaches the turn, it trips a mechanism which pumps a special non-sliding lubricant onto the track. The wheel of the train then passes through the lubricant and spreads it along the track. "This is a market item," said Sirinek. "They're used on the downtown [Chicago] elevated tracks along the big screeching curves like Lake Street."

The demise of the streetcar was ultimately brought about by the development of the automobile. Member Greg Lang said, "The Green Hornet streetcar from the city of Chicago was developed when railroads began losing business to the automobile. The President of the United States called together representatives from the railroading industry to form the President's Conference Committee. It served up until 1958, when it was abandoned completely. This is the only one still around." It was this car that served as the model for today's CTA buses, although streetcars were more successful. "They moved more commuters in one day than the CTA now moves in a week, and that includes buses," added Sirinek.

But the streetcars still roll at the Illinois Railway Museum along with locomotives, train cars, and other exhibits of railroading nostalgia that only such an operational museum can provide. Sirinek explained, "It's different when you come out here, feel it moving, [and] hear the steam. You understand what it meant." ■

A Night at the Press

After the news staff has gone home but before the newspaper is delivered in the morning, the Rantoul Press in Rantoul, Illinois, comes to life. A four-man crew works most of the night to run approximately 14,000 newspapers in an hour. The press crew makes plates of the newspaper, loads them onto the press, inks the press, and prints the paper. This night crew is constantly checking copies of its product and resetting the press to make sure the papers are evenly inked and easily readable. The Daily Illini newspaper here at the University is the main product produced by the Rantoul Press at night. *(photos by Dave Colburn)*



by Tushar Chande

Write a Thesis: Receive a Degree

The University Graduate Programs booklet states that a candidate for a PhD degree "...must demonstrate a capacity for independent research by the production of an original thesis on a topic within a major field of study....the thesis must be the work of a single author."

Feeling kind of bored lately? Need something to make you tear out your hair? Need something you can ignore for a year, and be paid to do so? Need something you can underestimate, overestimate, expand, contract, twist, straighten, write, rewrite, underwrite, overwrite, chew, spit out, hate and yet want to take home to Mom? Well, consider writing a thesis. It'll change your life, mostly for the better.

Writing a thesis could get you a master's degree. That's extremely valuable in the job market. Conventional wisdom has it that a BS being what it is, there's more of the same in an MS, and it is yet piled higher and deeper for a Ph.D. Actually, you'll learn technical, organizational and personal things that will come in handy. But that's not the whole story. Here's a personal view of what it's really like to write a thesis.

Let me bare the essentials. First, a natural ability to handle beer in reasonable quantities is very important. This helps to accomodate the ups and the downs, especially the ups, when the guys next door throw their graduation bashes. A taste for other liquid refreshments counts little, for beer is all you can afford. Secondly, you need a comfortable chair and a soothing light source. The chair will help you cogitate. I am inclined to think best at an angle of 133 degrees to the horizontal (measured counter-clockwise). The lamp is to shed light, for you can use all the illumination available. The chair is also useful for hanging messages. Mine, for example, has a blue and white, plastic Piedmont Airlines card that says "OCCUPIED by a Through Passenger." It helps to keep things in perspective. Thirdly, get a large box of pencils and several good quality erasers. It's amazing how often one uses the latter, and how frequently one loses the former.

An advisor is desirable, but not quite essential. He foots all the bills, though. He helps you get your feet wet, and keeps them pointed straight. Generally, productivity is way up when his feet are out of the way.

While good eyesight is useful, it is vision that is needed. Tunnel vision is not desirable, and oversight could be hazardous. If you have foresight, you are clearly in the wrong business. It's insight that is required, but you may need plenty of hindsight to develop this, so look out.

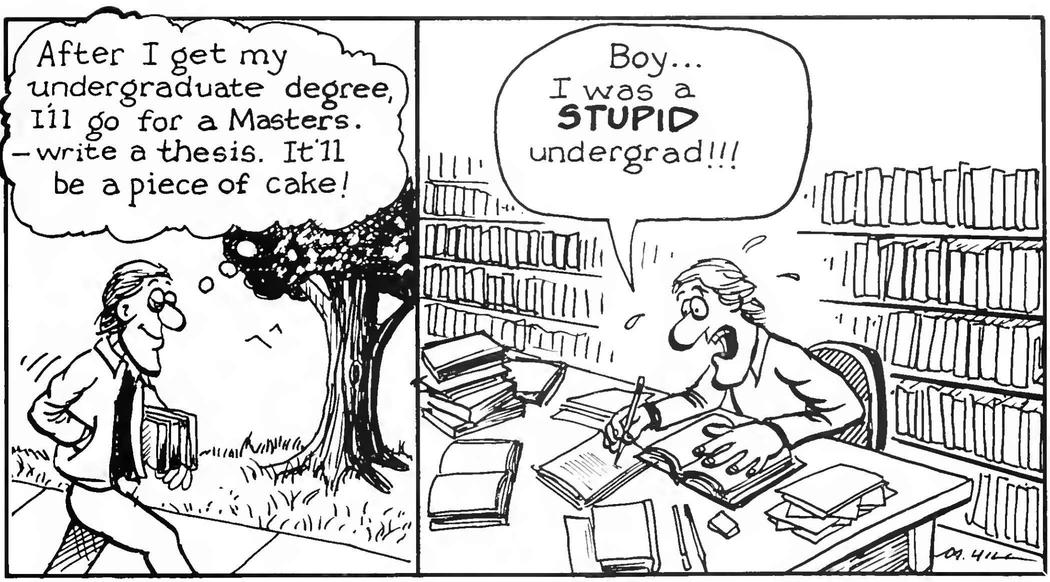
An appetite for fast food is convenient, if you have the stomach for it. Eventually though, you cannot tell if it's fast food cooked slowly, or slow food cooked fast. Lastly, a sense of humor is most beneficial. It takes some practice to laugh at your own mistakes, but it can help you meet the right sort of people, make friends with them, and even influence them. Sanity is unessential. Even if you had it to begin with, you would soon lose it on the way.

It helps to know what you are working on. Not that it's crucial, for you can seize on anything that is marginally familiar once the buzz words are recognizable. The research assignment shapes your registration schedule, and molds the nature of your existence. Is experimentation the order of the day, or is it time to meet your friendly computer? Experiments usually need some fabricated apparatus, and as time runs out, you form them on the run. Computations can only be made after you have recovered from multiple crashes, and by then your only concern is to get out in one piece.

A search for relative literature is the recommended way to launch your project, but the previous claims and counterclaims could easily send you into a tailspin. A word to the wary: if well-begun is half done, ascertain you are indeed beginning what you are supposed to. Half-baked ideas could raise hopes, only to flatten them later.

Preliminary findings are cause to plan an out-of-town trip to the society meeting furthest from campus. When you can't zap them with substance, sway them with style. Plus, these findings please sponsors, thrill your advisor, and confuse the competition. They are heaven-sent. Also, you are in great shape, for by now you have found out what not to do. You can begin writing a first draft of your thesis, and track down a suitable typist. A typist you know well can be real lifesaver, in more senses than one.

The plot thickens after all course requirements have been completed and the placement office has announced the new company lineup. Then either the equipment breaks down or you hit the proverbial dead end. I like to call this the counter-current principle. What you most expect is what is least likely to occur. It's a principle veteran NFL linebackers are well acquainted with. Your advisor, convinced he has simplified things so even you can do them, offers but a few tantalizing pointers. The data does not fall along the nice line you predicted, or worse, there is no data at all. To really brighten things up, all your dear friends are lost to graduation. This is trial by misfire. It can be a



real character-builder about now. All you do is simply hang in there, see?

Research. It's aptly named. Search and search again for a glimmer of truth, for some reproducible, measurable, predictable facts. If you search long enough, strong enough, you'll find something. It doesn't have to be big. It just has to be there. Once you find it, you tell it like it is. That's your thesis.

Writing it up is not difficult. It's a search for precision of expression. Write all you like, and reduce it by a half. Let someone read it, hack it, and slash it till it's red all over. Then just patch it up so it looks presentable.

Production is the biggest pain: the graphs, and the pictures, and the prints, and spacing, and margins, and those references, and those typos, and oh, all those deadlines. Cross those lines and you are dead. Cross that limit, and you are dead too. The endless iterations. Reference 15 is not referred to in the text. Has Fig. 21 been referenced in the write-up? Captions never seem to meet the items they describe. Cut this out. Did you paste that? Then, the many approvals and reapprovals flow in. By now, you don't care anymore. Does it really matter? Who on earth is ever going to read this junk? Not much has been accomplished that you know. But then, the talk during the plant trip seemed to have gone down well. There's nothing like a little self-doubt to really make you think.

Unexpectedly, the advisor signs the thesis approval form. Graduate College was concerned about the margins only. There are smiles all around. The thesis does look, uhm. . . impressive. A journal publication seems possible. Since abstracts are stored in data bases for information retrieval, this could well be your one tiny claim to immortality. Well, you learned something. You learned how to learn. Perhaps it was a little late, and not quite as much as you wanted, but you learned. Oddly enough, there are people out there who think enough of you to make an offer that you dare not refuse. Unbelievably, it's your turn to host a graduation bash. Then, with your thesis bound, you take it home to Mom. ■

Technotes

Sum of Research

The Summary of Engineering Research-1983, a complete update on what professors do when they are not teaching, has been released by Engineering Publications.

The report is a 300-page summary of research activities at the University. Issued each year, it stimulates interest and awareness of the engineering program and includes listings of faculty publications, theses, technical reports and faculty honors at the University.

The summary is necessary as a guide to the $32.7 million research program, encompassing over 2100 persons working on over 800 projects. "It shows the high regard with which the college holds its research programs," said Ann R. Sapoznik, editor of the manual.

The summary is available upon request in 112 Engineering Hall.

Research Attracts New Firm

For several years, University researchers have been developing a method of cancer treatment using intense heat—hyperthermia. The program has now attracted a high-technology firm to Champaign.

URI Therm-X Inc. is a company specializing in the development of high-technology medical equipment. "We are building six to twelve prototype units for distribution to major medical groups throughout the country," explained Steve Goss, Director of Research for the firm.

The advances University researchers have made in the hyperthermia field have brought international attention to the method, which uses either ultrasound or microwaves to heat cancerous cells and destroy them. Although hyperthermia will probably be used with traditional forms of treatment, common side-effects are eliminated. Goss, who received his Ph. D. in EE from the University in 1978, said, "The EE Department is one of the finest in the country and the bioacoustics and biomechanical engineering departments have been engaged in hyperthermia research for some time. It's a very strong organization."

The project is expected to improve cooperation between scientists and businessmen while accelerating basic research into life-saving technology, explained project coordinator Charles A. Cain, professor of electrical and bioengineering.

Summer Research

Students interested in science or engineering research may apply for a research participation appointment at Argonne National Laboratory in northern Illinois.

The summer program provides opportunities for research-oriented students interested in fields related to energy. Individual work with Argonne staff members, educational seminars, and independent study are included in the research experience.

Appointments are made for an eleven-week summer term, with undergraduate participants receiving $165 per week. Graduate and faculty research programs are also available.

Further information is available in the Associate Dean's Office, Room 207 Engineering Hall.

Oxford professor visits

Sir Zelman Cowen from Oxford University speaks at the Tykociner conference. (photo by Jane Fiala)

Sir Zelman Cowen, Provost of Oriel College in Oxford and past Governor-General of Australia, was guest lecturer at the sixth Tykociner memorial lecture held here on November 10.

The Tykociner conference consisted of a lecture by Cowen on "Contemporary Tasks for the Law" in which he addressed issues ranging from capital punishment to student rebellion. The following day Cowen met with several student leaders from campus to discuss these topics and explore their views on the subject. "I tried to provoke thought among the students as to the questions that contemporary law must address," explained Cowen. "From the types of questions that arose I am very pleased."

The conference, sponsored by the Electrical Engineering department, aims to emphasize the late Joseph Tykociner's devotion to the science of research encompassing humanities, arts, and social and physical sciences. G. W. Swenson, Head of the Electrical Engineering Department, said, "Tykociner felt that there was a unity to knowledge that all scholarship was of equal importance. When he left, he requested that his endowment should be used for these lectures. He felt the lectures should be taken from all fields of knowledge. We've sought to bring in the very best scholars."

Tykociner was a member of the Electrical Engineering faculty at the University from 1921 until he retired in 1948. The pioneering developer of the sound on film technology he successfully demonstrated at Engineering Open House in 1922, he bequeathed his estate to the University for continuation of his ideals.

James O'Hagan

Perky Piping

Midwesco has developed a new warning system to detect problems in underground piping that promises to save money and time spent in repairs.

These systems, manufactured by Perma-Pipe of Niles, Illinois, are designed to constantly monitor pre-insulated piping networks. Should a leak occur in either the outer casing or service pipe, audible and visible alarms are initiated. A fault locator is then used to pinpoint the leak location.

Perma-Pipe's PermAlert system now consists of stations that can individually monitor up to 3000 feet of pipe. In turn, a PermAlert central control panel (CCP) oversees as many as 4000 stations for a total of 12 million lineal feet of pipe.

Conveniently located for easy access, the CCP places all data at a central station and displays a circuit number identifying the PermAlert station signaling a problem and its type. Remote PermAlert panels connect to the CCP via a coaxial cable through which the coded data is transmitted. Problems can be located within two feet.

In operation, PermAlert's visible and audible alarm is activated when moisture from a break in the casing or service pipe comes into contact with copper wires embedded in the insulation. The leak also disturbs calibrated pulses sent through the copper wire by the time domain reflector (TDR), which are reflected as echoes allowing PermAlert's fault locator to pinpoint leak location. Its video screen then displays the position of the break while a permanent record is printed on a strip chart.

Push-Button Protection

For roommates who frequently lose their keys, Roberto's has developed a push-button lock.

The shackle lock is made of hardened steel and features buttons rather than a traditional dial or keyhole. Pushing the correct five buttons enables the owner to open the lock much faster than conventional locks.

The Model PL 70 lock combines push-button convenience with the protection of hardened steel. (photo courtesy of Roberto's)

A self-closing mechanism makes the lock ideal for the sightless or for use in winter when hand movement is hindered by heavy gloves.

Videocise

Quadraplegics may be able to exercise and play video games at the same time by using a head-operated controller designed by Jon R. Willey of Teledyne MEC. The controller is an ultrasonic device that replaces one of the joysticks on the Atari TV video game. The other stick remains functional.

This device, tested by both handicapped and non-handicapped players on Atari Pacman and Combat games, consists of two microphones placed some distance behind and to one side of the player's head. Ultrasound from the headset is picked up by the microphones and translated into forward, backward and right and left movement on the screen through an interface. Besides being fun, using the controller forces quadraplegics to exercise their neck muscles. This is especially important for young patients.

According to Willey, the controller could be fitted with either voice, bite or tongue activated buttons to allow the player not only to maneuver the tank, but also to fire at will.

Classical Discs

With digital audio gaining increasing popularity in the musical world (see *Digital Audio* in the November Technograph), even local firms are taking advantage of the high-quality equipment.

WILL-FM, a University-funded classical music station, uses a Sony CDP-101 compact disc player as a regular part of daily broadcasting. "We incorporate it mainly into portions of programming done by announcers," explained Ed West, Assistant Chief Engineer for the station.

Because some of the programming is modulated, a 25 Hz tone is inserted at the end of a piece of music. Although inaudible to the human ear, the tone is detected by electrical equipment and switches to the announcer. When finished, another tone returns music to the airwaves.

"We have another disc player coming soon," said West. "It's a very fine instrument. We can usually get the equipment at cut-rate prices as well." This arrangement works out well for the manufacturer because it helps convince consumers of the quality sound such equipment can reproduce.

James O'Hagan

from page 3

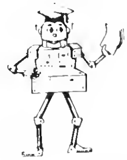
Tech Teasers Answers

1. $203^3 = 8365427$.

2. The original price per dozen can be given by $p = 12m/n$. Also,
$[(n+10)/12](p-.8) = 2$.
Combining these equations gives:
$[(n+10)/12](12m/n - .8) = 2$.
Solving for m in terms of n results in:
$m = n(n+40)/[15(n+10)]$.
Since n and m must be integers greater than zero, (n,m) must be (5,1) or (50,6), the first being the only reasonable proposition.

3. The probability will equal $2[1/(a\pi)]$.

4. 67.



Tech Profiles

Judy Liebman received her Ph. D. from Johns Hopkins in industrial engineering and operations research (IE/OR), after having received a bachelor's degree in physics. She is currently an associate professor of IE/OR here at the University.

Liebman views the involvement of the IE profession in the "current trend in automation leading to enormous amounts of information in computer-readable data bases. The analytical techniques of industrial engineering will find increasingly wide use." She foresees the power of artificial intelligence in management decision making and in operations research models.

Her advice to students interested in IE/OR is to tack a master's degree to the undergraduate education; this gives the student additional technical knowledge to handle real-life problems. The student could eventually get an MBA in order to obtain managerial skills, important if he or she wishes to become a project manager or top executive.

Liebman's hobbies fall into two categories: those for which she has time and those for which she does not. Bird watching, reading, and vegetable gardening fall into the former category, while golfing, playing classical piano, and gourmet cooking make up the latter.

Larry Mallak

Joseph M. Crowley graduated from MIT with a bachelor's degree in electrical engineering in 1962. He received his master's and Ph. D. degrees in electrical engineering from MIT in 1963 and 1965, respectively.

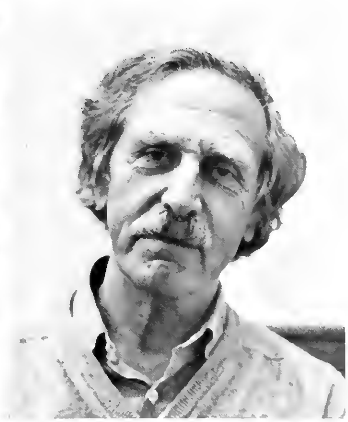
Professor Crowley has been with the University since 1966. Currently, he teaches EE 330 (Electromechanics) and EE 356 (Applied Electrostatics).

In the past, Crowley has been involved in the development of new methods for pumping cooling oil at low pressures to underground power cables.

Crowley's research interests combine the fields of electrostatics and bioengineering. His latest research involves an electrostatic process of sorting cells, such as blood cells. In this process, cells are passed single-file through a machine where a laser beam is directed at each cell. The fluorescence spectrum of the cell is then automatically analyzed to determine if the cell has the properties which are being studied. The machine will then electrostatically divert those cells to a separate container. These samples are very useful in medical and biological research.

Presently, it may take as long as eight to ten hours to process a single sample. Professor Crowley hopes to reduce this time and thus reduce the cost per sample.

Richard Barber



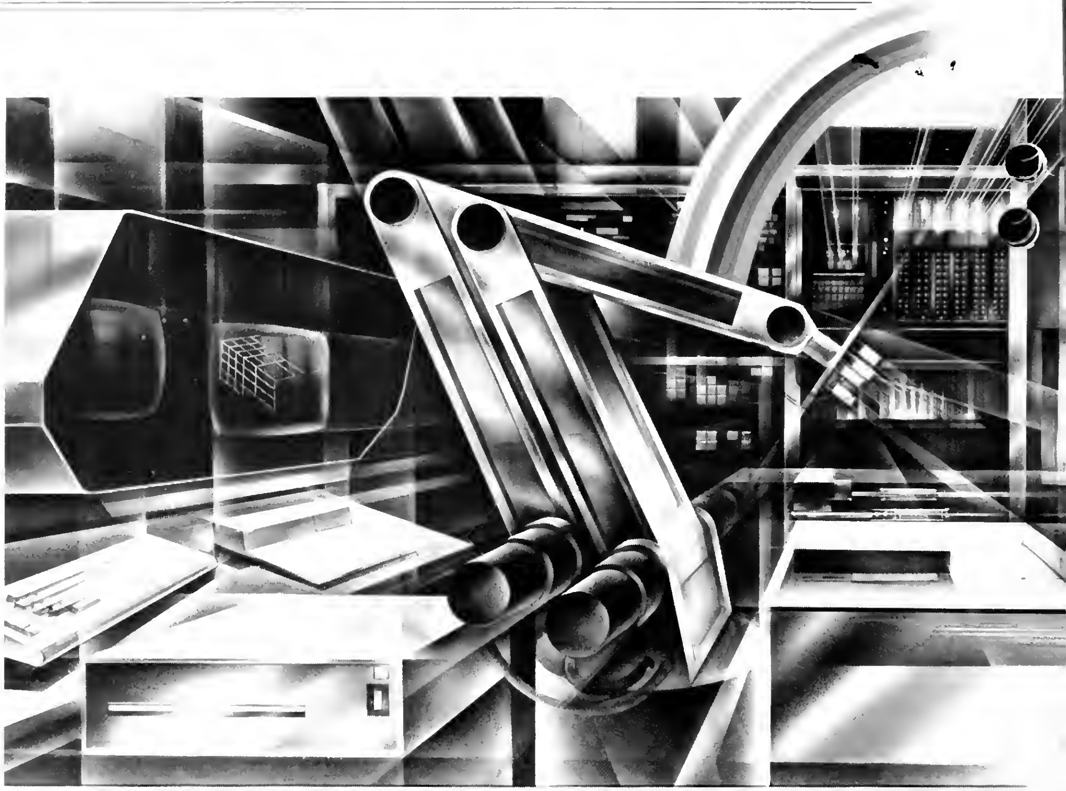
Adriaan J. de Witte joined the Mining Engineering department in 1961. Prior to this he did geophysical research in the petroleum industry. The University sought de Witte to participate in a new program to include all types of geophysics. Unfortunately, because of administrational difficulties, the program never got off the ground.

Currently, de Witte teaches Min E 302 (Political, Economic, and Environmental Aspects of Minerals and Their Utilization). Before he took over the class in the late 1960's, it concerned the economics of minerals. Originally, de Witte was reluctant to teach the class, but he realized the opportunity to expand it to include the political and environmental aspects of minerals. At the time, environmentalism was not very popular. However, after The Year of the Earth was declared in 1971, there was increased awareness to environmental problems and Min E 302 became very popular.

Professor de Witte keeps the class interesting and up to date by introducing current events and issues. He tries to convey to the students that the earth should be understood and worked with, but not conquered.

Jane Fiala

I · F · Y · O · U · C · A · N · D · R · E · A · M · I · T · Y · O · U · C · A · N · D · O · I · T



Convert the production line into a frontier of creativity.

The cast-iron technology of the factory will soon be silicon technology.

Chips and computers transfer design information directly to the factory floor. Other chips make possible flexible robotics, programmable controllers for machine tools, automated test systems and digital inspection cameras. Local area networks tie together all these systems.

These are revolutionary changes that can result in better-made products, manufactured of new materials at lower cost.

GE is deeply involved in bringing manufacturing into the silicon age. In one plant, electronics and computer systems enable us to reduce production time of a locomotive's diesel engine frame from 16 days to 16 hours. At our dishwasher production plant, a master computer monitors a distributed system of programmable controls, robots, automated conveyors, assembly equipment and quality control stations.

We're working on robots that can see, assembly systems that hear, and machinery that can adapt to changes and perhaps even repair itself.

This transformation of manufacturing from the past to the future creates a need for new kinds of engineers to design and operate factories of the silicon age. They have to be as familiar with the realities of the assembly line as with the protocols of software communications.

They will synchronize dozens of real-time systems whose slightest move affects the performance of every other system. The frontiers of manufacturing technology have been thrust outward. Old ideas have been questioned, new ones probed. Some ideas are now on production lines. Others are still flickers of light in an imagination.

All offer opportunities for you to seek, to grow, and to accomplish.

If you can dream it, you can do it.

Illinois

Technograph

February 1984 Volume 99, Issue 4
Newsstand $1.25

Acid Rain

Illinois

Technograph

February 1984 Volume 99, Issue 4

8 **Chip Wars** *Mary Kay Flick*
The constant battle over one up-manship in technology continues. The divisive efforts on the part of the United States and Japan are curtailing the chances for harmonious benefits.

10 **The New Breed of Reactors** *Kirt Nakagawa*
Basic chemistry says you cannot get more material out of a reaction than you put into it. Physics has once again turned out to be a rebel, and found a way for reactors to make more fuel than they burn.

12 **No Return With Deposit** *James Yun*
The acid rain dilemma is widespread, for it has major ramifications in the political, social, technological and natural environments.

16 **Plato Matures** *Jeff Sargent*
The Plato system has gained international fame since its innovative and experimental beginnings, necessitating changes for the better.

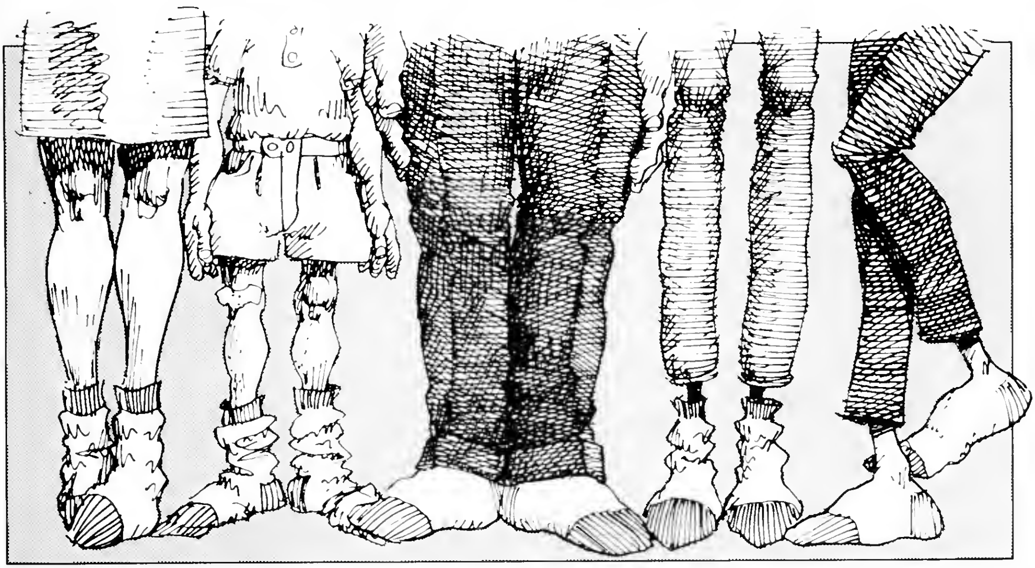
Departments
Editorial 7, Tech Teasers 19, Technovisions 14, Technotes 17, Technovations 19, Tech Profiles 27

On the cover: Abbot Power Plant's emissions are fueling the formation of acid deposition, commonly called acid rain. Money, politics, and technology are being employed in varying proportions to combat the problem. (photo by Jane Fiala)

Illinois Technograph (USPS 258-760) Vol 99 No 4 February 1984 Illinois Technograph is published five times during the academic year at the University of Illinois at Urbana-Champaign Published by Illini Publishing Co., 620 East John St., Champaign, Illinois, 61820. Editorial and Business offices of the Illinois Technograph Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3733 Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001, 221 N. LaSalle Street, Chicago, IL., 60601 Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879 Illinois Technograph is a member of Engineering College Magazines Associated

Best foot forward at the HP Showcase.

Recruiting Dates
February 29 and March 1



Discover the difference between the one-size-fits-all career and the one that really fits.

At Hewlett-Packard we place special importance on the "fit."

What we have to offer are diverse, challenging projects... unequaled advancement and growth opportunities, and acknowledged technological leadership.

The way we operate on an **informal** basis is not for everyone. You owe it to yourself to find out if it's for **you.**

Computer Science, Computer Engineering, Electrical Engineering, Mechanical Engineering.

Sign up at your College Placement Office now.

HEWLETT PACKARD

An Equal Opportunity Affirmative Action Employer.

Editorial

Robots, the Recession, and Reorganization

The change in the composition of the labor force has been the subject of many news stories recently. Indeed, many workers are concerned with this issue since the progress of modern industry has meant the replacement of these workers by automated equipment, thereby eliminating their jobs. The number of jobs in the auto and steel industries has been reduced because of hard economic times, and human employment in these areas will never reach their pre-recession levels. Efficient reorganization and robots are the reasons.

The recent downswing in the economy left many companies trying to point fingers in the direction of cost-cutting. And the fingers pointed at labor. Upwards of $20 per hour, labor costs in the United States are out of line with those of other industrialized countries. According to CBS News, costs for Japanese laborers average $13 per hour, while those in Mexico are about $4 per hour. These figures provide sufficient economic incentive to have goods produced outside the United States to be imported back for sale to American consumers.

Detroit is currently negotiating for auto factories in Mexico. This would mean that many potential jobs that could be filled by Americans will be performed by our friends south of the border. Is this un-American? No. If the product can be made cheaper in Mexico, then make it in Mexico. The primary goal of the Big Three automakers is to maximize profit, and it appears that maximum profit conditions exist in Mexico.

Many of America's laborers have priced themselves right out of the market, and the price they will pay is their jobs. High labor costs, a recently weak economy, and changing technology are creating a new group of displaced workers.

Robots have been replacing many workers whose tasks are either repetitious or easily mechanized. New developments in robotics are producing machines that can "see" and take actions based on these stimuli drawing from their artificial intelligence. Though these robots are not cheap, the high price of labor has hastened their cost-effectiveness.

An economically sound plan for the unemployment compensation dollars would be in the form of a training program which would be funded by the money set aside for unemployment compensation. By training workers for jobs which have greater stability and that are in tune with the changing labor force, the chance that the newly-trained worker would return to the dole queue should be sufficiently reduced.

Because it would probably take about six months from being laid off to being placed in a new job environment, no savings in unemployment funds would be immediately recognized. The placement of workers in new stable jobs would be expected to reduce the number of future jobless claims, and therefore reduce the total compensation amount.

A secondary advantage results from this plan. Instead of paying the unemployed worker to sit home and be nonproductive, they are being paid while learning a new skill. Unemployed minds and bodies are kept busy, and this reinforces that unemployment compensation is provided to ease the transition to a new job; it is not intended to be a handout so that one may enjoy a period of leisure at others' expense.

The shift from manufacturing to a largely service-oriented labor economy reflects the fact that technology has advanced to the point where the consumers of specialized products require specialized services which those products demand. We must not be ignorant of this fact. We should train our workers for the future. We must use unemployment dollars to finance the future of our labor force and not to let it stagnate, for the present will soon be the past.

Letters

Student Questions Tactics

I appreciate Nicaragua's ex-dictator trying to educate his people by printing scientific formulas on postage stamps, as mentioned in the November Tech Teasers. But did you know that 53% of his people couldn't even read or write letters?

Now that the Nicaraguan people have overthrown the Somoza dynasty (backed by the U.S. government since 1933) the illiteracy rate has dropped to 12%.

If Somoza had the good intention of educating his people, he sure went about it the wrong way. If our government has the good intention of bringing peace to Central America, are we going about it the right way?

Greg Stoewer
senior, civil engineering

Professor Finds Answer the Hard Way

I had an interesting experience with the December Tech Teasers problem on finding a perfect cube comprised of consecutive integers.

I programmed my microcomputer to test consecutive numbers but I made no provision to stop after 2146, the cube of which is greater than 9876543210, the largest number which satisfies the requirements. The first time I ran the program nothing happened and, after waiting some time for a printout, I interrupted it. The number displayed was 8365427, the cube of 203. I recognized this as an answer, probably one of many, and I proceeded to determine why the program was finding numbers but not printing them.

I found the bug. The program was incrementing but not properly testing. I just happened to interrupt it as it reached 203. This answer, found on the first random cut, turned out to be the only one of 2145 candidate numbers.

Howard Knoebel
Retired Professor
general engineering

by Mary Kay Flick

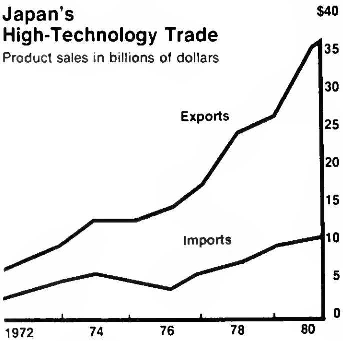
Chip Wars

With today's increasing product demands, the inexpensive production of quality hardware is proving to be a most important issue. The real-world case of the United States vs. Japan illustrates how specialized governmental funding and aid can be a solution.

The United States and Japan have evolved as two of the most comparable economies with respect to electronic technology in the modern world. They are the first and second most powerful economies in the free world. Although the United States remains a world leader in many aspects of electronics, Japan follows closely behind.

This race for technology has caused the United States and Japanese economies to respond strongly to the challenge. Each has served to drive the other to an unprecedented mastery in the use of new technologies while at the same time improving existing ones. It is this fiercely competitive drive for new technological discoveries and innovations that has kept both countries established as world leaders and will allow them to forge ahead into the next generation of computers and consumer electronics.

Japan's High-Technology Trade
Product sales in billions of dollars



Source: **Newsweek**, August 9, 1982.

Japan has quickly become a world leader in electronics. This is largely due to the support and influence of their government's Ministry of International Trade and Industry (MITI). Japan is a capitalist country which uses indicative planning. This planning is done primarily as a forecasting mechanism and is in no way binding to Japanese producers. However, the government does influence the economy through its use of industrial policies in which MITI plays a major role. MITI primarily uses monetary supports to promote research and development in preferred areas. MITI's current project is the development of a computer with artificial intelligence (AI)—the fifth generation computer. Japan intends to become the pacesetter in using computers to simulate human reasoning in problem solving.

MITI not only gives support through financial aid, but also influences the nature of competition within the Japanese economy. They ideally wish to have a few large companies which enjoy economies of scale; however, small business firms comprise 70% of companies in Japan. On the regulatory level, MITI aids ailing industries by slowly phasing them out and channeling their resources to more stable industries.

However, MITI has not always made the right decisions about which industries to support. When transistors were first developed, MITI chose to back inefficient vacuum-tube makers. They also gave virtually no support to Sony when they first began to market their Betamax videocassette recorder and the Walkman portable radio.

Another aspect of the Japanese economy which distinguishes it from other economies is the nature of its internal competition. Japan has become the world's leader in consumer electronics because its target is the discriminating Japanese consumer. Therefore, manufacturers have been forced to produce high quality products at extremely low prices. This also explains why so many other countries, including the United States, want to import Japanese products.

The nature of competition has also caused duplication of products to become a frequent practice. As soon as companies see the success of one company's product, they begin to produce it or a similar product to gain a larger share of the electronics market. For example, since Sony introduced the popular Walkman portable stereo, twelve other companies have come out with similiar models. In additon, Sony now has eleven different Walkman models on the market. Sony co-founder Akio Morita is quoted as saying, "The nature of business is to make your own product obsolete. If we don't do it ourselves, we know our competitors will do it for us. That's why we always try to come up with something new. That is our incentive, our driving force."

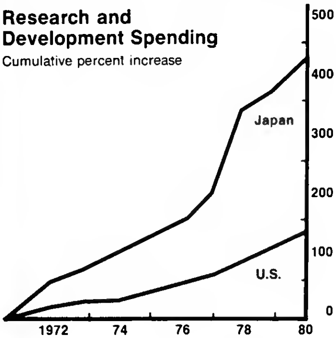
These philosophies and practices have carried through to the computer industry as well. Japan's current goal is new ultra-high-speed computers dedicated to artificial intelligence. Their extensive research is backed by a $450 million grant from the government. For most of the world, the fourth generation computers, using Very Large Scale Integrated circuits (VLSI), are just emerging while Japan is setting targets for its fifth generation computers using AI.

Japan has also become the largest user of robotics for manufacturing. Because job security is stable in Japan, workers do not fear labor-saving improvements such as robotics. Workers often welcome them because they are freed from tedious and boring jobs. Fifty-nine percent of robots in use for production reside in Japan. According to the Robot Institute of America, there are more than 14,000 programmable robots being used in Japan. Experts predict that Japan may be producing $1 billion worth of robots by 1985.

This is an optimistic picture of the Japanese computer and electronics industries since they are not without problems. Japan has a shortage of good software written specifically for Japanese machines, as well as a shortage of software written in the Japanese language. They also underestimated the extent of marketing and distribution necessary in the area of small computers. In addition, the Japanese entered foreign markets later than they should have to gain a good market share. They concentrated more on personal computers rather than lower-cost, consumer-oriented home computers.

Even though Japan has a large amount of technological skills, they tend to borrow rather than originate. However, they are beginning to realize that they must develop their own ideas in order to compete in the modern world. They are no longer concentrating on the development of specific products, as they have done in the past, but moving toward basic research and development. Japan has made great strides in agricultural hybrid development, nuclear breeder reactors, and harnessing geothermal energy sources.

Research and Development Spending
Cumulative percent increase



Source: **Newsweek**, August 9, 1982.

Japan's fierce internal competitive drive has caused a few problems in the international market. In order to survive in the economy, a Japanese firm must have an incredible amount of information to remain competitive. Companies are as familiar with the competitor's products as with their own. Whenever a company comes out with a new product, the others tear it apart and analyze its components. As a result, this thirst for information led to the attempted purchase of IBM trade secrets from FBI agents last year. Some companies have opened employee-only night clubs to keep employees from giving away trade secrets while having a good time.

Since Japan has experienced such a rise in its economic growth, the standard of living for its people has increased dramatically. What seemed like bare essentials of modern living ten years ago are commonplace today. The number of families with cars has risen from 17% to 62%, those with color TVs from 26% to 98.9%, and those with air conditioners from 5.9% to 40%. Popular consumer items are video-cassette recorders and pianos. The Japanese are becoming more Westernized in their habits as many single women spend large amounts of money on designer clothing and accessories. However, Japanese women still purchase traditional dress items as well.

Although Japan is a strong force to be reckoned with, the United States is responding to the challenge brought about by the computer and chip wars. For example, the government is expected to increase its spending on supercomputer development. According to a government spokesman, the fiscal 1984 budget already contains requests for up to $100 million in supercomputer development funds from defense and aerospace agencies. Although the U.S. government intends to play a major role in aiding this new computer milestone, it does not intend to compete with American industrial and commercial efforts. In addition to increasing the development of supercomputers as a whole, American industries are trying to become major producers of the VLSI circuits that go into these giants.

Thus, America and Japan have issued a challenge to one another. The two countries have been driven to compete with one another and with themselves individually. The aspects of this contest are destined to influence both countries profoundly in the coming years. However, the contest cannot last forever.

Perhaps what the future holds for Japan and the United States is a common working relationship. Combining resources and brainpower can produce the most advanced systems and designs ever imagined. The potential is limitless. Realistically, Japan needs the United States' abilities in research and development while at the same time the United States needs Japan's capacity for innovation. Japan needs improved technology to keep pace with internal demand while America would benefit because it would no longer be in direct competition with Japanese efficiency and quality.

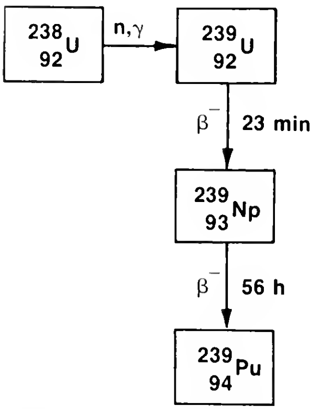
The possibilities for the two world powers in computer and electronics are astronomical in number. No one knows what the next generation of computers will bring. American technology and Japanese competitiveness can produce the new marvels of the modern world, but nobody can predict what they will be or how they will affect society. ■

by Kirt Nakagawa

The New Breed of Reactors

Liquid metal fast breeder reactors solve all the classical problems of energy needs. Most people cannot believe that these reactors create fuel while using it, but a careful inspection of the complicated LMFBR process puts an end to any queries.

Chain for conversion of fertile nuclides to fissile nuclides.



Source **Nuclear Energy Technology**, Ronald Allen Knief 1981

Of all the advanced reactor systems currently in the development stage, the liquid-metal fast-breeder reactor (LMFBR) is receiving the most support by the governments of major industrial nations of the world. The United States, USSR, France, Japan, and the United Kingdom all have LMFBR's planned, if not already in operation.

The governments of these countries are providing support because of the great potential the LMFBR has shown. In theory, the LMFBR will be able to supply energy while producing more fuel than it consumes and it can operate at higher efficiencies than the more common light-water reactors (LWR) currently in use. Add this to the fact that LMFBR's would operate relatively independently of uranium costs and they become even more inviting.

In the mid-1960's, after evaluating reactor development programs and research done until that time, the Atomic Energy Commission (AEC) chose the LMFBR as its number-one priority. The AEC had chosen the LMFBR over other breeder concepts because of its proven feasibility, interest expressed by related industries, and its economic performance potential. The fact that economically recoverable reserves of domestic uranium were forecast to deplete within 25-50 years make the LMFBR even more attractive, if not essential. The decision was made to develop the technology for construction cooperatively between AEC labs and private industry.

Many of the aforementioned nations already have small-scale LMFBR plants operating, but mostly for experimental purposes. Despite its proven feasibility, many problems surround the LMFBR and its future is not entirely certain. One may learn more about how an LMFBR works by understanding the principles behind the conventional LWR.

In a conventional LWR the neutrons moderated, or slowed down (to what are known as thermal velocities), by water cause the fission of uranium-235 (U-235) which produces heat, radiation, and some fission fragments, or the remnants of the U-235 atom. In the fission process, the U-235 releases some neutrons which in turn may induce the fission of another U-235 atom, and the process continues provided there are sufficient quantities of U-235 and the proper physical conditions are satisfied. U-235 is not the only fissile nuclide. Plutonium-239 (Pu-239), an artificial isotope of the element plutonium, is also fissile, as well as the natural nuclide U-233.

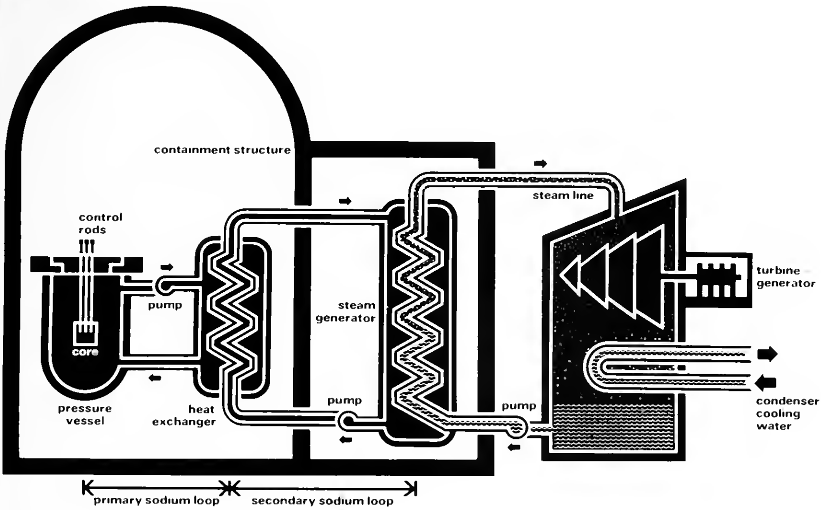
The water in an LWR is also used to cool the reactor core and steam produced by the heat of the nuclear reactions drives a turbogenerator. It is in this manner that LWR's produce electricity.

The theory of the breeder reactor rests upon the fact that more than two neutrons are produced when either U-233, U-235, or Pu-239 undergo fission, and that U-238 can be transformed into Pu-239 upon capture of a neutron. What a breeder reactor does, then, is to utilize the neutrons released by the fissioned nuclide to sustain the reaction and breed more fuel than is consumed. It is the small fraction of a neutron that enables a breeder reactor to create fuel faster than it consumes it; one neutron is used to sustain the reaction, one neutron is used to replace spent fuel, and the small portion leftover is used to create excess fuel.

The number of neutrons provided by the isotopes U-233, U-235, and Pu-239 upon fission can be increased if the fission is induced by a fast neutron, one that has not been moderated (hence the term "fast" breeder reactor).

The neutron yield per neutron absorbed is described by its Eta value. Higher Eta values mean greater neutron yields. One set of Eta values refers to thermal fission and the other refers to fast fission. The fast fission of either U-233 or

Liquid metal cooled fast breeder reactor nuclear steam supply system.



Source: **Nuclear Power,** James J. Duderstadt, 1979.

Pu-239 will yield the most neutrons for breeding fuel, based on their Eta values. Therefore, one of these nuclides and a moderator will not be used, thus allowing a fast neutron flux. Pu-239 is chosen over U-233 as a fuel not only because of its high Eta value, but also because U-233 is not being produced in large enough quantities to supply the demand that an LMFBR market would produce.

The process by which U-238, a fertile (or fissionable after the capture of a neutron) isotope, becomes the fissile element Pu-239 is referred to as the uranium-plutonium cycle. (See diagram on opposite page.) When a U-238 atom absorbs a neutron, it becomes an unstable isotope U-239. The half-life of U-239 is about 23.5 minutes. The U-239 emits a beta particle from its nucleus, gains an electron from its outer shell, and becomes the element neptunium-239. However, neptunium-239 is also unstable; its half-life is 2.35 days. It emits a beta particle and some gamma rays, and becomes the fissile nuclide Pu-239.

The fact that 99.3% of all naturally ocurring uranium is U-238 and only .7% is U-235 serves to make the breeder reactor even more attractive, as the potential to utilize all of this otherwise "wasted" uranium is realized. Also, the spent fuel from most LWR's is comprised mainly of costly U-238, as the small amounts of U-235 (2%-4%) are depleted. Thus the LMFBR has the potential to "run" off of otherwise "used" fuel.

In order to breed fuel, the LMFBR must expose the fertile isotope U-238 to fast neutrons. This is accomplished by surrounding the core of the reactor with a blanket region, an area enveloping the core filled with U-238. The core, like an LWR, employs a matrix of fuel rods containing a fissile nuclide. The actual fuel

continued on page 22

by James Yun

No Return With Deposit

Common man-made emissions can be naturally converted into sulfuric and nitric acids in the atmosphere, bringing about harmful effects back on earth. This is involving both government and scientific communities in a world-wide clean-up effort.

A sparkling, scenic lake basks under a bright, morning sun. It is placid except for a soft, refreshing breeze that blows from the west; it is enough to designate the area as God's Country. But there is a problem: it is *too* placid, and the breeze may not be *that* refreshing. On closer scrutinization, one discovers that there are absolutely no fish living in the lake. In fact, the lake contains almost no living organisms at all.

The above scenario, however grim it may sound, is repeated dozens of times in the eastern United States and the eastern provinces of Canada. The local residents and officials claim that it is caused by what is commonly known as "acid rain," blown from the heavily industrialized states of the Midwest. The scientists say that there is no conclusive scientific evidence to support that claim, though they do not discount the possibility that the pollutants emitted from the Midwestern states may be a major contributing factor to the formation of the acid rain that destroys wildlife in the East. Thus begins one of most intense debates concerning a delicate environmental and highly political issue.

The generic term acid rain is a misnomer for two reasons. First, not all pollutants are acidic when deposited; some may become acidic after deposition. Second, there are both wet and dry pollutants. In other words, the pollutants may be transported to the ground with rain, snow, or fog (wet deposition), or they may fall to the ground as dry particles. Therefore, the correct term for acid rain is acid deposition.

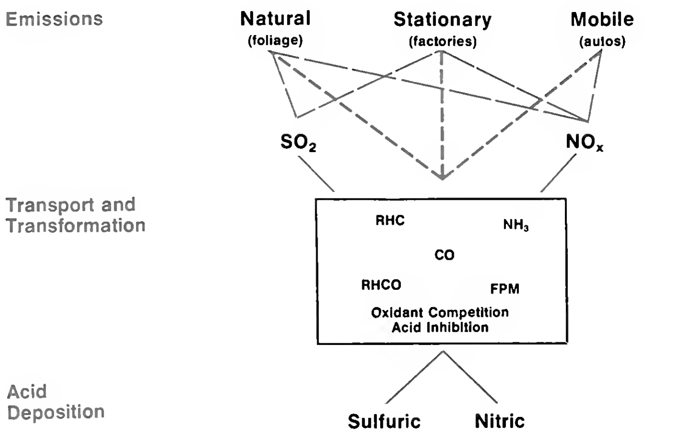
The primary sources of acid rain are sulfur dioxide and various nitrogen oxides, and they are often referred to as "precursors" of acid rain. (See diagram on opposite page.) Sulfur dioxide and nitrogen oxides may be chemically converted directly to sulfuric and nitric acids respectively. Alternatively, they may be converted to sulfate and nitrate before they react further to become acids. But the conversion processes, which can occur in the gas phase in cloud or rain droplets, aerosols, or on the deposition surfaces at the ground (e.g., water or soil), require oxidizing agents (oxidants) such as hydrogen peroxide, ozone, or hydroxyl radicals. The production of all of these is directly related to a class of pollutants known as reactive hydrocarbons (RHC's).

It is an undisputed fact that the phenomenon of acid rain is very complex and that it is still not well understood. First, there are many sources, both natural and anthropogenic, of sulfur dioxide, nitrogen oxides, and RHC's. Natural sources of sulfur and nitrogen include swamps, volcanoes, decaying vegetable matter, and the natural sulfur and nitrogen cycles. The contributions of these biogenic sources are highly variable on a global scale but they nonetheless are considered significant. Anthropogenic sources include both stationary and mobile sources, such as smokestacks and automobiles. These sources are considered to have a greater role in the formation of acid rain than the natural ones.

Second, when precursors are released to the atmosphere, they encounter a diversity of conditions affecting their rates and pathways of conversion to acids. Therefore, the magnitude of atmospheric concentration of acids and precursors varies from location to location, which is one of the reasons why it is very difficult to determine what effect emissions from one specific region are having on the acid deposition in another specific region. Knowing what effect emissions from one region are having on the acid deposition in another is essential since, after acid rain regulations are imposed, this must be known to determine who is the guilty party when a violation has been committed. Mathematical models attempt to do just that.

According to a report released last June by a National Research Council committee chaired by Jack Calvert, direc-

Schematic diagram of atmospheric acid formation.



The major acid precursors are transformed into acids. The acid conversion process is characterized by competition for oxidants and inhibition of one acid's formation by the presence of the other acid.

Source: **Environment**, Vol. 25, No. 4, 1983.

tor of the National Center for Atmospheric Research (Boulder, Colo.), these models are inadequate and unreliable. However, there are scientists who insist that the models, however imperfect they may be, still provide valuable information which cannot be obtained in any other way. As an analogy, they compare these models to those used to predict weather, where the information is also imprecise but, nevertheless, are unobtainable from any other source. Still, there are those who say that the confidence in the reliability of the models can be enhanced if they are tested with more data. They point out that the models have been tested with field data from only one year—1978.

Third, and lastly, acid can elicit a variety of responses from different ecosystems. Thus, increased acidity may be slightly beneficial to one site but harmful to an adjacent one.

Faced with such a complex issue, the Reagan administration is attempting to find means to deal with it. The fact that it is acting on the issue marks a dramatic departure from its position just a few months ago when it said that years of additional research were needed before the EPA could even begin to design an emission control strategy to combat acid rain. The administration not only has high political stakes at home, but also international ones, involving neighboring Canada.

Since the signing of the Memorandum of Intent on Transboundary Air Pollution on August 5, 1980, the United States-Canadian negotiations, both scientifically and politically, have been characterized by accusations and disagreements, and have been acerbic at best. When the Canadians presented a proposal last June that would have commissioned the Royal Society of Canada and the U.S. National Academy of Sciences (NAS) to review findings of scientific work groups that were established to review available information about the acid rain phenomenon, the U.S. government rejected it. The reason for the rejection was thought to be the fact that the NAS recommended stricter pollution controls in the report written by the National Research Council, which is the same report that declared the present mathematical models used for studying patterns of acid deposition as unreliable. Apparently, the Reagan administration has since realized that it needs to act.

Most of the present proposals to reduce acid rain revolve around the reduction of sulfur dioxide (rather than nitrogen oxides or RHC's, for example) released by coal-fired power plants for at least three reasons: first, sulfur dioxide is considered to be responsible for most of the acidity in precipitation; second, coal-fired power plants generate significant percentages of the total sulfur dioxide emissions in the United States; and third, the technology for controlling sulfur dioxide emissions is currently available.

It must be noted that, as soil scientist from the University of Pennsylvania Arthur Johnson points out, the effects of acid rain are not caused by sulfur dioxide itself. Instead, it is the fact that sulfate, a negatively-charged compound, moves efficiently through the soil to lakes and

continued on page 24

Powder Paradise

The snow storms that swept the country this winter may have wreaked havoc with the orange crops, but they were a boon to the ski industry. Ski resorts in Colorado, by the end of December were reporting more snow than they usually have by the end of March. The big snowfalls came just in time for the Christmas vacationers to enjoy some fantastic skiing. *(photos by Jane Fiala)*

by Jeff Sargent

Plato Matures

"Sorry. PLATO is off. Service will resume in a few minutes."

Those glowing orange words can strike terror into the heart of a Physics 106 student whose homework is due by the end of the day. There has always been a danger of putting instructional material on a large computer system such as PLATO, whose hundreds of terminals dot the Urbana campus. If the computer "crashes," the student is out of luck until the PLATO computer can be fixed.

Over the winter break, new hardware was moved in, and old hardware was shipped out. Specifically, the two old central processing units (CPU's), associated memory banks, and peripheral equipment was replaced by modern versions of the same. In addition to upgrading their central system hardware, CERL (the Computer-based Education Research Lab—home of PLATO) is also developing ways to use PLATO through the cable-television system in Champaign-Urbana.

The present incarnation of the PLATO computer-based teaching network has been in operation since the summer of 1962. Though a powerful computer in its day, the machinery that ran PLATO until last winter was over 10 years old. Some parts of the PLATO computer system, notably the hard disk drives, have been upgraded within the last few years.

The very brain of PLATO—the two CPU's (a Cyber 73 and a Control Data Corp. 6500)—were replaced by twin Cyber 730's, both of which are merely five years old, improving PLATO's performance and decreasing its downtime. Tina Gunsalus, an administrator at CERL, believes: "We expect to have much greater reliability, and 40 to 60 percent more processing power available." What this means to a student using PLATO is a faster key response, fewer and shorter delays while using the system, and fewer unplanned crashes to contend with.

In addition, all four million words of the old computer memory (ECS—extended core storage) were replaced by faster, smaller, and cooler-operating memory known as ESM (electronic semiconductor memory). The old ECS is made up almost entirely of discrete components: transistors and core planes; there is not an IC chip to found on the boards. Cold water pipes ran alongside the boards to keep them cool. The new memory boards do indeed have IC chips, and do not require the internal water cooling system, making a substantial saving in overall cooling costs. Whereas the old CPU's could only support four million words of memory, the new pair can access up to four times that amount.

The installation was done from 8:00 p.m. on Sunday, December 25, to Wednesday, January 4—a remarkably swift job considering the effort needed to move, install, and debug the new system. Those responsible for the installation wanted one month to complete the job; CERL negotiated that down to 10 days. "The first few days [were] scheduled down to the hour," said David Frye, Head of Operations at CERL. Though classes did not resume until January 12 here at the University, PLATO is used on other campuses that began their spring semesters earlier. The new machines take up about 30 percent less space than their predecessors. The implementation required for the entire rewiring of the machine room, which was a formidable task.

PLATO is also expanding through the use of the local cable television system. Traditionally, communications between central PLATO and individual users on remote terminals has been handled by a combination of dedicated telephone lines and microwave towers. For example, the large site of terminals at the Foreign Language Building sends data to PLATO via phone lines, and receives data by microwave. Cablevision cables are strung throughout most of Champaign-Urbana, providing cable service to large part of population. Herein lies a ready-made means of bringing PLATO to the masses. PLATO might fare well against other "subscription networks," most being little more than glorified electronic-mail systems; PLATO can deliver the results of over a decade of instructional courseware, mail capabilites, and recreational games as well. Note that this idea of a cable-PLATO network is just now under development and is not yet commercially available.

The improved performance experienced by students this spring will be a short-lived phenomena, Frye believes. "If tradition serves as an example, we will clearly use a big part of the increase for more terminals and a higher on-line usage ceiling." The long term benefits of greater system reliability and easier maintenance are a boon for all the users of PLATO. ■

EOH Developing

Final developments for "Developing Tomorrow—Today! Engineering Open House 1984" are now proceeding, as engineering societies put the finishing touches on projects to be displayed March 2 and 3 throughout campus engineering buildings.

This year's event will feature several new attributes in an effort to encompass all facets of engineering. Student organizations have been invited to present displays recognizing the non-technical aspects of an engineering career. A special contest exploring the various questions of waste management has been developed, and an engineering king and queen will be elected.

In addition, the traditional ingenuity displayed by College of Engineering faculty and students will be evident in the assorted exhibits and lectures around campus. Industrial displays are sponsored by many groups. Student bridge constructing, vehicle building, cement pouring, and other competitions will be sponsored. Tours will be available of the major displays and various exhibits around campus.

For information on the specific displays at Engineering Open House, watch for the Technograph insert in the March 1 Daily Illini.

Permanent Foundations

A handbook on permanent foundations for manufactured housing will be developed by the Small Homes Council-Building Research Council at the University of Illinois.

A contract for the handbook was awarded to the council by the U.S. Department of Housing and Urban Development. The $100,000 contract covers a series of quick-response studies to be assigned by HUD during the next 18 months, said council director Donald E. Brotherson, who will be in charge of the project.

Other studies will include an evaluation of new housing installed on vacant lots in New York City and the production of a handbook of design concepts for the HUD Affordable Housing Program.

As a cross-campus coordinating agency for research in housing, the council will use its own staff and that of other University departments, including civil engineering and the Fire Service Institute.

Rewarding Robots

This year's Engineering Open House will feature a new competition sponsored by the American Society of Mechanical Engineers (ASME).

The Lockmiller Awards in Robotics will be awarded to persons developing outstanding projects dealing with robotics, artificial intelligence, computer control, and related areas. Intended to stimulate competition and creativity among students in the development of these projects for Engineering Open House, the awards will be broken into three amounts: $600 for first place, $300 for second place, and $100 for third. The winners names will also be placed on a plaque.

A student committee has been organized to develop the rules for this competition, to publicize it, and to judge its entrants. Professor James Peters of the Department of Mechanical and Industrial Engineering, the current ASME advisor, will oversee the organization and committee activities. Shirley Pearson, ASME, will chair the committee.

Funding for the awards was donated by matching funds from Richard G. Lockmiller and the industrial gifts funds to the College.

Dean Wins High Award

Daniel C. Drucker, dean of the College of Engineering at the University, has won the 1983 Timoshenko Medal.

The highest award of the American Society of Mechanical Engineering, the medal recognizes contributions to applied mechanics.

Drucker was cited for "contributions to inelastic solid mechanics with particular reference to [his] unifying principle for plasticity constitutive relations and insight into the relation between theory and experiment."

Drucker joined the University as dean in 1968. He is a member of the National Academy of Engineering and the American Academy of Arts and Sciences.

PC's in Action

For one Friday afternoon, the second floor of the Electrical Engineering building came alive with electrical ingenuity as students in Advanced Digital Projects Laboratory exhibited class projects for the public.

The course is an open lab designed to give students experience in applied microprocessor technology.

"It is a project lab with both undergraduate and graduate students," explained course director Ricordo Uribe. "Students are free to do [their projects] at their own pace during the semester. Then they display their debugged, well-documented, ready-to-be-used projects." Such projects may be new devices, or equipment necessary for development in another phase by students in the following semester.

Projects included a speech synthesizer, developed by Eric Romesburg and Albert Thaik, which could recognize common English words and use them in a sentence. Those words which were not immediately recognizable were sounded out, similar to a child learning to speak. Another computer was also capable of speech, but understood words written in a phonetic spelling, explained Tony Waitz.

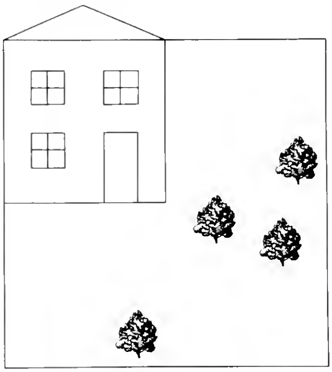
Another project was a computer operated cart. "The idea behind this is an improvement in mobility; there is really no forward direction," explained Ken McMillan. "You can align the wheels to go in any direction and change curvature." Developed by Martin Eberhard as a EE master's project, the cart is operated by four individual computers tied together by a fifth computer which provides interface to the outside world.

Other projects featured sythesized music, updated terminal hardware, and displays vital in robotics development. "We've been doing a lot," noted Uribe.

James O'Hagan

Tech Teasers

1. While apartment hunting one day, Egbert Edelman discovered a beautiful four-room house with four large fruit trees in the yard (see picture). The landlord agreed to rent the home to Egbert and his three friends, but would only include the land surrounding the house if it could be divided into four lots of equal size and shape with a fruit tree in each. How should Egbert divide the lot?



2. One of the most important members of the College of Engineering has had his share in the cares of life, yet he is always in good luck. Without him, physics, chemistry, mathematics, and all the exact sciences would look far different than they do today. He has been found frequently with both princes and commoners, and today is making a beginning in cooking. Who is this?

3. Two trains are approaching each other on the same track without brakes. When the engines are 2 miles apart, a very fast fruit fly leaves the first engine and flies toward the other at 90 miles per hour. Upon reaching it, he ignores the laws of physics and instantaneously reverses in direction, flying toward the other train at the same speed. He continues to do this until the trains, both travelling at 60 miles per hour, collide. How far did the fly fly?

Technovations

Workers Judge Work

The most thorough final construction safety check program ever developed for the nuclear industry—asking workers their opinion of the plant when their work is finished—is underway at the Enrico Fermi 2 nuclear power plant near Monroe, Michigan.

Billed as "Fermi 2 Safeteam," Detroit Edison's newest safety assurance program may end up as a model for the nuclear construction industry, according to several utility officials.

The Safeteam interviews of workers leaving the project help Detroit Edison pinpoint possible safety-related problems that could cause a delay in the plant's startup this year and lets the utility thank each construction worker for his or her contribution.

Fermi 2 workers leaving the job site report to an "Appreciation Center," where they are offered the opportunity for an interview, explained Bert Heffner, director of the Safeteam project. The confidentiality of the interview is protected by computer safeguards and by never matching the names with the concerns.

"The Fermi 2 Safeteam is unique in the nuclear power industry," said Donald A. Wells, Detroit Edison's manager of quality assurance. "It focuses on the concerns of the workers because the workers really are the ones who built the plant in a way to help ensure that it will operate safely and efficiently."

"If we save just one day in getting this plant up and running safely and reliably, we've saved the people of Michigan in our service area $1 million," Heffner remarked.

London Bridges

Despite the popularity of collapsing bridge movies in high school math classes, Selective Electronic Inc. (Selcom) has developed a new system for monitoring bridge movement and preventing structural failure.

The new and highly accurate highway bridge motion monitoring system incorporates Selcom's SELSPOT II motion analysis technology and related hardware with a highly sophisticated software system. It permits, for the first time, non-contact three dimensional measurement of structural movement.

According to Rolf Svensson, Selcom's Vice President of Marketing, the new highway bridge motion monitoring system provides highway structural and safety engineers with a dependable method to measure bridge movement. "With nearly half of the more than half a million bridges in the U.S. structurally deficient, functionally obsolete or in need of major repairs, careful monitoring of abnormal bridge motion may provide an early warning system to local, state and federal officials," Svensson said. "With proper training and periodic bridge monitoring, unusual rotation, sway and vibration should be easily detected."

The new system consists of four basic components: a SELSPOT II camera, an array of three LED's which work together to provide three dimensional measurement, an LED control unit, a main processing unit, and computer with printout.

The LED light array, consisting of strong infrared light sources, is mounted on strategic sections of the bridge in a fashion designed to maximize motion measurement data collection but minimize disruption to traffic. Minute changes in bridge motion are transmitted by infrared beams through a unique opto-electronic camera, located on the bridge.

This camera detects the light from the light sources and generates output signals which are converted into precise position information and routed to the main controller. The controller then converts the position into information signals ready for computer recording, analysis and storage for future comparison and use.

Movement due to camera motion is easily neutralized by the system, allowing for a high degree of accuracy within ±0.5 percent and a measuring resolution of .025 percent. Easy to operate and control, the system can be operated by two engineers or safety personnel.

James O'Hagan

continued from page 11

rods are capped with U-238 both above and below. The core is further surrounded by rods containing only U-238 in them—the blanket region. In this manner, the neutron availability is utilized to a high degree.

At high neutron energies, however, the likelihood of a neutron capture is decreased and thus a greater degree of enrichment is necessary for the reactor fuel. LMFBR's need about 15%-25% fissile material as opposed to 2%-4% for an LWR.

The rods containing the U-238 in the blanket region can be removed after they have been sufficiently exposed to the neutrons. Extraction of fissile material is accomplished by a process similiar to the enrichment process for reactor fuel. The isotope Pu-239 can be concentrated to the desired levels and then can be used to fuel another reactor. The amount of time it takes for an LMFBR to provide enough fuel to start up a second nuclear plant of similiar size is called the doubling time. This, ideally, should be kept to a minimum in order to insure that power shortages do not occur.

The LMFBR has a very high power density, somewhere on the order of 380 kW/l, thus it requires a coolant with excellent heat-transfer properties in order to control the reactor. Water cannot be used as a coolant because of its tendency to moderate neutrons. The metal sodium, in the liquid state, has the necessary properties to be considered as a coolant for an LMFBR. (See diagram on page 11.)

Liquid sodium has a high boiling point and it remains a liquid over a high range of temperatures. Its heat transfer properties are excellent, and just as importantly, its cross-sectional area is in the low-absorption range, thus it does not have the tendency to moderate neutrons. The power requirements for pumping liquid sodium are low, and there exists an established capacity by U.S. industries to produce sodium.

Liquid sodium does, however, have its drawbacks. It is activated when exposed to neutrons and thus will be highly radioactive after a sufficient number of cycles through the core of an LMFBR. It reacts very violently when exposed to water or air, and care must be taken to insure that the two do not meet. Another problem centers around the fact that special pumps, valves, and flowmeters need to be designed, manufactured, and refined. This is an expensive process, but obviously a necessary one.

In all LMFBR designs, the sodium that cools the core is not used to raise the steam that drives the turbogenerators. Instead, an intermediate, or secondary, sodium loop is employed. The primary core cooling loop is confined to the reactor containment building so in the event of a mishap, the radioactive sodium is isolated from the environment. The secondary loop is interfaced with the first in a heat exchanger, and the secondary loop raises the steam to drive a generator.

The controversy surrounding the nuclear power industry includes the LMFBR. This is compounded by the fact that the LMFBR has some serious technical problems left unanswered. One of these is fuel lifetime.

For the fuel assemblies to have a reasonably long lifetime in an LMFBR, the burnup tolerance will need to be about 10%. However, such a high burnup may lead to fuel assembly damage in the form of swelling or distortion, due to the high neutron flux in the reactor. This damage to the fuel assemblies could possibly alter the configuration of the core over a long period of time. Changes in core geometry could result in a change in the multiplication factor, thus suggesting the possibility of a core-disruptive accident.

The LMFBR development program is far behind schedule. The Energy Research and Development Administration (ERDA) had foreseen that in the early 1990's a "viable and commercial industry" for the LMFBR would exist. This would involve a market of reactor companies, architects, and engineers from whom interested utilities could solicit bids and select favorable designs. However, costs continue to rise as deadlines are not met. With the rate of demand for electricity declining, many people are questioning the need for an advanced reactor system.

But the dream of the LMFBR lives. The French and Soviets already have small-scale LMFBRs operating, but only with outputs of 250MW-350MW. For the United States, development of the LMFBR would greatly improve our utilization of uranium resources as well as alleviate some of the pressure on fossil fuels to supply the energy needs of the country. But other factors, such as the public's aversion to plutonium due to its toxicity and proliferative tendencies, has a great influence. The potential of the LMFBR is matched only by its long history of setbacks. Only by objective, careful consideration should the fate of the LMFBR be decided; and then only after all of the relevant facts have been examined and carefully judged. ■

continued from page 13

streams, releasing positively-charged hydrogen and aluminum ions as it travels. While the added hydrogen ions are responsible for increased acidity of the water, the aluminum causes direct toxic effects for fish and other organisms, not excluding human beings. It has been suspected for some time that aluminum ingested in food or water may be one factor in Alzheimer's disease and other degenerative brain diseases, though the theory is unproven.

At present, the Federal government is undertaking an ambitious effort to mimic how the atmosphere transports sulfur dioxide. The project is known as the Cross-Appalachian Tracer Experiment (CAPTEX). In this project, in place of sulfur dioxide, an inert, pristine tracer gas, perfluorocarbon, is released either from Dayton, Ohio or from a predetermined site in Ontario, Canada. A fan of eighty observation stations on the East Coast then takes air samples to determine where the tracer is transported and how it is diluted during transportation. The results of this experiment will be announced around midyear.

Currently, there are three principal methods in use or under discussion to reduce the emission of sulfur dioxide from coal burning: coal washing, flue gas desulfurization (scrubbing), and switching to low-sulfur coal.

Washing involves removal of naturally-present sulfur through physical or chemical cleaning of coal before it is burned. This process can remove up to forty percent of the sulfur before combustion, depending on the type and quality of coal.

Scrubbing of flue gases involves removal of sulfur from combustion emissions through a sulfur-trapping system. Scrubbing is highly successful in reducing sulfur emissions, but consumes massive amounts of lime and produces large quantities of waste.

The third option, fuel switching, is an alternative that could allegedly achieve a reduction of up to 90 percent in sulfur emissions from coal-burning facilities. But this option poses a serious economic problem for states that produce high-sulfur coal, mainly Illinois, Indiana, and Ohio. Because of this concern, Valdas Adamkus, Midwest regional chief of the EPA, recently announced that he ordered a study of potential economic, employment, and social impacts of acid rain regulation in the Midwest. Results from that study are not yet available.

To repair, reduce, or delay the environmental damage brought on by acid deposition, there is essentially one mitigation option available, which works mainly by neutralizing the acids already deposited on forests, soils, rivers, and lakes. The method, called "liming," involves distributing calcareous materials over acidified or vulnerable regions to provide a "buffer" against acidification. The state of New York had moderate success with its liming program, while the Swedish government and the Provincial Government of Ontario each had mixed results. The principal problems associated with liming as a mitigation alternative are: 1) the uncertainty of the long-term impacts of repeated treatments on factors other than water quality; 2) the relatively uncertain costs associated with such a program; and 3) the potentially broad areas that might require liming applications.

Several bills have already been introduced in Congress to combat the acid rain problem. The important legislation in the House, introduced by Reps. Gerry Sikorski (D-Minn.), Henry Waxman (D-Calif.), and Judd Gregg (R-N.H.), basically spreads the cost of reducing the emission of precursors over the contiguous 48 states, while indirectly mandating that the 50 largest sulfur dioxide emitters (50 power plants) use high-sulfur coal by requiring them to install scrubbers, an obvious benefit to the Midwest since it produces high-sulfur coal and is also experiencing the worst of the economic slump. But the major acid rain bill in the Senate, introduced by Sen. Robert Stafford (R-Vt.), does not spread the cost of reducing the emissions over the contiguous 48 states and, in effect, allows the power plants to use any method available to reduce the emission of precursors, which can most likely have a detrimental effect on the Midwestern economy.

While there are people who claim that present scientific evidence does not warrant the imposition of acid rain controls, there are others who argue that there is a precedent for the adoption of regulations in the absence of complete information about other environmental threats. That was the case, for example, in the debate over whether chlorofluorocarbons (CFC's) threatened the earth's ozone layer. In the United States the mere hypothesis that the ozone layer could be depleted by CFC's was enough for the government to impose regulatory restrictions and bans on certain uses.

Because lack of adequate scientific information makes it very difficult to formulate regulations to control acid rain, some initial regulations should still be imposed. As the acid rain review panel appointed by the White House Office of Science and Technology Policy states, "Recommendations based upon imperfect data run the risk of being in error; recommendations for inaction pending the collection of all of the desirable data entail even greater risk of damage." ■

Tech *Profiles*

Nicholas Vlachos came to the University in 1982 as an assistant professor in mechanical engineering. In 1967, Vlachos received his undergraduate degree in mechanical and electrical engineering from the National Technical University in Athens, Greece. Vlachos received his M.S. in thermopower engineering and his Ph.D. in fluids engineering in 1972 and 1977, respectively, from the University of London. Upon completing his studies, Vlachos was a research engineer for the National Center of Scientific Research in Strasbourg, France.

Here at the University, Vlachos' research involves experimental and numerical fluids engineering. More specifically, separating flow, flow instability, and blood flow are analyzed using microprocessors for signal processing and Laser, Doppler, and Hot Wire Anemometry (LDA). LDA involves the use of laser light and the principle of Doppler shift to measure the velocities of particles seeded in a flow. Vlachos' doctoral thesis concerned the development of LDA for blood flow and numerical modeling of blood flow around arterial stenoses and thrombuses (blood clots).

Vlachos has held seminars on LDA and numerical flow modeling in England, France, Germany, and the United States.

Joseph Wyse

Burks Oakley owns a $10,000 Zeiss microscope to make sure he cannot see the probes he fabricates for his research.

Funded by grants from the National Institute of Health and by the G.D. Searle Company (developers of Nutra-sweet™), Oakley does research on the vertebrate retina.

He has developed a special probe that allows measurement of electric and ionic potentials on the retina within living tissue. The probe has a tip so small it cannot even be seen under a light microscope.

Then why invest $10,000 in one?

Oakley observes each probe to make sure he cannot see the tip. If he can, he knows the probe is defective.

Oakley is an associate professor of electrical engineering. He has been at the University for three years and has taught basic circuit EE classes as well as three bioengineering/electrical engineering courses. He enjoys using his time for research.

His research data has been published and is used by professionals such as clinicians. It is hoped that the data can be used to develop better retinal disease tests and perhaps cure night blindness.

Oakley feels that his special position as an engineer looking at biology gives him a great advantage for the type of work he does.

Dave Colburn

Gerald DeJong does not own a personal computer. Nonetheless, he is a major entity in the fields of artificial intelligence and computer science at this University.

Assistant, Resident Assistant, and Exxon Assistant Professor DeJong is currently the mentor for EE 371-GDJ (Advanced Artificial Intelligence Programming Techniques), and has taught EE/CS 348 (Introduction to Artificial Intelligence). He obtained his doctoral status in computer science from Yale in 1979, after graduating from the University of South Dakota.

"Intelligent" computers must have a knowledge of the world they are working with, and currently this knowledge is programmed in by humans. Professor DeJong is working to make computers capable of obtaining this knowledge on their own, learning it bit by bit like humans do. This would be quite handy, especially since most human experts who would program their own knowledge tend to be too inarticulate to comprehend—even for a computer. DeJong is affiliated with several projects on campus that deal with this idea.

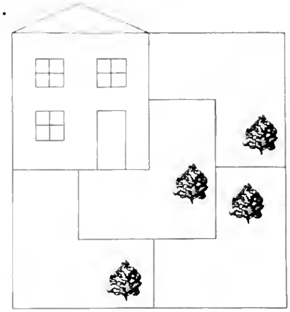
DeJong is very optimistic about the field of AI, and he hopes that everyone at this University involved with any of the cognitive sciences will be able to band together, combining their expertise to make Illinois a mecca for AI.

Langdon Alger

from page 19

Tech Teasers Answers

1.

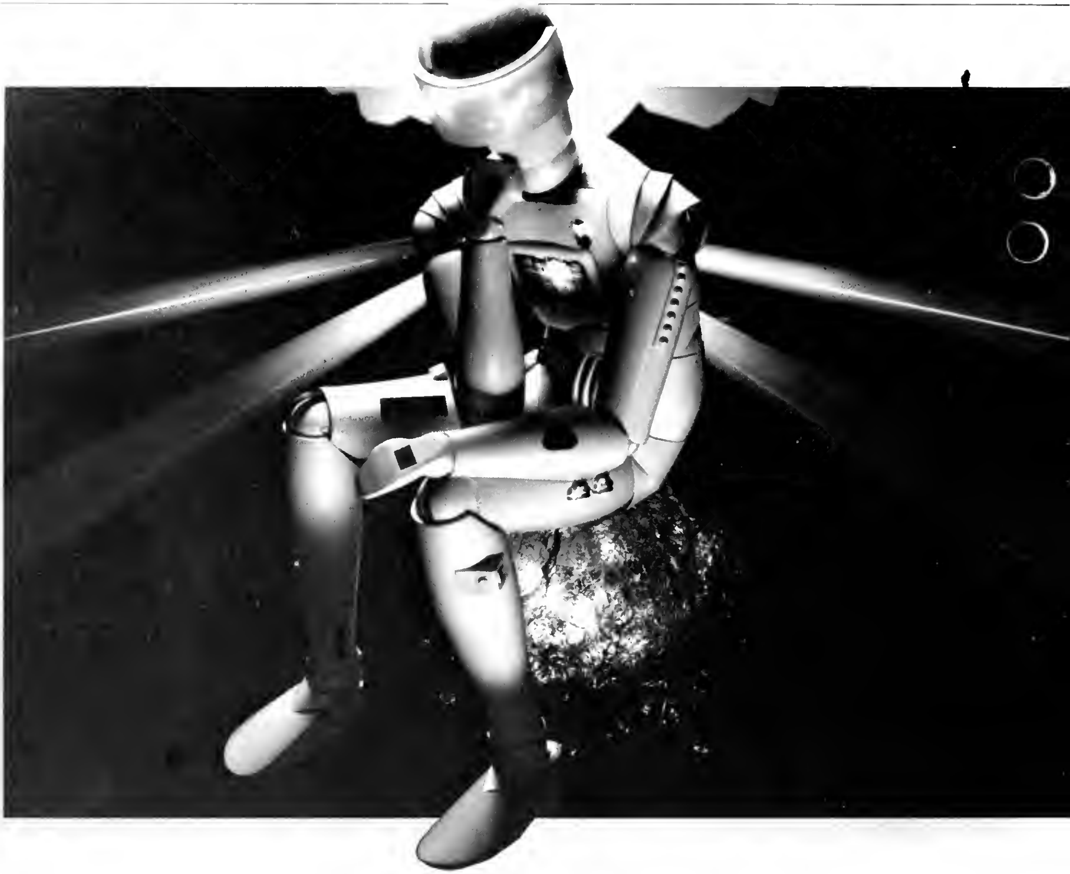


2. This character is the letter C.

3. Since the trains will collide in one minute from when the fly first takes off, the fly will fly:
(1 minute) × (90 miles/hour) × (1 hour/60 minutes) 1.5 miles.

Congratulations to the 1984 Knights of St. Pat

Ian Chen
Daniel Costin
Bradley Dewey
Patricia Feit
Karen Friese
Laura Kubiak
Thomas Little
Larry Mallak
Brett Miller
Lawrence Newman
Karen Powers
Raymond Prill
William Ping Tai
Michele Wegscheid
Kevin Wenzel
Eugene Ylo



Create computers that capture the mysteries of common sense.

The brain does it naturally. It wonders. It thinks with spontaneity—advantages we haven't been able to give computers. We've made them "smart," able to make sophisticated calculations at very fast speeds. But we have yet to get them to act with insight, instinct, and intuition.

But what if we could devise ways to probe into the inner nature of human thought? So computers could follow the same rationale and reach the same conclusions a person would. What if we could actually design computers to capture the mysteries of common sense?

At GE, we've already begun to implement advances in knowledge engineering. We are codifying the knowledge, intuition and experience of expert engineers and technicians into computer algorithms for diagnostic troubleshooting. At present, we are applying this breakthrough to diesel electric locomotive systems to reduce the number of engine teardowns for factory repair as well as adapting this technology to affect savings in other areas of manufacturing.

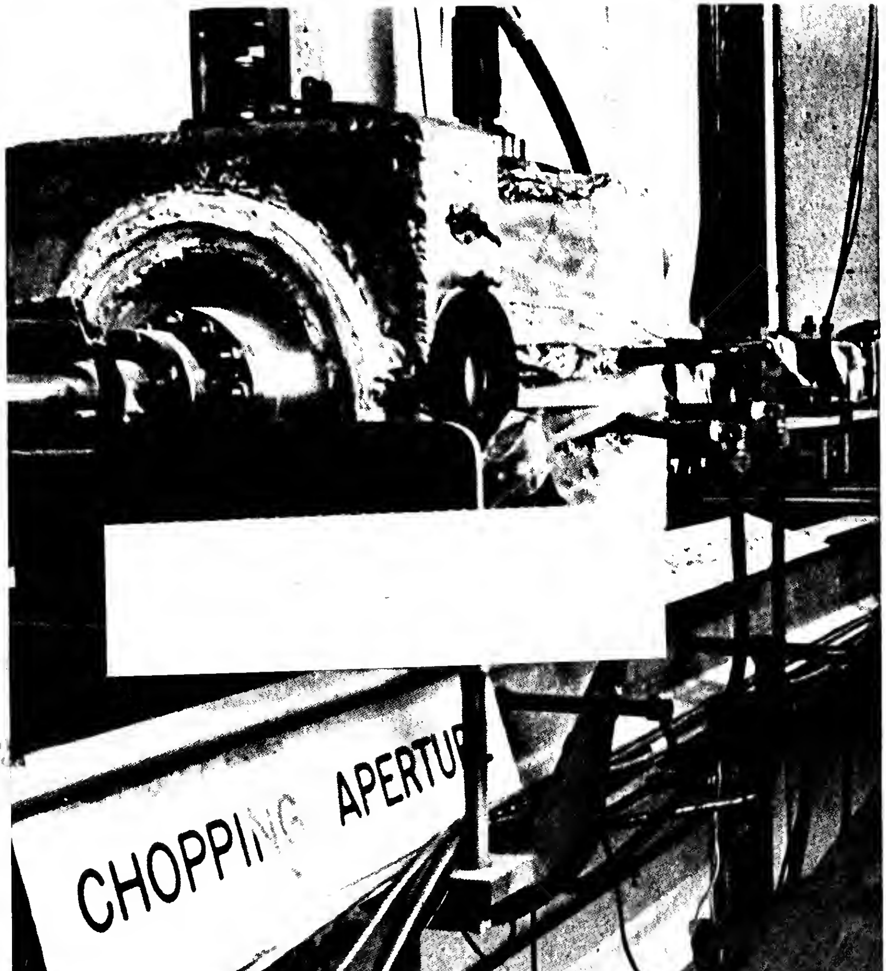
We are also looking at parallel processing, a method that divides problems into parts and attacks them simultaneously, rather than sequentially, the way the human brain might.

While extending technology and application of computer systems is important, the real excitement and the challenge of knowledge engineering is its conception. At the heart of all expert systems are master engineers and technicians, preserving their knowledge and experience, questioning their logic and dissecting their dreams. As one young employee said, "At GE, we're not just shaping machines and technology. We're shaping opportunity."

Thinking about the possibilities is the first step to making things happen. And it all starts with an eagerness to dream, a willingness to dare and the determination to make visions reality.

An equal opportunity employer

If you can dream it, you can do it.



Nuclear Physics

E-Systems continues the tradition of the world's great problem solvers.

Maxwell's electromagnetic field theory led to huge practical scientific advances. His light theory led to his own development of one of the first color photos and the kinetic theory of gasses.

Scientists and engineers at E-Systems are carrying on in the tradition of Maxwell's genius. Today, they are solving some of the world's toughest problems in electronically steered phased array antennas, electromagnetic scattering and solar ray concentration, using his findings as tools.

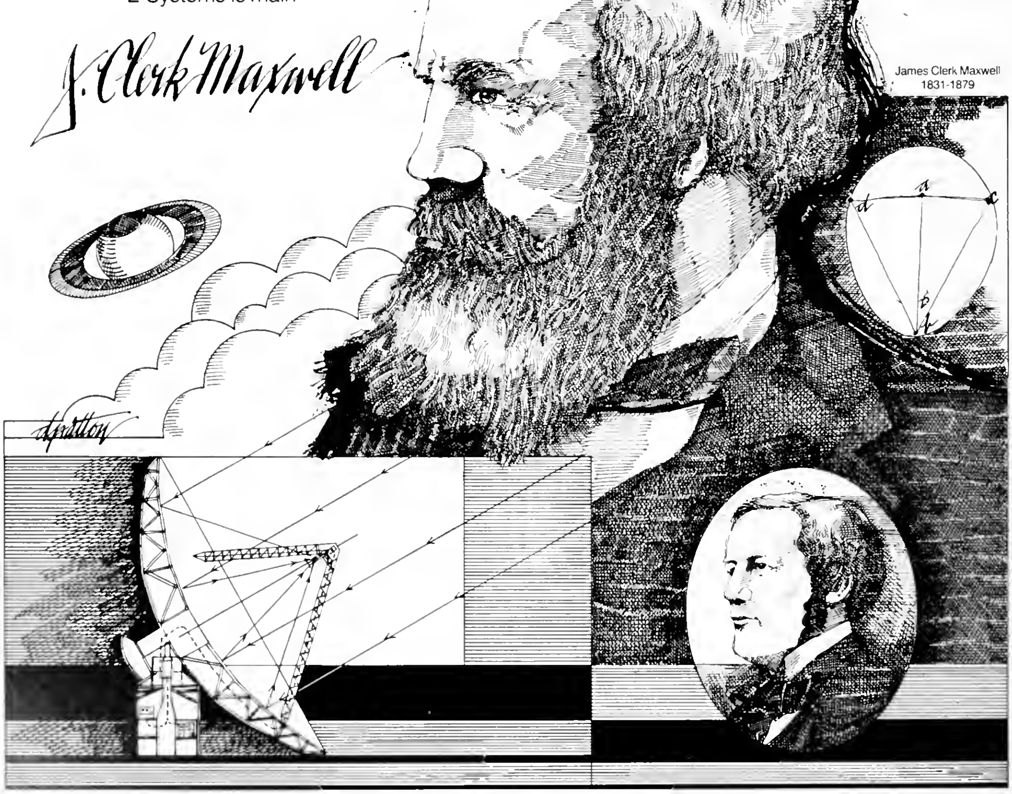
E-Systems is maintaining a reputation for designing and building communications, data, antenna, intelligence and reconnaissance systems that are often the first-of-a-kind in the world.

For a reprint of the Maxwell illustration and information on career opportunities with E-Systems in Texas, Florida, Indiana, Utah or Virginia, write: Lloyd K. Lauderdale, V.P.—Research and Engineering, E-Systems, Corporate Headquarters, P.O. Box 226030, Dallas, Texas 75266.

E-SYSTEMS

The problem solvers.

An equal opportunity employer M F H V



James Clerk Maxwell
1831-1879

HOW SECURE WILL YOU FEEL AT BUSINESS LUNCHES WITHOUT THE AMERICAN EXPRESS CARD?

The American Express® Card can be as important to your new job as a pinstripe suit. After all, it won't be long before you're out at a business lunch or off on a business trip. And at times like these, the Card is a must. Besides, it's a terrific way to start establishing your credit history. And it comes in handy for all sorts of personal expenses. Best of all, it's simple to get. All you need is the promise of a $10,000 career-oriented job. So before you pick up your pinstripe suit, pick up an application on campus. And apply for the American Express Card. Then, chances are, you won't get caught with your pants down.

The American Express Card. Don't leave school without it.™

Illinois

Technograph

April 1984 Volume 99, Issue 5

6 **Very Large Scale Integration** *Robert Ekblaw*
RAM is almost a household word nowadays, but the design process of dense chips is another story.

8 **Speak and You Will Be Heard** *Mary McDowell*
The ultimate human-computer interface is here, and with it is coming fascinating new methods of speaker recognition.

10 **A Matter of Particles** *Kirt Nakagawa*
As physicists learn more and more about matter and its atomic components, sophistication in equipment becomes mandatory.

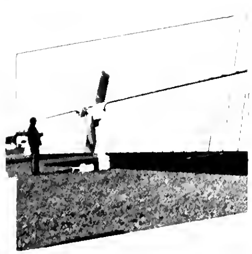
14 **Stranded Waves** *Eric Guarin*
Fiber optics has proven its superior utility as a communication link, both theoretically and in practice.

16 **Vacancy to Fill** *Jim O'Hagan*
After fifteen dedicated years as Dean of the College of Engineering, Daniel Drucker has decided to return to research.

Departments
Editorial 5, Tech Teasers 5, Technovisions 12, Technotes 19, Technovations 21, Tech Profiles 23

On the cover: The Nuclear Physics Laboratory's linac, or linear accelerator, is currently being used to crack atomic particles to learn more about matter. This linac is one of the smaller varieties, but it offers plenty of versatility. (photo by Joseph Wyse)

Illinois Technograph (USPS 258-760)Vol 99 No 5 April 1984 Illinois Technograph is published five times during the academic year at the University of Illinois at Urbana-Champaign Published by Illini Publishing Co., 620 East John St., Champaign, Illinois, 61820 Editorial and Business offices of the Illinois Technograph Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3733 Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001; 221 N. LaSalle Street, Chicago, IL., 60601 Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879 Illinois Technograph is a member of Engineering College Magazines Associated



Tech *Teasers*

1. Into how many pieces can a pizza be divided with only four straight cuts?

2. Carolyn has a gold chain consisting of 25 links. Being fidgety, she begins to twist apart the links at a rate of one per minute. How long will it take to separate all the links?

3. How can 25 consecutive integers be arranged into a five by five matrix such that the sum of any row, column, or diagonal is 0?

4. A right pyramid is cut from a ceramic cube of side c. The base of the pyramid is a side of the cube. How far from this side of the cube must a plane be passed parallel to the removed face so as to divide the remaining volume of the cube into two equal parts?

5. OK engineers, prove yourselves. After a year of math games, how many of these grammatical questions can you solve?

a. Which eight letter word contains only one vowel?

b. What word contains all 5 vowels in alphabetical order?

c. What word contains 3 sets of double letters in a row?

d. What trait do the following words share? Deft, calmness, laughing, stupid, hijack, first, canopy.

Answers on page 20

Editorial

What I did with my summer vacation

Sounds like a stupid grade school or high school assignment. What did *you* used to do in the summer? Go on vacation, party, work, lay in the sun, get bored, secretly wish that school would start again? Looking back, what did you actually accomplish over the summer? Make a few dollars, experience a few pleasant diversions, maybe take a class or two.

Summer, when most of use are away from school, is a time period that seems to whizz right by. What do we usually have to show for ourselves after summer has passed: a tan, a beer gut, a lazy mind, a disturbed social environment, and hopes for the future.

Life after graduation can be similar to those lazy summers unless we take action to set goals for the future and strive to meet or exceed them.

I won't have to go to classes anymore. Maybe you won't. But the education process should be continuous; it does not stop at graduation. If you don't keep up on new technology in your field, be prepared to let younger ones take your place. One of the best ways to keep abreast of developments in a certain field is to read its associated journal. *Sounds boring*. If it is boring to you, then perhaps you're in the wrong field or you're into stagnation.

I'll live the easy life with the money I'll be making. Possibly. Just remember that $25,000 goes a lot farther in Champaign-Urbana than it will in the cities where most engineering jobs are found. Many engineers graduate and move to Silicon Valley to take high-paying jobs. But what good is a high-paying job if the cost of living is similarly high? Also, standards of living have a way of adjusting to income levels and there will always be "the next step up" to strive for.

I've got my degree, but I don't think that it's what I really want. No problem. Have you ever heard of an advanced degree? Studying a different area of engineering than that of your undergraduate field can often open up new corridors of opportunities. There is no reason that a person with an engineering education cannot find a rewarding niche—unless that person has no drive.

The engineering degree can qualify its holder to many exciting occupations; but the holder must decide what is exciting. Is it molecular physics or planetary orbits? Weapons or health care? Cars or Concordes? Construction or fission? Computers or television?

The choice is yours. A little planning and goal-setting will make the future a welcome era. Don't let your life whizz by like summer. Have something to show at the end and at each stage in between. Build up material for the ultimate essay—"What I did with my engineering degree."

Illinois Technograph invites letters in response to its articles and editorials, or any other item of interest to our readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.

by Robert Ekblaw

Very Large Scale Integration

These days, it is difficult to decide if computers can reproduce themselves, or if they only assist in the complicated process. In the past, people have expressed their fear of computers being able create other computers. A grasp of the design methods, however, for such a process often allays any worries.

Have you ever watched in awe as those massive computer systems hummed and churned in their attempt to process information? Have you ever wondered what is the key of success in those monsters? Have you ever pondered the inner workings of them, wondering just what it is that makes those babies tick? If you have, then you will be extremely interested in this article.

The topic of this article is VLSI circuits. VLSI stands for Very Large Scale Integration. This refers to the integration of a very large number of transistors into a single capacity or single space. VLSI is the descendent of SSI (Small Scale Integration), MSI (Medium Scale Integration), and LSI (Large Scale Integration). Each step along the progression from SSI to MSI to LSI to VLSI increased productivity by increasing the amount of work capable of being accomplished, while at the same time decreasing the time necessary to perform the work.

The progression of technology from which VLSI circuitry emerged was a long and complicated one. When computers began, they were run by vacuum tubes, glass tubes with the air forced out of them and circuitry within (much like the tubes found in television sets). The central memory was stored on drums, large cylindrical units processed by a drive system that was separate from the rest of the computer system. These massive machines were known to fill entire rooms. They were so large, in fact, that often the computers were placed on the newly-constructed floor of a building and the walls were built around them.

As technology grew, so did the necessary capability of the computer. The memory was changed to large magnetic reel tapes. This was fine for awhile, but it was eventually changed to large, flat, hard magnetic disks. In time, both the memory and the processor were changed to the integrated circuitry that now exist. However, this circuitry has also seen changes.

A little background will be necessary in order to understand the importance of its change. A division of a memory circuit board in a computer is a chip. Each chip, referred to as a RAM (for Random-Access Memory), can support a certain amount of data. Data is typically divided into "bytes." A byte is a fundamental unit of data composed of eight bits. These bits hold one piece of information each. The information stored is either a 1 or a 0. Each bit holds either a 1 or a 0. The arrangement of the 1's and 0's in the bytes determines the type of information.

The equivalent of a bit in the English language is a letter, and the byte's equivalent is a word. A common collection of bytes is a K, which is 1024 bytes. K is short for kilobyte, but notice that it is not a thousand, as a normal kilo- would denote. This is due to the binary numbering system used by the computer instead of the decimal numbering system utilized by humans. Now, with this information in mind, let's analyze the memory circuit's progression.

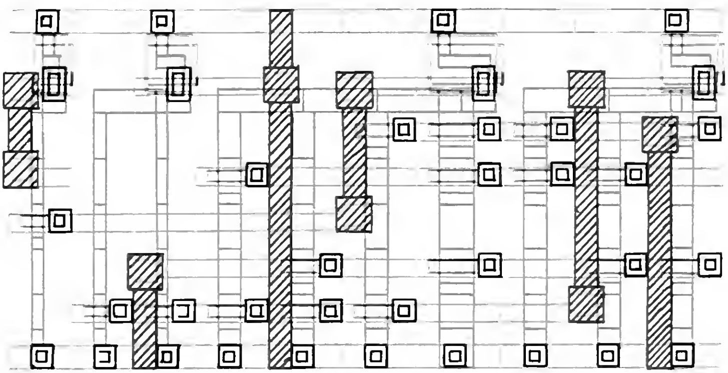
When the RAM circuit first came out in 1971, it was composed of 1K RAM chips. In other words, each chip could only hold 1K of information. However, as Miles Lewitt, manager of Software Development at INTEL Corporation said, "Technology is not slowing down. It is increasing at an ever-increasing rate." Thus, as technology increased, so did the chip's data capacity. In 1974, 4K RAMs were used in memory boards. In 1977, the amount of data in each chip grew to 16K. Not slowing at all, 64K RAMs were used in 1980, followed by 256K RAMs in 1983. It grew in powers of four, with each new chip coming out three years apart. This exponential growth in a linear amount of time illustrates the tremendous leaps in the computer industry over the last twelve years.

A startling situation surrounding the memory's growth is its price. One would expect that as the capacity grew, the price would increase, however, the opposite is true. When the 1K chips came out in 1971, they cost approximately one cent per bit. The price gradually diminished until 1974, when it was about half that price. From then on, it maintained that price until its demise in 1981. The 4K RAM of 1974 started its cost at the point of the 1K at that time—half-a-cent per bit. This price steadily decreased until 1978, where it was one tenth its original cost. This price remained until its death in 1982. The 16K RAM of 1977 was projected in 1976 to cost two-tenths of a cent per bit to produce. When it hit the market in 1977, however, it had dropped to one-tenth of a cent. This cost fell all the way to an eight-thousandth of a cent per bit, reaching that point in 1982. The 64K RAM started at one nine-hundredth of a cent per bit in 1980 and hit a seven-thousandth of a cent per bit last year, and is still dropping. In fact, the starting price of a 256K RAM was a fifteen-thousandth of a cent last year. The reason given for the higher price per bit for the new 256K RAM chip is the new production and design methods used in it. This makes it more expensive than the 64K, but its processing is said to be much better.

The manufacturing of these little silicon wonders is an interesting procedure in itself. The manufacturing is divided into three main stages: architecture, circuit design, and device characteristics defining. All of these steps are carried out via a set of masks. These masks are design stan-

Product of VLSI Technology

Diagram of one bit of a one megabyte RAM chip.



Source: Department of Computer Science, University of Illinois

dards and techniques generally outlined, with enough definitions to create the actual product by expanding and enhancing the masks.

Today, architecture and circuit designs are being produced by computers, using the guidelines contained in the masks, and these designs are transmitted to other computers. The job of these other computers is to manufacture and/or control the manufacturing of the photoresistant silicon RAM chips. Then a circuit board is designed and etched, electron paths are soldered, and the chips are placed in the board. The board is then combined by wires and circuits to other boards and the network of boards is placed into a mainframe. A computer is thus made.

A layman may ask why the advanced VLSI systems with their 256K RAM chips are necessary. One of the many reasons is an everyday commodity for video-game buffs—highly-defined, sharp-resolution computer graphics. The use of VLSI in graphics systems is constantly growing. VLSI facilitates, increases, and speeds the needed processes in graphics: data manipulation, arithmetic processing, fast drawing, text processing, microprocessing, and many more. VLSI circuits connect and regulate the data processor, graphics processor, memory, video generator, screen buffer, and monitor. Most important of all to the viewer/player/customer is that VLSI systems and high-capacity RAM chips enable higher resolution and faster refresh time.

The higher the resolution, the sharper and more lifelike the image. The refresh shows maximum actions in time; the higher the refresh, the faster the motion can be. In general, successively higher resolutions allow higher refreshes. Thus, the higher the chip capacity, the less memory needed for the screen buffer and more memory can be used for the program. In video games, this means that the games can be more complicated, with a myriad of different scenes and actions, making the game more exciting and less repetitious.

VLSI's most important responsibility is to act as a interface between humans and the computer. The high capability given to computers due to VLSI technology has paved the way for high-level languages that are more easily understood by the average person, yet can suntil be compiled and translated into the machine language understood by the computer. This situation has enabled the computer to expand and encompass all facets of human life, since it is possible for practically anybody to utilize a computer system. Thus, VLSI is on the forefront of a new frontier: a frontier cultivated by a computer-using society and reaped by all people in all walks of life. ■

by Mary McDowell

Speak and You Will Be Heard

Vocal control of computer systems has been fantasized and talked about as much as robots have—since the first sci-fi stories. As usual, however, reality is taking over and allowing the utilization of such conceptions.

The past few decades have seen a rapid technological expansion of our American culture. Space exploration, new forms of energy, and advances in communication are continually changing our lifestyles. One of the most frightening things for many people, however, has been the evolution of the computer. From the first vacuum tube model to HAL, the WOPR, and the Apple II, computers have invaded every facet of daily living. People are wary of computers, whether due to new words the machines have introduced or unease when a machine is capable of diagnosing illnesses.

Computer engineers, anxious to spread the application of computers, are working to develop systems that make computer use more feasible for those who could benefit from a computer's applications, but don't necessarily need to know how a computer works. One of the biggest steps toward achieving the goal is the development of the voice-operated computer. These computers are activated by the human voice and execute commands accordingly.

Voice-controlled computers operate by interpreting the energy patterns of sound waves generated by a human speaker. The sound waves are first converted to digital electrical signals by a microphone. The varying loudness of the spoken word is recorded as well as the time elapsed, resulting in a time versus loudness scale. A mathematical technique known as a fast Fourier transform then characterizes the wave form into a three-dimensional event. The signal is thus converted from the time to the frequency domain. Band-pass filters divide the signal into three octave-long frequency bands. At this point, the machine has characterized each basic unit of sound, as well as noted the time elapsed between each unit.

There are two types of interpretation that can occur at this point: linear and warped. A linear system is one in which the word order is specified. The commands must be entered in a prearranged way in order for them to be processed correctly. A warped system relies upon techniques of natural language processing and artificial intelligence. They offer a great deal of input freedom, but they are considerably less accurate than their linear counterparts, due to linguistic rather than electronic complications.

The input energy patterns are matched against a referent within the computer. Each sound that the computer is programmed to respond to has such a referent template. These are generally previously recorded by the operator, but they can be computer generated. If the input energy distributions agree, the computer executes the command.

There are two diametrically opposed functions of voice activated systems: speech identification and speaker recognition. Research on speech identification was begun by Bell Labs and Carnegie Mellon University in the late 1950's. Its objective is to have a system that will respond to the commands of any speaker of that language. The speaker recognition process limits the input to a few restricted users.

The primary difference between the two systems lies in the matching procedure. A speech identificaton system compares the input to the average spectral pattern for a speaker of that language. The computer compares the input signal with the referent and assigns mathematical scores to quantify the similarity to the referent. A tolerance is allotted so as to allow for speaker variation. Because of the allowed variance, these systems must have a restricted vocabulary and a very limited form of interaction so as to reduce the number of potential input errors. This form of system is speaker independent and available to a large number of users.

Speech identificaton systems have wide application when there are a great number of users communicating the same basic message or type of message and where the response to the query may be deferred and a tape recorded message will not suffice. For example, Bell labs has been working on one to handle airline reservations. It has constrained syntax and grammar, and the vocabulary is limited to one hundred twenty-seven different words. It is able to process almost six billion different sentences with an accuracy rating of ninety-five per cent. Bell has also been developing systems to provide directory assistance and automatic dialing services via computers.

For a speaker recognition system, the spectral pattern is more closely scrutinized. The system relies on the fact that every person has a distinct characteristic speech energy distribution within the sound waves of their voice. Before using the machine, one must read certain target words into it so that the spectral patterns can be stored as templates within the system. In order for the machine to respond to the given command, the input signal must be well within the range of the referent template. Since the tolerance for each phoneme is so much smaller than it is for speech identification systems, more sound templates can be stored without fear of overlapping ranges. These systems will therefore have the benefit of an expanded input vocabulary, as well as being necessarily restricted to a few specified users.

Speaker recognition systems are useful in situations in which the commands should only be implemented following the directive of certain persons. A potential application is use in banks. Instead of matching an account holder's signature as a means of identification, a voice spectral pattern would be compared to referent on file. Funds would be released only if the two matched.

With this use comes the obvious concern about security. This could be solved, however, if the degree of matching was extremely high. If the matching was close enough, even mimicry would not be a problem, says University Electrical Engineering Professor Narendra Ahuja, who outlined this potential applicaton. An imitator could pick out the dominant features of a speaker's vocal pattern, but they could never reproduce it exactly. Even people with very similar voices, such as siblings, have discemable patterns. Theoretically, as long as the matching procedure was very precise, the account would be secure.

Susan Ratcliffe, Secretary to the Associate Director of CERL, demonstrates some of graduate student Eric Pelajan's voice operation equipment. (photo by Richard Barber)

The major problem with voice-operated computers is the accuracy with which they interpret sound. The computer could make three basic errors: it could match the input to the wrong referent, it could fail to recognize a sound for which it has a referent, or it could accept a sound for which it has no stored referent.

Some errors are caused by background noise. Noise either distorts what the user is trying to input, or it is taken as input by itself. This problem can be controlled by the use of more sophisticated input devices. The major sources of error, however, arise from linguistic factors.

An issue of concern for designers of successful systems lies in the utterance of the sound themselves. Homonyms create an obvious problem and are thus excluded from computer recognition vocabularies. Even fairly similar words can cause difficulties. The difference between the average pattern of one sound (with tolerance added) and that of another is very slight. It would become exceedingly difficult for the computer to discern whether the inputted signal most closely matched the beginning of one range or the end of another. In order to have an operable system, the commands must be read in very distinctly without the usual tendencies to swallow ends of words or to run them together.

The speed of processing the input is another hindrance. Normal english conversation proceeds at 150 words per minute. A computer making seven million operations per second takes over one hundred seconds of computer time to process one second of speech when full sentences

continued on page 18

by Kirt Nakagawa

A Matter of Particles

Some scientists claim nuclear physicists' work is like pounding a watch with a hammer to see how it works. Be that as it may, such hammers are becoming more and more powerful and sophisticated with every blow.

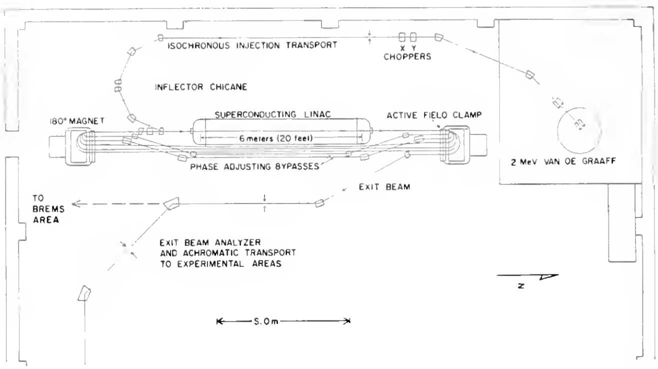
Located less than two blocks from Memorial Stadium, home of the Fighting Illini, lies the University's Nuclear Physics Laboratory (NPL), where research in electromagnetic nuclear physics is conducted.

The NPL consists of a linear accelerator, or linac, five major experimental areas, a computer control system, and a host of other technical support systems. Some of the experiments include the study of basic nuclear structure, bremsstrahlung (the process by which accelerated charged particles emit radiation), and the study of collective modes, which are the forms of vibration and rotation of nuclei when they are excited to high frequencies.

The heart of the lab is the linac, a particle accelerator. The device was built in the fall of 1977 by the High Energy Physics group at Stanford University at a cost of a half of a million dollars. Larry Cardman, technical director at NPL, stresses that the linac is not a reactor of any sort. The operation of a linac can be understood in terms of the law of electrostatic interaction: that opposite charges attract and that like charges repel (see fig. 1). This principle is employed to accelerate the given charged particle to high kinetic energies. By virtue of this energy, the particle can be used to extract data from atomic and nuclear systems, usually by studying the physics of a collision between the particle and a target system.

Microtron Using a Superconducting LINAC MUSL-2

Figure 1 The arrangement of magnets and major components in the MUSL-2 accelerator.



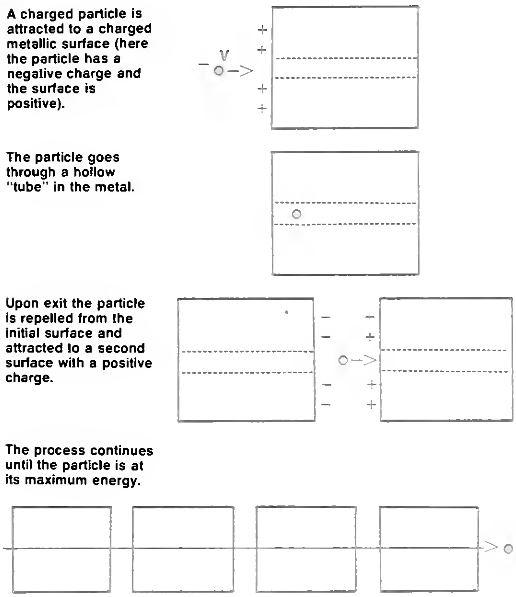
Source: **Status Report December, 1983,** Department of Physics, University of Illinois at Urbana-Champaign.

At NPL, electrons are accelerated to maximum energies of 70,000,000 electron-volts (eV), which corresponds to a velocity greater than ninety-nine per cent of the speed of light. The actual acceleration system consists of a six-meter niobium linac operating at two degrees Kelvin. Due to this extremely low temperature, the linac is superconducting, which means that the energy loss in operating the linac is drastically reduced due to the disappearance of electrical resistance. To maintain this temperature, the linac is encased in a thousand-liter tank filled with liquid helium.

The linac is a "racetrack" design for the electron beam; that is, the beam can be accelerated through the linac up to six times, each time giving the beam successively greater energy by turning the beam around and redirecting it through the linac. This is accomplished by using two sets of large magnets located at opposite ends of the linac (see fig. 2). When the beam is in an external magnetic field, the moving charges experience a force, thus causing them to accelerate. The acceleration is in the form of a change of direction. The first set of magnets reverses the

How a LINAC Works

Figure 2.



Source: Kirt Nakagawa

direction of the beam and the second set of magnets reverses the direction of the beam again, this time back into the linac. The direction change is along an arc while in the magnetic field. As the electrons gain energy the radius of curvature increases. What limits the linac to six passages is the size of the magnets. Technically the linac is called a MUSL, or microtron using a superconducting linac.

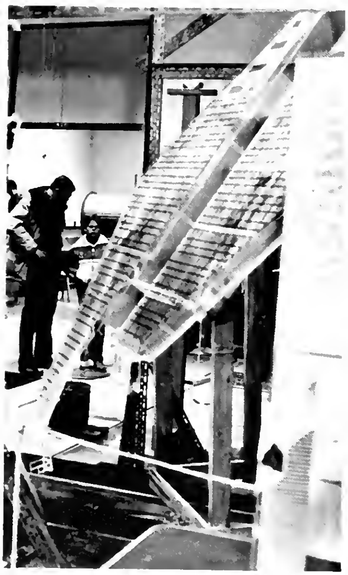
In addition to experimental areas, the accelerator and its operation are part of the studies being conducted. While operation of the accelerator itself is understood, the necessary related technologies are still in the experimental stages and are undergoing testing. They are prototypes for larger systems for eventual use. Some of these prototypes include: vacuum systems, control system computers, and basic linac design. When studies on the prototype systems are complete, the National Science Foundation (NSF) is likely to continue substantial funding in the form of a grant for construction of a 300MeV accelerating system. This would involve a new building that would cost between sixteen and twenty million dollars. Its anticipated date of completion is 1988.

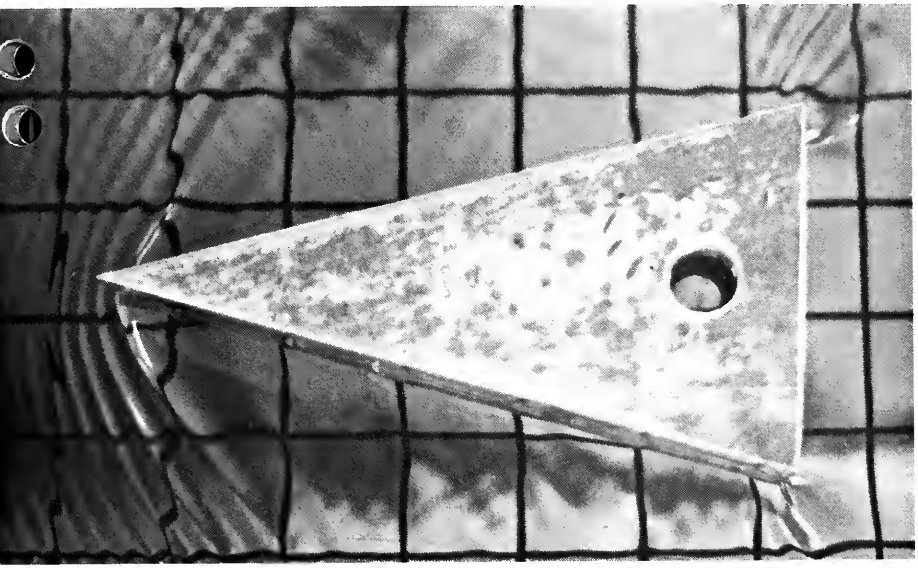
With the greater energy a 300 MeV system would provide, greater resolution of atomic systems is attainable. For example, at energies of 140 MeV and higher, pions (particles in the meson class) can be produced. What these are, says physicist Paul Debevec, are "the entities which represent the forces between nucleons." In other words, higher energies allow a deeper probe into nuclear systems. By comparison, the accelerator at Fermilab near Batavia, Illinois, is a factor of a thousand times more powerful. With that kind of power, the nucleons themselves may be probed.

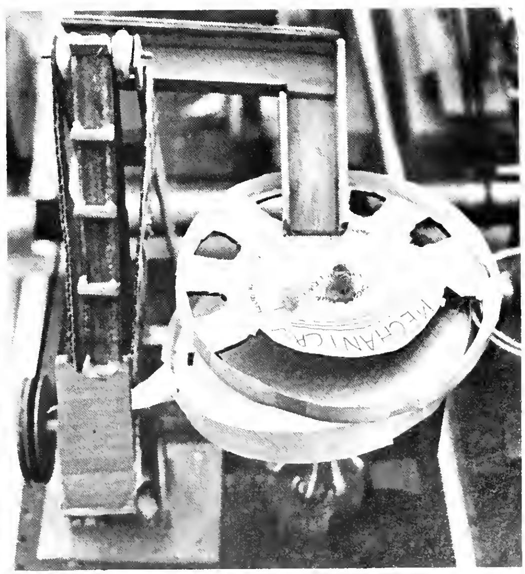
Testing on the prototypes has been favorable, according to Debevec. The NSF is traditionally generous in the funding of nuclear physics research, so future for NPL looks very good. ■

Engineering Open House

The 1984 Engineering Open House was another grand success. Every year EOH attracts high school students from all over the state. For many of them, this is their first exposure to engineering. There were exhibits on display from nearly every engineering department and society, all of which aptly expressed this years theme, "Developing Tomorrow, Today." Among these were the latest advances in sail technology, robotics, and roof design. *(photos by Jane Fiala)*





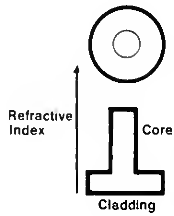

MECHANICA

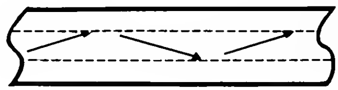
by Eric Guarin

Stranded Waves

Two Approaches to Fiber Cables

The refractive index is like a guide to optical density. The higher the refractive index, the more optically dense the material. A change in refractive index causes a change in the direction of wave propagation.





The sharp change in refractive index causes the light to bounce or reflect from the core/cladding boundary, allowing the light to travel along the fiber instead of leaking through.

Source: **Popular Science**, August, 1982.

The time has arrived for travel at the speed of light. Although human transportation is not yet possible, your likeness can be sent vocally via laser beams to people and places all over the world.

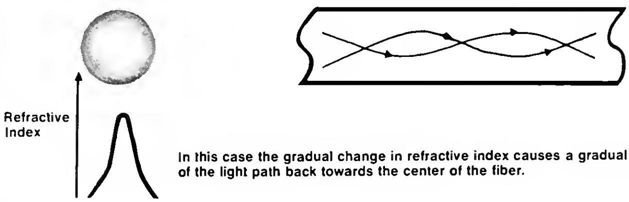
In the minds of many people the words "fiber optics" conjure images of cheap novelty shop lamps. Today, however, fiber optics is a serious business in many fields. In addition to the novelty lamp, fiber optic principles find applications, though primarily in the communications field, in such diverse fields as medicine, instrumentation, and others.

An interesting historical note lies in how all this new technology was preceded over a century ago when Alexander Graham Bell first transmitted a voice on a beam of light using what he called a "Photophone", an invention which he maintained was far more important than the telephone.

Today's version of the photophone sends beams of laser light through thin glasslike fibers. The technology involved is called fiber optics, and finds applications in many fields other than communications. Medical technology uses fiber optics to look inside the human body. Some mechanical devices utilize a fiber device to detect rotation of as little as one thousandth of a degree per hour. Many other sensing and monitoring devices based on fiber optics are under development or in use: alarm systems, probes, and all sorts of sensors. Applications of fiber optics to computers and artificial intelligence may well cause new discoveries in those fields, and military applications have been found for this technology. Such exotic uses notwithstanding, the most common and perhaps most important applications of fiber optics are for communications purposes.

Use of fiber optics in the communications field did not progress much from the experimental level of Bell's Photophone until the early 1960's and the invention of the laser, the light emitting diode (LED), and then the invention of the semiconductor laser. These inventions both paved the way and stimulated interest in the use of light technology. Even though existing glass fiber at the time had severe signal losses, time, money, and research brought about a reduction in these losses.

Fiber loss, or attenuation, is most usefully expressed in decibels per kilometer, where each ten decibels represents a loss factor of ten. A 20 dB/km fiber one kilometer long would therefore attenuate a signal to 1/100 of its original value. Common silica fibers can attain attenuations of .2 dB/km, while exotic fibers may have as little as .00001 dB/km loss. Using one



In this case the gradual change in refractive index causes a gradual bending of the light path back towards the center of the fiber.

of these exotic fibers, a cable could be strung between the Earth and the Moon which would attenuate a round-trip signal by a factor of less than ten. Due to the properties of the fibers, the actual attenuation depends on the wavelength of the light—longer wavelengths generally travel best through the fibers. As might be expected, the fibers with the least attenuation are by far the most expensive.

On a general level, fiber optic and conventional electronic communications sytems resemble each other quite a bit. The technology involved is different, but both types of systems use transmitters, cables, and receivers, with repeaters in between if needed. A repeater is a device which receives the incoming signal and boosts its amplitude to prevent the signal from getting lost in the background noise. Present fiber systems consist of a grab-bag mix of conventional electronic components and electro-optic devices like LED's and phototransistors. This approach leads to difficulties due to size mismatch between the minuscule fibers and the generally much larger devices at the ends of the fibers. The future of electro-optics will most likely be dominated by photonic circuits, components wherein bulky discrete components like the LEDs and phototransistors are shrunk to a microscopic scale, and an entire circuit is made out of substrate layers on a tiny chip. In this respect optical information sytems will resemble more and more the current integrated electronic circuitry prevalent in many fields, but will use light instead. The question naturally arises: if the systems are so alike, why use fiber systems which are not yet cost-competitive with conventional systems? The reasons are many and varied.

Various factors make fiber optics superior to conventional electronics in communications systems. Perhaps most importantly, fiber systems have potentially a much higher information density; fiber systems can handle more data in less space in the same amount of time. Rates of almost 600 megabits per second—8000 simultaneous phone calls, for example—have been achieved, far outstripping current systems. Fiber cables, also called waveguides, have proven smaller, lighter, stronger, and more flexible than copper cables. Fibers can be as thin as a human hair and yet have a tensile strength higher than steel. Fiber waveguides are also immune to crosstalk between adjacent fibers, and are immune to electromagnetic interference, even though receivers may not contain this same immunity. As a result, wiretapping a fiber system poses quite a challenge.

Fibers can also be made extremely resistant to heat, corrosion, lightning, short circuits, and so forth, and electric shock and spark hazard do not exist. Although the fibers can be damaged by radiation (their attenuation may increase), proper fiber cladding can surmount this problem. Indeed, a fiber cable recently developed by Hughes Aircraft withstood one million rads of radiation, in addition to a temperature of 400 degrees centigrade and two percent strain. While not invulnerable and faultless, fiber systems thus have significant advantages over conventional copper cable systems.

As might be expected, fiber optic sytems do have drawbacks. One drawback lies in situational economics: optic systems are not yet cost compatible with present systems. Furthermore, fiber systems require very precise handling and highly purified materials are necessary to make the fibers. The advantages of lower bulk and less need for repeater amplifiers along the signal path will eventually even cost difference to a degree, and the greater information capacity of the fiber systems should also help. Handling problems are being worked on, and ingenious devices like British Telecom's automated splicer rugged enough to use in a manhole should ameliorate handling difficulties.

All in all, fiber optics seems to be the wave of the future in a very literal sense. IT&T scientist Dr. K. C. Kao, a pioneer in the field, foresees optic fiber networks carrying information at 1000 times the rate of today's systems. In the long run, it would seem, fibers are the future in communications. ■

by Jim O'Hagan

Vacancy to Fill

"I believe the mantle of leadership should be passed to someone younger who can guide the college during the exciting period for engineering which lies ahead."

—Daniel C. Drucker

"I look upon it as a terrible loss to the College of Engineering. I'm sorry to see him go," said Engineering Dean R. W. Bokencamp.

Indeed, technological progess in the last 15 years has brought American society past the realm of science fiction and into the most rapidly changing social era since the Industrial Revolution. But rather than being left behind in the face of deep budget cutting coupled with increasing costs, the College has actually progressed to the forefront of this developing field. And because of the leadership provided by Daniel C. Drucker, no one has been surprised.

"He has really done a tremendous job with the College," explained Dean H.L. Wakeland. "He brought it to a very high prestige among engineering colleges in the United States." In fact, the regard with which the University is held by fellow members in the engineering community has improved to the point that it is now consistently picked among the top three in the country.

Such has not always been true, however. "It's been a rugged time in higher education," said Dean P. E. Larson. "The last 10 years higher education has not been the fair haired boy it was for years before that. The priorities of the legislature have changed. That's made it tough for high education." Drucker considers this a major accomplishment. "I guess there are a large number of things in general terms though what I'm proudest of is in the period of financial stringency we were able to maintain the quality of the College. It was no easy task to not

Daniel C. Drucker, Dean of Engineering, recently announced his plans to retire after more than 15 years of leadership. (college file photo)

just maintain the College but move it in new directions," said Drucker.

During such difficult times however, the leadership exemplified by Dean Drucker has proved indispensible in preserving the quality of the College and of the University. In a letter to Drucker by John E. Cribbet the chancellor said, "There can be little doubt that the preeminent position of our College of Engineering, even during the difficult financial period that has affected the entire university, reflects the considerable wisdom and leadership you have brought to the deanship."

Indeed, Drucker was recognized internationally as a leading figure in the engineering community. Chancellor John Cribbet said, "You are among the giants in engineering and engineering education. During the past fifteen years, you have played a significant leadership role not only in our own College of Engineering but on the national and international scene."

"There are really two things that stand out in my mind," said Bokencamp. "One is his successful campaign to bolster the Engineering budget at a time when there was a shortage of funds. . .the second thing is that I had a rare opportunity to observe him in positions of national leadership at a time he served as chairman of the Engineering College Council of the American Society of Engineering Education. I saw him exhibit the foresight to see problems that have come about and encourage deans to take action to minimize problems if not solve them." Drucker's leadership easily cut through traditional departmental divisions. "He brought people together from different areas to work together," explained Wakeland, as Drucker bolstered such projects as the Coordinated Science Laboratory.

These abilities brought significant recognition to Drucker. Before coming to Illinois from Brown University, Drucker taught at Columbia, Brown, and Cornell Universities. Now a member of the National Academy of Engineering and a fellow of the American Academy of Arts and Sciences, Drucker has served as president of the International Union of Theoretical and Applied Mechanics, the American Society of Mechanical Engineers, and several other professional organizations.

Despite Drucker's impressive resume the task of determining a successor must be completed before Drucker leaves his post in August. After nationally advertising for applicants, a search committee will determine the individual most qualified to head the College. "There are lots of things that need doing that one couldn't ascertain before. Financial stringency, overloaded faculty, the fraction of time on the curriculum and the undergraduate level hindered progress," explained Drucker. "Now things are loosening up. People are beginning to ease."

Drucker's leadership has been a vital force in the College, but its loss will not spell doom. "It's a very strong college. No big institution is indispensible," Parker said. But this very strength may be Drucker's largest contribution to the College of Engineering. "It's very positive to what he's done," explained Wakeland. "He's led the College through difficulties and now positioned it so that it is ready for another quantum jump." ■

continued from page 9

are used. Input must be reduced to a very slow level in order to facilitate comprehension.

The use of full, unrestricted sentences is the ultimate goal of voice-operated systems designers. Interpreting whole sentences, however, creates an incredible linguistic quagmire. Every functional sentence processing system constrains its users to a specified syntax. When free input is allowed, systems such as Bell's airline reservations drop to only 35% accuracy. Most sentence processing systems rely on a serial form of interpretion.

Research on improving the accuracy of voice-operated systems is being carried out in CERL in the laboratory of Eric Petajan, an electrical engineering graduate student. His system, being developed as his Ph.D. thesis, involves use of a solid state camera focused on the lips of the speaker. The computer then matches the shape of the speaker's lips to the frequencies being received. This helps the computer be more accurate in its reception of the sound.

Petajan's system operates strictly by matching the frequencies of the voice pattern to a template. It uses a VotermII to process the speech. A sixteen channel filter band converts the analog signals into digital ones. The computer only recognizes words of maximum utterance of 1.25 seconds. It has one hundred templates of thirty-four bytes each which generates an accuracy rating of 90-95%. Forty templates, according to Petajan, is the maximum for nearly total accuracy due to the acoustic similarity of many words.

The system is speaker-dependent with a fixed syntax. It uses a head-mounted microphone and recognizes isolated words only. Petajan says he achieves optimum results using a combination of keyboard and voice input methods.

The voice-operated system has been used by people from the rehabilitation center with moderate success. The system is ideal for those whose limitations are in their limbs and have perfectly natural speech, says Petajan. The system can be adjusted to accomodate those who do have speech disabilities.

Voice-operated systems could be used wherever keyboard input devices are currently utilized. Their application could be extended to cases where traditional forms of input are not feasible. Texas Instruments has developed a system to aid their quality-control inspectors on assembly lines. Instead of picking up each object, putting it down to log any discrepancy, and picking it up again to continue the inspection, the inspector merely enters all data verbally and thereby increases productivity. Applications for aircraft pilots and automobile drivers are being examined by researchers as well.

The basic premise behind voice-operated computers is to make them more accessible to human users and to gear the whole computer-human interaction more toward the person and not the machine. As Professor Stephen J. Whithers of the University of Warwick stated in the January, 1983 issue of *Simulation*, "Designers of systems that involve people should be fit for people to use and not sacrifice human requirements for technological convenience. These machines widen the scope of accessibility of computers and are just one more step toward the integration of high level technology into mainstream culture." ■

Legislators Visit

With the increasing tax burden and decreasing accountability being received from state employees in recent months, the need for direct contact with elected officials is at an all time high.

Engineering students received this opportunity recently at the TBΠ Legislative Forum. Several state senators and representatives attended the all-day affair consisting of group discussions with interested students, a luncheon, and concluding banquet.

Despite extensive publicity by TBΠ and the important opportunity to personally associate with state leaders, student turn-out was low. "Students don't realize how important government is to them now," explained an event organizer Amy Baits.

Physics Flares

Loomis Lab, longtime liberal hot spot on campus, reached dangerous proportions in a recent early-morning fire.

The blaze, now attributed to arson, was first reported by a building service worker as a burning bulletin board on the first floor, with heavy smoke on the second floor. University fire fighters, reporting to the scene, found heavy smoke and intense heat on the second floor and immediately connected hoses to a nearby hydrant in an attempt to cool down the building. "On the second floor you have cement block walls, concrete under the floor, concrete above the ceiling, so the corridor contains heat like an oven," explained Chief Duckowitz of the University Fire Department. Temperatures in the second floor hallway reached over 1500 degrees.

The high temperatures made the fire difficult to control. Approaching close enough to effectively fight the fire was difficult because the temperatures could easily melt rubber straps or boots. Also, when water was sprayed onto the brick walls, they exploded, sending fragments of masonry throughout the area.

The intensity of the fire required that additional workers be brought in. The University Department had immediately contacted the Urbana Fire Department, who quickly arrived on the scene. A third alarm was sounded to bring in additional manpower from the City of Champaign Department. Also present was Arrow Ambulance, which arrived on its own accord but proved beneficial when fireman Tom Pardick suffered an injured elbow and smoke inhalation. He was rushed to Burnham hospital for treatment. Finally, the Fire Service Institute provided manpower and equipment for replenishing air tanks for the nearly 60 men working amidst the dense smoke.

The most extensive damage resulted on the second and third floors where intense heat and smoke destroyed most of the hallways and ceilings. Smoke may have also damaged the $8000 PLATO terminals on the second floor, even if such damage does not become apparent for some time. Original estimates put the damage around $200,000, although Chief Duckowitz estimates that to rise to well over $300,000.

An Awarding Experience

Nearly a year of organizing, planning, and hard work came together on March 2 and 3 as students exhibited some of the newest developments in the country to visitors at Engineering Open House.

Successful projects were exhibited by nearly every Engineering Society and Honor Society as well as several sponsored by individual students. A four-wheeled robot, created by Martin Eberhard and Kevin McMillan, captured first place in personifying the EOH theme of "Developing Tomorrow—Today!" AIIE emerged victorious in demonstrating the use of engineering in today's society with their display on statistical quality control. Engineering in tomorrow's society was best displayed by J. Hill, R. Drexler, G. Karlov, K. Levenson, and M. Wiecher with a computer controlled robot, while two ASCE members, Jennifer Kurtz and Steve Zibowitz, provided the superior project for demonstration purposes.

Other projects represented individuals or societies and were also successful. AIIE presented a music video "Come On, I.E.'s!" to capture the top rating in their division, while AAE claimed the honors for presentation of research with a study of wind tunnels. John Anderson explained sulphur concrete slats while Richard Derksen clarifiied laser optic methods for determining droplet sizes as they won awards in undergraduate and graduate research respectively. In the Waste Management Contest, Clifford Fedler took first with a display on an anaerobic digester.

Departments also did well. In the EOH Central Exhibit, Metallurgy and Mining captured first while the granddaddy event, best overall society, went to Joe Lehman and Agricultural Engineering.

"In terms of the number of students that showed up and the quality of exhibits compared with last year, I would consider it a success," explained EOH chairman George Mejicano. "I think the awards went very smoothly and my committee did an outstanding job."

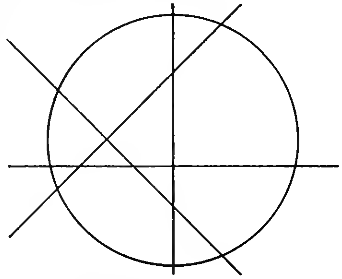
"There seemed to be a core group in each department who did most of the work," explained Steve Alexander, co-chairman of awards. "The projects were good, but could have been even more outstanding with more people involved."

Jim O'Hagan

from page 5

Tech Teasers Answers

1. 11.



2. 12 minutes.

3. One way is:

−10	3	−4	9	2
7	−5	8	1	−11
−6	12	0	−12	6
11	−1	−8	5	−7
−2	−9	4	−3	10

4. The volume of the cube is a^3 while the volume of the pyramid is $a^3/3$. Lo and behold, the volume of the resulting solid is $2a^3/3$.

Now let a plane cut the cube parallel to the base of the pyramid. The cross-sectional area is clearly:

$$a^2-(a-x)^2=2ax-x^2.$$

So that the volume cut off is:

$$\int_0^x(2ax-x^2)dx=ax^2-x^3/3.$$

Since the volume must be half the total volume:

$$ax^2-x^3/3=a^3/3.$$

So $x=a(1-2\sin 10°)$ or $a(a-2\sin 50°)$ or $a(1+2\sin 70°)$

$$=0.6527a \text{ or } -.5321a \text{ or } 2.8794a.$$

The first of these is the only solution which applies, and is thus the answer!

5a. "strength."

b. "facetious."

c. "bookkeeper."

d. They all contain three letters in consecutive alphabetical order.

Travelling by Trolley

Trolleys played a significant role in the development of the Midwest (see Illinois Technograph, December, 1983). But recent developments on rail transport have brought this nearly extinct technology back to the forefront of public transportation.

At the beginning of the 1980's only a few U.S. cities still had operating trolleys. But San Diego and Seattle have recently inaugurated new light-rail systems and Buffalo, Sacramento, Portland, San Jose, Los Angeles, and Detroit are all planning modern light-rail systems for the near future.

Unlike the earlier trolley systems, light transit vehicles would run along exclusive routes, not competing with vehicular traffic and would be partially or wholly automated to avoid excessive staffing. The new systems usually run short trains of one or two cars that allow for more frequent service, smaller and cheaper stations and lighter construction requirements.

One innovation in light-rail transit is the use of induction motors which push the trains along by magnetic induction between the undercarriage and the track. Recent tests by Urban Transportation Development Corporation have shown that the induction motor can drive trains through snow up to a foot deep.

The wheel-to-rail interface may severely limit the future capabilities of high-speed rail systems. Traction, braking, and guidance are all provided by this interface and, if the interface is less than ideal, performance will decline. The use of magnetic systems to support, guide and propel vehicles can eliminate the wheel-rail interface completely.

Magnetic systems, called maglev, eliminate all contact between the vehicle and guideway, and the train can be levitated and guided by magnets, propelled by a linear-induction or synchronous motor. On-board power requirements can be met through the use of a non-contacting linear generator which eliminates another troublesome interface, the third rail.

The SkyValet garment bag provides a convenient means of carrying luggage around airports or bus stations. (photo courtesy of Executive ScanCard Systems)

It's in the Bag

For frequently homesick students who grow tired of lugging home heavy suitcases from Altgeld Hall's bus stop, Executive ScanCard Systems has developed a new garment bag.

Designed to eliminate many of the hassles regularly experienced by executives and other frequent travelers, the SkyValet wardrobe-on-wheels is a soft-sided garment bag that carries clothing flat, without folding. Unlike conventional garment bags however, recessed rubber wheels are built into a lightweight polycarbonate base, allowing the user to wheel the unit quietly and almost effortlessly.

The bag, available in a variety of colors and models, is held upright by a telescoping handle assembly which locks in place to give the entire unit stability. To fold the unit, the user simply presses a button, and the entire handle assembly retracts into a hidden compartment. The bag can then be folded, carried, or stored like conventional garment bags. By pressing a release lever, a parcel carrier, complete with baggage straps, can be released to carry a briefcase or other carry-on luggage. The SkyValet garment bag will even stand by itself, freeing the user's hands for other tasks as the need arises.

Listen Up!

Although hearing aids have progressed extensively from the hearing horns of several decades ago, the hearing impaired still suffer from difficulties such as static feedback, unstable response, and amplification of unwanted noise. All these could be solved, however, with a new device developed by researchers at the University of Wyoming.

The first digital hearing aid has been developed by Auditone Inc. working in joint agreement with the University of Wyoming's electrical engineering department.

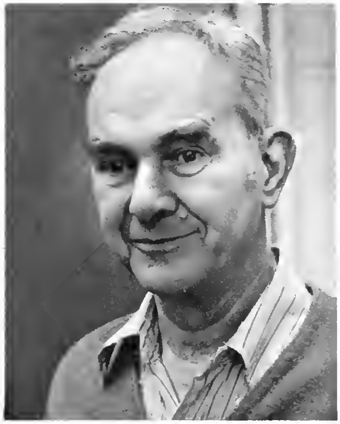
The basis of the computers used in the hearing aid is digital-signal processing (DSP). A central processing unit handles digitized data to acquire designed programmed results. Software programs handle information fed into the computer by instructing the CPU on how to process the input data.

Next, the computer processes signals in two steps. First, the analog input is converted to digital input information. Secondly, the digital signal is manipulated by the CPU. With sound for example, the data may indicate that a sound is very loud. This digital signal is altered using mathematical algorithms, changing the filtering capabilities of the hearing aid to adjust to the loud noise. This use of digital signal processing of analog signals removes the dependency on conventional analog components such as transistors, resistors, capacitors and modulators.

The new digital device improves upon its predecessor through its ability to adapt to changing signals by using a microprocessor, by suppressing noise better, and by responding more quickly to necessary changes.

Jim O'Hagan

Tech Profiles



Franco Preparata came to Illinois in 1965 to expand his research after receiving his Doctor of Engineering degree from the University of Rome, Italy in 1959. In recent years his main research interest has been the analysis and design of computer algorithms. Being an EE and CS faculty member, his interest has led him to the design of VLSI systems and use of VLSI circuits for algorithm execution.

Enjoying the intellectual freedom of doing research and teaching, Preparata sees his responsibility as a University faculty member as a continual strive for excellence. He has developed the Berlekamp-Preparata optimal convolutional codes and the Preparata nonlinear codes in coding theory; published some 70 journal articles, 29 conference papers, and 3 textbooks in the last 21 years; and is a Fellow in the Institute of Electrical and Electronics Engineers.

This summer will take Preparata to China, the Xian Province, to lecture in graduate level courses. His interest in China stems from a personal fascination with archaeology, art, history, and the exotic. In October of 1981, he spent three weeks at the Huazhong Institute of Technology, Wuhan, Hubei Province as a visiting professor.

James Lee

Jay Gooch graduated from the University of Missouri-Columbia in 1943 with a bachelor's degree in electrical engineering. He received his master's degree here at the University in 1951.

Beginning in 1951, Gooch worked as a research engineer at the Coordinated Science Laboratory for twenty years. He then worked for ten years with the University's Aeronomy Radar program where he had an active role in the construction of the five megawatt, 41MHz transmitter.

Since that time, his duties have turned to teaching. Gooch currently teaches EE 245, Electrical Engineering Lab II, and EE 353, Radio Communications Circuits.

Radio communication is an area of special interest to Gooch. He is an active amateur radio operator, and has been the advisor to the Synton Amateur Radio Club for the past four years. While amateur radio is mainly a hobby, he does enjoy the exchange of technical information it can provide. One of his regular radio contacts works with the Radio Telescope in Arecibo, Puerto Rico.

Gooch frequently posts current information about amateur radio and astronomy on the bulletin boards outside of his office in the lower level of the Electrical Engineering Building.

Richard Barber

Samuel Stupp received his bachelor's degree in chemistry from UCLA in 1972. In 1977 he was awarded a Ph.D. in material science and engineering from Northwestern University. After teaching at Northwestern, Stupp came to the University in 1980 as an assistant professor of ceramic engineering and bioengineering.

Here at the University, Stupp has taught polymer and polymer-composite classes, as well as the implant materials class he is presently teaching.

Although Stupp enjoys teaching and interacting with students, a large portion of his time is devoted to research. His research interests range from polymers to bone cements and biodegradable implants for bone growth. Results of his research can be applied to lightweight structural materials, microelectronics, and surgical implants.

Stupp views polymer science as an ever-expanding field. In the future, he expects that polymer technology will expand to include electrical applications, drug-delivery systems, and the medical field.

Phil Messersmith

The Logical Suspect

Soot particle growth as it takes place in wood-burning fireplaces, diesel engines, and industrial furnaces, has been attributed to a complex set of interdependent chemical reactions. A researcher at the General Motors Research Laboratories has demonstrated that the decomposition of a single species is primarily responsible.

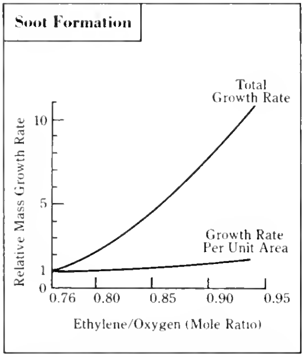
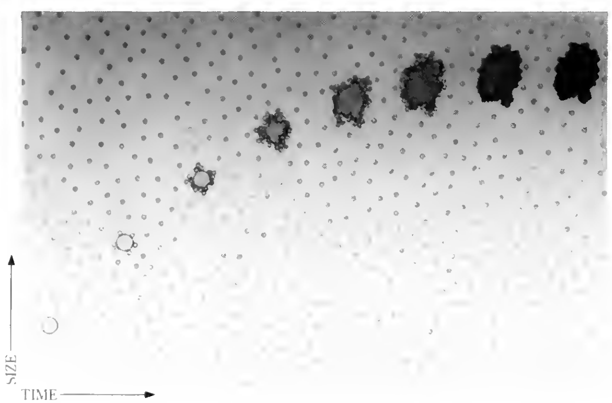


Figure 1: Total growth rate contrasted with growth rate per unit area plotted as a function of ethylene/oxygen mole ratio measured at a given height above the burner face.

Figure 2: Artist's rendition of the surface growth of a single soot particle by the incorporation of acetylene molecules.



SOOT FORMATION may be divided into two stages. Microscopic soot particles are generated in the "inception" stage. They reach full size in the "growth" stage, which accounts for more than 95% of their final mass. Most scientific exploration has concentrated on particle inception which, despite all the effort, remains unexplained. Dr. Stephen J. Harris, a physical chemist at the General Motors Research Laboratories, has reversed traditional priorities. Combining experiment with logic, he has formulated the first quantitative explanation of the growth stage in soot formation.

Dr. Harris arrived at his mechanism through an elaborate process of elimination. To focus on the chemistry of soot growth, he began by eliminating from his investigation the complexities introduced by turbulence and mixing. He limited his research to premixed, ethylene/oxygen, laminar flames with one-dimensional flow.

Previous descriptions in the literature told him that two processes take place simultaneously during growth. Incipient particles collide and coalesce into larger particles, while growing at the same time by incorporating hydrocarbon molecules from the burned gases.

The first process reduces total surface area without changing total mass, while the second, called "surface growth," increases both total surface area and total mass. Hence, the increase in the total mass of soot can be entirely attributed to surface growth.

Dr. Harris set out to identify the hydrocarbon molecules—or "growth species"—responsible for surface growth. Increasing by increments the richness of the flame, he made the key discovery that although the total mass growth rate (gm/sec) increases strongly when the ratio of ethylene to oxygen is increased, the mass growth rate per unit surface area (gm/cm^2/sec) increases only slightly (see Figure 1). Thus, the controlling variable for how much soot is formed is not the concentration of growth species, but the surface area available for growth.

This finding led him to conclude that richer flames produce more total soot because they generate more particles in the inception stage. More incipient particles offer greater initial surface area for the incorporation of hydrocarbons.

Since the growth rate per unit area must depend on growth species concentration, this concentration must be similar from flame to flame. Dr. Harris went on to reason that there must either be enough growth species at the outset to account for the total soot growth in the richest flame, or the species must be rapidly formed within the flame from another hydrocarbon present in high enough concentration.

HE NARROWED his search to the four most abundant classes of hydrocarbons found in flames: acetylene, polyacetylenes, polycyclic aromatic hydrocarbons (PAH), and methane. Methane can be eliminated, because its concentration does not decrease as soot is produced. There is not enough PAH to account for soot formation in any flame. Neither of these two hydrocarbons can be readily formed from the other major species present. That left only acetylene and the polyacetylenes.

Acetylene contains enough hydrogen to account for the hydrogen content of soot measured in the early stages of growth. But among the polyacetylenes, only diacetylene could possibly supply enough hydrogen. That left acetylene and diacetylene.

There is more than enough acetylene to account for the mass of soot produced. There is not enough diacetylene, and while diacetylene can be formed from the abundant supply of acetylene, the reported rate of conversion is too slow for diacetylene to play a significant role. That left only acetylene.

Dr. Harris verified that acetylene is the growth species by determining that the slight increase in growth rate per unit area is proportional to the increase in acetylene concentration (see Figure 1). He also found that the rate constant he measured was in agreement with the reported rate constant for the decomposition of acetylene on carbon. These findings confirmed his hypothesis that soot particles grow in flames by the incorporation and subsequent decomposition of acetylene.

"Now that we know how soot grows," says Dr. Harris, "we can examine how it begins with greater understanding. Then, perhaps our knowledge will be complete enough to suggest better ways to reduce soot."

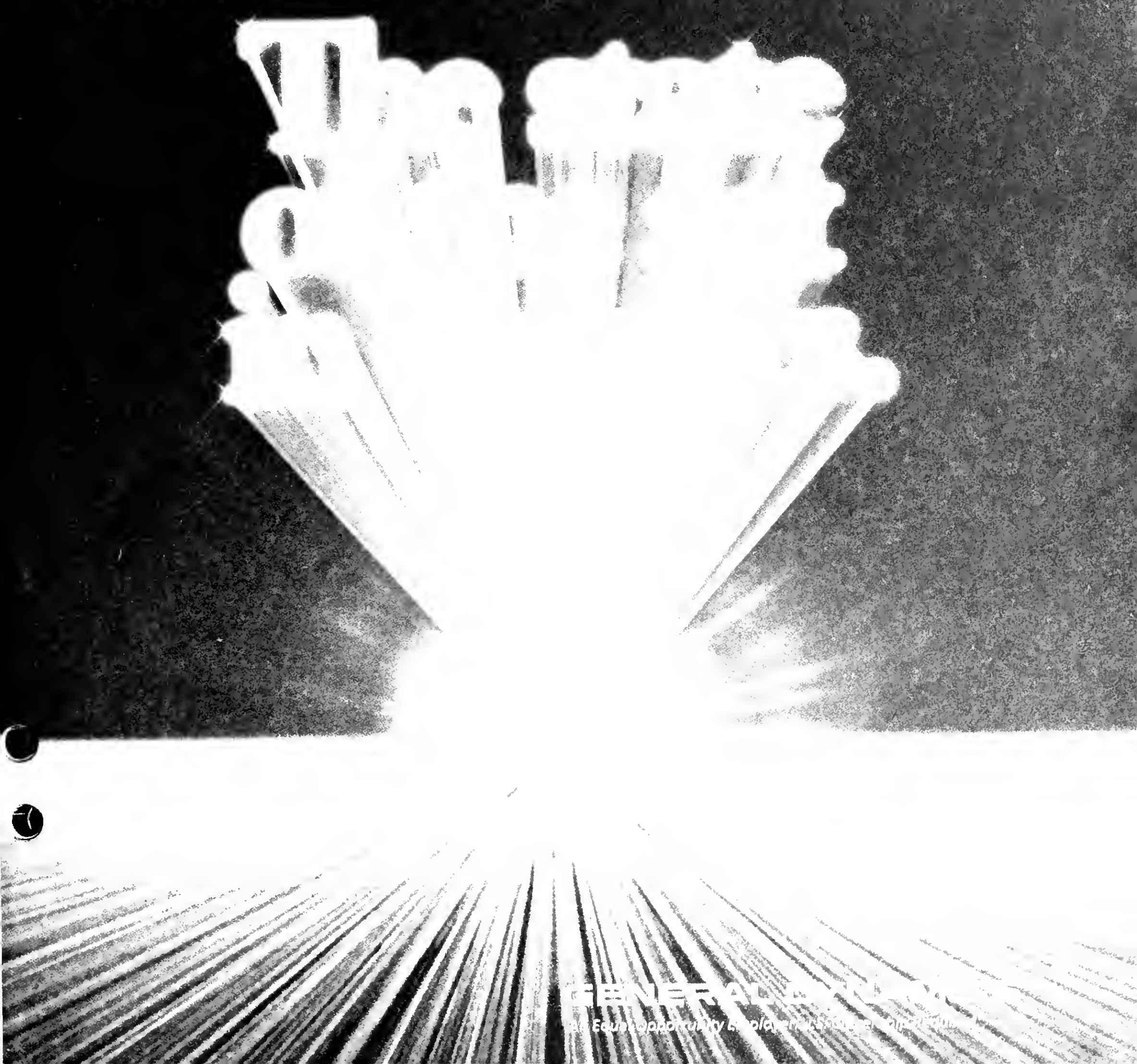
THE MAN BEHIND THE WORK

Dr. Stephen J. Harris is a Staff Research Chemist at the General Motors Research Laboratories. He is a member of the Physical Chemistry Department.

Dr. Harris graduated from UCLA in 1971. He received his Master's and Ph.D. degrees in physical chemistry from Harvard University. His doctoral thesis concerned Van der Waals forces between molecules. Following his Ph.D. in 1975, a Miller Institute Fellowship brought him back to the University of California, this time at Berkeley, where he spent two years studying laser-induced chemistry. He joined General Motors in 1977.

Dr. Harris conducted his investigation into soot particle growth with the aid of Senior Science Assistant Anita Weiner. His research interests at GM also include the use of laser diagnostic techniques in combustion analysis, with special emphasis on intracavity spectroscopy.

Energy From Animals



Illinois

Technograph

October 1984 Volume 100, Issue 1

Celebrating 100 years of publication

6 **Network Teleprophesying** *Langdon Alger*
Telecommunication networks have recently soared in importance and an understanding of their simplicity makes the reasons apparent.

8 **Producing Energy From Wastes** *Jim O'Hagan*
Cliff Fedler's University research may lead toward making Illinois farms energy self-sufficient.

12 **Engineering Family Album** *Mary McDowell*
A description of the College's many and varied extracurricular activies which make student life exciting for University engineering students.

14 **Atomic Weaponry** *Kirt Nakagawa*
The development of nuclear weapons over the last decade has raised many moral and political questions, but the technology behind the weapons has changed greatly over the last 39 years.

Departments
Letters 4, Tech Teasers 4, Editorial 5, Forum 5, Technovisions 10, Technotes 15, Technovations 17, Techprofiles 19

On the cover: Anaerobic digestion of swine waste leads to the production of biogas, a viable energy alternative. (photo illustration by Dave Colburn and Kris Ludington. Pig courtesy of Bill Ruoff, Animal Genetics Laboratory)

Illinois Technograph (USPS 258-760) Vol. 100 No. 1 October 1984. *Illinois Technograph* is published five times during the academic year at the University of Illinois at Urbana-Champaign. Published by Illini Media Co., 620 East John St., Champaign, Illinois, 61820. Editorial and Business offices of the *Illinois Technograph*: Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3558. Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001, 221 N. LaSalle Street, Chicago, Il., 60601. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879. *Illinois Technograph* is a member of Engineering College Magazines Associated.

Bring Out Your Best At
It took pride, talent and a commitment to excel in all you do, to take you where you are today. That's why you're determined to find a career that brings out your best ... a career that offers challenge and room for growth both personally and professionally.
At Anheuser-Busch, we've been bringing out the best in talented people for over one hundred years, with stimulating projects and a commitment to quality that inspires superior achievement.
You can make the most of your talents in one of these positions.
CORPORATE ENGINEERING
B.S.M.E.'s — you will have the opportunity to advance in such diverse fields as materials handling, equipment layout, piping system development, steam generation, compressed air systems, ventilation, heating and air conditioning and high-speed bottle and can packaging.
B.S.E.E.'s — you will be involved in such areas as electrical machine design and application, power distribution, sub-station layout along with industrial and commercial lighting, electrical control circuits and systems control.
Our Corporate Engineering Department offers BSEE's and BSME's the opportunity to become involved in an environment that is project-oriented and presents the challenge of taking the project from conception through completion.
Find out how you can bring out your best at Anheuser-Busch by speaking with our recruiters when they come to your campus.
For more information and sign-up please contact your placement office.
...Anheuser-Busch!
ANHEUSER-BUSCH COMPANIES
St. Louis, Missouri 63118
An Equal Opportunity Employer M/F

Letters

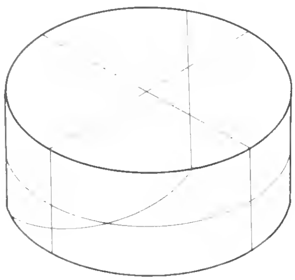
A call for pizza-cutting pizazz

To the editor,

Regarding the first Tech Teaser of April 1984, I've seen thin-crust pizzas before, but your pie takes the cake: it's two-dimensional! I offer some cutting remarks: consider cutting between the crust and its covering. Continue with three more carefully contrived cuts. Contemptible! But I count 14.

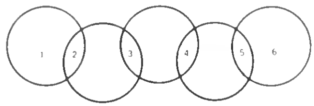
Dave Fathauer
(A crusty old codger)

Editor's note: Actually, one should order deep-dish pizza for an even more interesting answer. Then with only four straight cuts it can be divided into a total of fifteen pieces, as seen below:



Tech Teasers

1. The *Technograph* is proud to belatedly present the official teaser of the 1984 Los Angeles Summer Olympic Games.



In the above configuration, how many ways can the digits be arranged so that:

a) No two digits in one circle will be in one circle

b) No three digits in two linked circles will be in two linked circles

c) No four digits in three linked circles will be in three linked circles

d) No five digits in four linked circles will be in four linked circles.

2. The muscles of the human body produce sound waves. At what frequency is this sound?

3. When Noah was letting the animals off of the ark, he instructed them to go forth and multiply. All of the creatures willingly agreed until he got to the snakes.

"We're adders," they protested. "We can't multiply."

There was a forest nearby. Noah instructed them to cut down some trees and make a table from them. How would this solve their problem?

4. A space shuttle of the far distant future makes stops at eight lunar resorts. How many different tickets must be printed up to to take care of all one way journeys, including any stop-overs that might be requested?

5. Every engineer in a certain group belongs to at least one of these categories: those who always wear their calculators on their belts, those who always wear pocket protectors, and those whose pants are invariably three inches too short.

In the group there are 10 engineers who are never parted from their calculators, 12 who never have to worry about pen marks on their pockets, and 13 who wear floods. Now, three engineers carry calculators and wear pocket protectors, four wear short pants and pocket protectors, five wear their calculators on short pants, and two true squids are guilty of all three offenses. How many non-fashion-conscious engineers are there in all?

6. Muscle fiber has been classified as being either fast twitch or slow twitch. In a chicken, what kind of meat is slow twitch and what kind is fast twitch?

7. The number 14 (2×7) is relatively prime to 45 ($3 \times 3 \times 5$) because it is less than 45 and shares no common factors with it. How many numbers are relatively prime to:

a) The number of years for which the *Technograph* has been in existence?

b) The number $2^5 \times 3^4 \times 5^7 \times 7^8$?

answers on page 20

Illinois *Technograph* Statement of Ownership

Editor-in-Chief of the Illinois *Technograph* is Langdon Alger, 620 E. John St., Champaign, IL 61820. General Manager of the Illini Media Company is E. Mayer Maloney, Jr., 704 Harmon, Urbana, Il 61801. Business Manager of the Illinois *Technograph* is Mary Kay Flick, 620 E. John St., Champaign, Il 61820.

The Illini Media Company is a not-for-profit organization established in the State of Illinois in 1911.

Average number of copies of each issue during the preceding 12 months 4600. Annual subscription rate $6.25. Paid circulation through dealers and carriers none. Average mail subscriptions preceding 12 months 1077. Free distribution preceding 12 months 3423. No copies distributed to news agents. Total distribution preceding 12 months 4500. Office copies preceding 12 months 100. Total average distribution 4600. No paid circulation through dealers or carriers. Actual April mail subscription 1073. Free distribution at the Engineering campus of the University of Illinois nearest to filing date 3427. Total distribution nearest to filing date 4600. Actual number of office copies nearest to filing date 100. I certify that the statements made above by me are correct and complete. E. Mayer Maloney, Jr., Publisher

Editorial Forum

Functional Observationalism

It was one of those days that made you want to sit down on the sidewalk, stare out into the horizon, and contemplate existence. It was during one of those nasty periods when you are so busy with classes, problem sets, and exams that one small accomplishment allows you to feel the internal warmth of satisfaction. It was last year, and just the right mixture of these feelings made me look around while walking home.

I started to embarass myself. I found numerous inscriptions, satellite dishes, and sculptures on buildings; every one of them camouflaged from me through their ingenious placement on the roofs. I found details in steps that some architect probably spent hours designing, only to brush by my feet half a dozen times a day. I saw trees pass by that I had never seen before. I was observing.

Considering the fact that people have been committing the act of noticing since time began, and that a lot of them have been able to formulate useful philosophies and formulas from their observations, I suppose my observationalism was no big deal. But it seemed symbolic to me. Here I am with some 4800 other engineers, all of whom are trying to get an education, but few of us are going about it correctly.

So what is an education? It is the expansion of one's knowledge, mind, and character; it is unique for each individual. A training program, on the other hand, simply programs you for some particular task. The latter is very easy to receive when one is enrolled in an engineering curriculum as intense as the ones down here. The former is something that needs some special work to obtain.

Time must be taken to think about, discuss, and perhaps read about philosophies and concepts that aren't necessarily related to one's engineering life. Time is needed to observe others, to notice one's surroundings, and look into your own psyche. There is quite a bit more to life than the grades, the degree, the one-fourtieth of a million dollars a year average salary, and the future spouse and family.

The engineers of the 1950's sought educations, and they were rewarded by society. People looked up to the technical students of America back then as heroes—the men and women who were going to bring a better way of life through their work. Today, engineers and scientists are looked at and conceived of as being hard-core, single-causal individuals. A big part of this comes from the fact that today's technical student is more concerned with finishing the training program than obtaining an education.

It is not all the student's fault, however. Technology is changing faster this second than it ever has in the past, and that kind of dynamic activity is difficult to deal with. Not to mention the fact that every year the new set of engineers down here has even higher entrance marks than the class before it. With both of these facts licking the engineer's heels, you can't blame them too much for overlooking the educational aspects of their college lives.

Nonetheless, there is no excuse for passing up chances for personal growth. You do not only hurt yourself by not draining life of its opportunities, but you indirectly hurt your peers and the rest of society as well. When it comes time to go out into the real world, and you don't have an education and the capability of observing your present situation, chances are that you won't understand everyone's needs—or your own. Your work and your future will reflect this oversight.

Illinois Technograph **invites letters in response to its articles and editorials, or any other items of interest to our readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.**

An Engineer's Responsibility

Another national election is near—less than a month away. It may seem like just another election, but it is probably the first one held since you became a student at the University. In that time, you have gained more independence, responsibilities, privileges, and been exposed to more ideas and people than you had ever contemplated. These influences have made you a much different person than you once were. Different things concern you and effect your life now.

As an engineering student, you probably realize that being an engineer means more than just having skills in math and scientific application. I assert that it is a way of thinking, and even a way of life. An engineer's thinking is directed toward helping create a more efficient and productive society. Since the engineer's purpose is far broader than merely using his analytical skills to mold society, he is also concerned with other questions and issues, and ways of addressing them.

In the simple matter of voting in the November election, an engineer fulfills his change by choosing the candidate who is most likely to direct society toward becoming more productive, secure, and stable. Candidates for offices other than President are equally as important as candidates for President. Our federal system of checks and balances insures that different branches of government each hold important components of the decision-making power.

You can be part of the influence that effects the decisions of our leaders. You can and should vote, serve in public service positions, and make your leaders aware of your thoughts and ideas. Remember, your job has the same end goal as our government leaders—to direct our energies and resources toward a better society. Let your leaders know that we are all partners in fulfilling this duty.

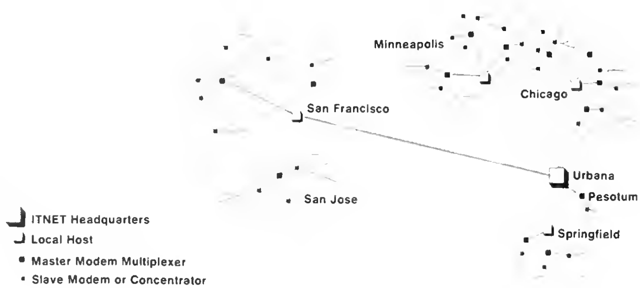
Joseph G. Lehman
President, Engineering Council

Langdon Alger

Network Teleprophesying

A plan for the implementation of a hypothetical telecommunications network leaves plenty of room for fiction. However, the linking of distant cities through telephone lines is not even close to being a fantasy.

Layout of the Distributed Hierarchical Network, ITNET



Source: Langdon Alger

There is a large probability that at this moment your name, as well as some information about you, is running across the country on telephone lines. This is not necessarily true because of your immense popularity, but because telecommunication network usage is quite high, and constantly growing.

Between 1840 and the late 1960's, our nation's telecommunications capacity grew linearly. Since the early 70's, this capacity has grown in an exponential manner. Today, banks use telecommunication networks to offer services such as the instant bank tellers that are popping up everywhere. Airlines, rental and travel agencies, and large corporations would be crippled without telecommunications. Advanced medicine is reaching remote areas and impoverished communities through networks.

Suppose the *Illinois Technograph*, in keeping with this general societal trend, decided to start its own telecommunications network, called the *Illinois Technograph* Network (ITNET). Suppose also that we can watch the growth of this network as time goes on.

In the beginning, the *Technograph* decides to set up its own word processing system. Each staff member receives a terminal that connects up to the host, or main computer. Instead of spending astronomical amounts of money to run coaxial cables under the streets of Champaign-Urbana to connect each user terminal to the host, the editors of the *Technograph* decide to use telephone lines for access. The telecommunications network is born.

Copper telephone wires don't change much over time, but the hardware at each end of a line is constantly undergoing evolutions. Questions and choices arise. The editors have better things to do than set up this system, so they wisely sign up a couple of engineers majoring in communications to figure the whole thing out.

The network coordinators decide to start with a star network, whereby each terminal has its own separate dial-up telephone line to access the host. The other choice is a multi-drop configuration, where one line starts at the host, and connects serially to every one of the terminals to form a "ring network." The problem with this setup is that the terminals aren't used all the time, so the host would constantly be polling every terminal in the system, and receiving null transmissions from most of them. This is a waste of money, and it slows the response time of the entire system.

The next step is made within a year. The ITNET applications have grown, and research files, a past story file, and numerous other applications are currently accessible. Requests from Rantoul and Pesotum to use the *Technograph* system arrive. Since these areas are much farther away from the host, modems become a necessity to modulate the digital computer transmissions into analog equivalents that the telephone lines can handle without loss of readability. The coordinators set up every user with a modem.

To save cost, two changes are made, one being the upgrading of the user terminals to "intelligent" terminals. Before the upgrade, the information being received or sent was relayed one page at a time, whereas now the terminals have memory and screen editing capabilities. A user can receive a block of data, do with it whatever is necessary, and only send new or altered information back to the host. The second change is adding a concentrator to the network.

This concentrator squeezes information from all the terminals onto one line from the host. The host-to-concentrator phone line is full-duplex (or duplex), meaning the host can transmit and receive data simultaneously on the same line. The individual lines to each terminal are half-duplex lines; they can only transmit or receive in one direction at a time. The concentrator is buffered, due to the fact that both the full-duplex and half-duplex lines are run at the same speed. If more than one terminal tries to access the host at the same time, the concentrator must store one terminal's data while it passes the other's onto the duplex line. For now this system is perfectly usable.

After another block of time, ITNET grows some more. It starts to spread to far away areas like Chicago, Springfield, and other larger cities. The concentrator is beginning to lose its efficiency; during peak times too much data is transmitted to or from the host, and the memory in the concentrator is too small to handle it all. Users of the system begin to complain about dial-up problems, because the access number is often busy. The coordinators find a solution through a hybrid network with dedicated digital lines.

The private, or dedicated, line becomes almost necessitous with increased distance from the host, because switched lines are so noisy. Private lines are always connected between two fixed points, and only become cost effective with heavy usage. The dedicated line can be conditioned, unlike the switched line, which cleans up the signals being received at either end. Digital carriers are used because the transmissions on these lines are intended only for computer-to-computer connections, and regenerative repeaters make the transmissions very clean.

Hybrid networks utilize several different kinds of telecommunication architecture, and the *Technograph* network coordinators decide to install an expanded concentrator with multi-drop lines. This setup requires a much faster duplex line between the concentrator and the host, as there is much more information being sent to the mainframe. The multi-drop configuration means that each line running from the concentrator out to the users now runs data to more than one terminal.

Pesotum has five users of the network, so each terminal has a regular speed half-duplex line to a Pesotum base station. At this station, all five lines are connected to one line controller. This device decides which terminal gets to access the phone line to the host. The host line is full duplex running at the same speed as each of the 5 terminal lines, and it connects to the concentrator in Urbana. Every one of the duplex lines, including the Pesotum one and several running to Chicago, are concentrated into one high-speed line at the host.

Eventually, the news of the capabilities and usefulness of ITNET has spread, and all kinds of places want to tie into it. Graphics start finding their way into the system, and since such high-resolution information tends to require a wide spread of frequencies to accurately transmit their information, the line bandwidths must increase. Luckily, the vendor of the lines has already been using fiber optic cables, which have huge bandwidths.

To handle the traffic, the network coordinators implement a time-division multiplexing system. Multiplexers, or mux's, convert one line into several by sampling the slower lines very quickly, and sending each sample of information down the fast line. The only difference from the previous setup is that the concentrator is replaced by a high-speed multiplexer, and the line controllers in each city are either left alone or replaced by smaller multiplexers.

More cities, like Minneapolis, Houston, decide to tie into the system. The host computer has now completely outgrown the office in 302 Engineering Hall, so it is expanded and moved to a building on Green Street. The coordinators are flooded with tie-in requests, and decide that within a year the host's single high speed line running to the main mux will have too small of a capacity.

Always looking for solutions, the engineers initiate a hierarchical network. This is almost the height of modernization. Now there are many high-speed lines running from the mainframe host. Each line is connected to a master modem, which runs high speed, suppose 9600 bits per second (bps), to each major city that has access to the system. In these cities, there are slave modems which drop transmissions down to four 2400 bps lines. Off each of these lines the individual terminals can be run via smaller multiplexers or concentrators. Thus one line running to Chicago can be dropped down to many locations in the city, suburbs, and other neighborhoods. The progressive dropping in speed and volume from the host down to the users is the reason for calling this a hierarchical network.

So what if a San Francisco user wants to send a notice to a location in San Jose? The two cities are so close, it seems silly to run a message all the way back to Urbana, and route it through the host and back over to California again. Thus a distributed system is born.

The distributed system is not unlike a heirarchial system, except each node connecting to the host is now also a host. That is, the main frame host on Green St. connects via high-speed lines to several giant cities, like Chicago and San Francisco. At these sites, another computer exists. This computer, the secondary host, breaks its master host line into nodes, then those nodes multiplex into individual terminal lines or controller lines. Thus at each city is a host, so transmissions need not be routed all the way back to the mainframe whenever information is needed.

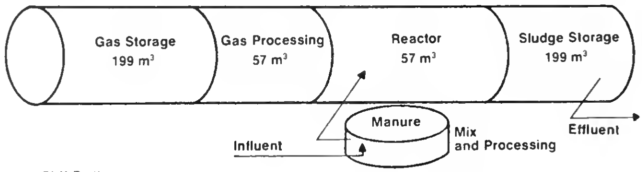
The telecommunications science is one that is purely dynamic. With the changing technology, ITNET follows with constant upgrades. Before long, other countries want to tie in to the system, and submarine cables and satellite transmissions become a necessity. These mediums of transmission are notoriously slow and noisy, but the *Technograph* network coordinators are confident that these problems will be combatted soon with more changes. ITNET's future looks bright, as telecommunications rises as one of the most major and important fields to society's wellbeing. ■

Jim O'Hagan

Producing Energy from Wastes

University research student Cliff Fedler is examining the possibilities for converting animal wastes to energy. This research, successfully applied on the University's South farms, is a vital step toward making America's farmers totally self-sufficient.

The University of Illinois Anaerobic Digester



Source: Cliff Fedler

Recent economic trends, including rising fuel prices, falling demand for American commodities, and the worldwide recession have been particularly hard felt on American farms. But research now being done at the University could allow farmers to lower their energy prices and increase their food production at a minimal cost by producing fuel from animal wastes.

This method, now being studied by Agricultural Engineering Professor Donald L. Day and researched by Cliff Fedler, concentrates on breaking down animal wastes into methane gas which can be used as fuel. Although similar processes have been used in municipal systems for several years, the large capital costs, handling problems, and chemical differences found on the farm have produced difficulties in adapting this technology. "We know there is energy in wastes, and we try to take advantage of it," explained Fedler, a graduate student in his fourth year at the University.

Fedler's research is currently financed by the Illinois Department of Energy and Natural Resources and the Illinois Agricultural Experimant Station, as well as the Departments of Agricultrual Engineering and Animal Science for the University in order to develop a self-sufficient farm of which the anaerobic digester would be an integral part.

Such a digester, now operating on the University's Swine Research Farm, is composed of a large cylindrical steel tank divided into 4 compartments by 12-inch thick concrete walls. Polyurethane insulation and a rubber lining coat the tank to guard against corrosion and heat loss. Finally, the system is buried in the ground to provide additional insulation.

Before the manure can be used, it must first be collected from the barn. "I feel the best way is a scraper system," explained Fedler. "A large scraper is used to scrape the wastes to a central sump from which it is pumped to the reactor. Running with 8 to 10 percent solids is a good loading rate." On some farms a fluid system is used to wash out the barns, but much of the volatile material will dissolve in water, thus reducing the yield of methane. "They've pretty much eliminated pumping problems with new equipment," explained Fedler.

In this system, sludge is pumped from the hog barn to a processing tank after passing through a classifier to remove grit and scum. The manure is diluted to 10 percent solids, then heated to operation temperatures with a heat exchanger because the digester must be kept warm to allow bacteria to thrive. These anaerobic bacteria then live off the wastes producing a mixture of methane gas and carbon dioxide, called biogas, as a by-product.

Upon reaching the correct temperature, the slurry is agitated and transferred into the reactor tank where it is digested by the bacteria to give off biogas. "We don't let it sit, we do mix it," explained Fedler. "If you don't agitate it, the solid settles. By keeping it suspended it gives the bacteria more access to the wastes." The amount of volatile material removed can be increased in this way, while the solid waste remaining can be decreased by 50 percent. "It's a big misconception that all the wastes you put in are changed to fuel. Actually, the volume of the solids is essentially the same," he explained. Thus, any reduction in the amount of solid remaining is a significant benefit.

Biogas given off in the reactor is drawn off, then circulated back through the tanks to provide agitaiton. After the slurry has been fermented for about 2 weeks, it is transferred to a sludge storage tank where it is agitated further, but not heated. This allows for maximum production of methane. Finally, the processed sludge is removed, and can be used as fertilizer. "The waste you put into and the waste you take out has essentially the same fertilizer potential," Fedler said.

Meanwhile, the biogas is collected at the top of the reactor and sludge storage container and sent through a processing system where a scrubber system removes the carbon-dioxide and hydrogen sulfide. By the time it reaches the storage tanks, the gas is 95 percent pure methane and can be used to operate gas engines.

Although the process itself is straightforward, certain difficulties exist as well. Animal wastes are corrosive to metal, meaning that all containers must be glass-lined or plastic. Less, however, is known about the effect which antibiotics have on the system, and this is where Fedler has chosen to direct his research.

Fedler originally became involved with the method as a junior at Iowa State University, where he earned a B.S. degree in structures and environment, as well as two Masters degrees. He now spends 7 days a week studying problems with the system, while also taking classes dealing with related areas such as hydrology or water and soil management.

The difficulty with antibiotics is that they can still be detected in the manure from the animals, and result in hindering methane production because of their adverse effects on the bacteria. "When I was at Iowa State, I'd be running an experiment, everything would be going fine, then bang! Methane production would just stop," Fedler recalled.

Realizing the field was wide open for research, Fedler began studying the effect of antibiotics and found it held a major impact on methane production. "On a typical farm, if all the animals were fed just one drug, I figure the level coming out in the wastes would be inhibitory," said Fedler. Thus, it is a severe difficulty on farms where antibiotics are vital to keeping animals free from disease. "Farmers today feed their animals anti-biotics every day," he explained. "So I mainly work on antibiotics and see what effects they have on anaerobic digestion."

Fedler's reseach at the Agricultural Engineering Building is carefully monitored at steady state conditions to remove variables such as temperature and flow rates from the analysis. Because the effects of such variables are not yet understood, this makes it possible to obtain reliable data, but creates handling difficulties as well. Four reactors are used to prepare the wastes for analysis. "In order to run the test at a steady state condition, I need to bring the material up to the steady state temperature," he explained. "Two reactors are used to feed the system, while the other two are getting ready for the next experiment." Temperature control is also achieved by running the entire experiment in a constant 35 degrees Celsius room. "It's critical that temperature be constant because in building the system there are so many unanswered questions," said Fedler. "This eliminates temperature fluctuations as a problem." A constant percentage loading rate for all the digesters is also used. "We have a completely enclosed tank where we draw off the gas, put it through a scrubber, then put it into a storage tank," Fedler added. The tank is enclosed because even a 10 percent mix of methane in air is highly explosive.

Although current research is important to the long-term prospects of anaerobic digestion, the outlook is already quite positive. "The University system stores two days' producton," said Fedler. "The methane is used to run a generator for electricity during peak use times. With two days production, we can use the extra day as a buffer or a standby system should the power be cut off." Because of the low efficiency of electric engines however, the system is suited even better to dairy systems where hot water is needed and can be produced directly from the methane flame. Presently 10 hours per day of electrical needs on the South farms are met with waste-produced energy, and a non-research farm using less electricity could expect to do even better. "On a typical farm very little electricity is needed. This system could be used to supply electricity for other parts of the farm such as the house," Fedler said.

"There is definitely great interest by farmers in utilizing a product into fuel and fertilizer while achieving pollution control," said Day. In fact, several large farms are now experimenting with systems of their own. The University digestor has especially been found to be not only productive but also environmentally sound. "We went through the EPA for our gas processing unit which the EPA says has to be regulated, but after a good amount of work, they've exempted us," said Fedler.

Like any equipment, the anaerobic digester must be manageable before it is marketed. Explained Fedler, "It's not a difficult system, but you have to have a knowledge of what to look for to detect problems," as well as knowing how to correct them. "You don't need expensive equipment to detect problems, but you do have to monitor it," he explained. "If a farmer wants to reduce the number of animals or increase the number of animals on his farm, he must also know what to do to the energy system," he added.

The major obstacle is still economic however. "It requires expensive equipment," said Day. "It's not so well known when this will be widely accepted." As the technology improves, costs should fall. Said Fedler, "I'd like to show a 10 year payback period, or less. . . perhaps as low as 2 to 2 ½ years." Another solution would involve cooperatives. "A complete system requires about $150,000 in capital costs," said Fedler. "You can't convince one farmer to put out that kind of capital. I'd like to see community digesters, where you'd locate a digester on a central farm, pump from one or two farms, and haul wastes from the others."

For now, the system is another step toward a completely self-sufficient farm. "The potential is enormous. I look for a totally closed system where you use gas to produce electricity, use wastes for fertilizer, use carbon dioxide in greenhouses," said Fedler. "I think people should look at that as a method to make a farm energy self-sufficient." ■

Air Rendezvous

Aerial acrobatics, vintage aircraft, military aircraft, and a special performance by the Air Force Thunderbirds were among the events featured at the second annual Springfield Air Rendezvous. Held in September at the Capital Airport in Springfield, Illinois, the event is a charity fund raiser which attracts thousands of visitors from the state and midwest.

Below: The Thunderbirds fly by the crowd in their sleek F-16's. Right: Duane Cole, stunt pilot and wing-walker, hangs from a monoplane in an aerial stunt. Top right: Visitors to the show tour through a C5-A, the largest production jet transport. Below right: Describing the interior of a C-130A transport is Wayne Hegele, one of the crew members. *(photos by Kris Ludington)*


MILITARY AIRLIFT COMMAN

Mary McDowell

Engineering Family Album

Classes and homework are important parts of an engineering education, but they're not the whole picture. Meeting people in the same major, learning about current research, and making contacts are valuable experiences for the future. The College of Engineering sponsors a number of organizations and professional societies that help students meet these goals.

American Academy of Mechanics (AAM)

Persons interested in all aspects of engineering mechanics will find this club beneficial. In addition to learning about their future profession by hearing speakers at the monthly meetings, club members also participate in a tutoring service. Interested students should contact Joel Vandon or Gary Fenn at 332-1863.

American Institute of Aeronautic and Astronautical Engineering (AIAA)

This group hosts several events throughout the year to highlight various aspects of aero/astro engineering. Guest speakers from industry are featured at their meetings. They also participate in a paper airplane contest and the Bendix Design Contest. Planning for EOH, social events, and plant trips round out their schedule. Interested people should contact Tom Penn in 105 Transportation.

American Institute of Chemical Engineers (AIChE)

AIChE provides opportunities for learning and experience in chemical engineering. Monthly meetings include faculty and industrial speakers, field trips to places like General Electric and Monsanto, and numerous social activities. This makes the group a major help as well as a good time for chemical engineering students. For further details, contact Ted Mole at 333-1587 or stop by 217 Roger Adams Lab.

American Institue of Industrial Engineers (AIIE)

AIIE is a society that works to increase the awareness of industrial engineering students in their chosen field. They sponsor monthly meetings and plant trips and were also the creators of the first place society project at last year's EOH. Students in IE can contact Jim McMahon at 384-4438 for further details.

American Nuclear Society (ANS)

Besides acquainting its members with professional news, the ANS also works to generate public support for nuclear energy. Other activites include attending symposiums in Chicago and touring the power plant at Clinton. Anyone interested in nuclear power should contact Craig Wepprecht at 333-2562 or leave a message in 214 Nuclear Engineering Lab.

American Society of Agriculture Engineers (ASAE)

Through monthly meetings, picnics, faculty-student get-togethers, various fund raisers and participation in events like EOH and the Farm Progress Show, this organizaton strives to inform students of opportuinities in agricultural engineering. Karen Jordan at 217 Agriculture Engineering Building may be contacted for membership information.

American Society of Civil Engineers (ASCE)

Concrete canoe races, picnics, pig roasts, fireside chats with professors, pizza parties, and industrial speakers are a few of the varied activites sponsored by the ASCE to promote involvement and awareness. Contact Laura McGovern at 367-0187 to stop by 308 Engineering Hall for more details.

Association of Computing Machinery (ACM)

An active group of computer enthusiasts, the ACM has speakers to discuss current trends in computer technology at their montly meetings. They take part in picnics, happy hours, and a hay ride to promote student involvement. They are also the sponsors of a programming contest for high school students and are award winning EOH participants. Go to 213 Woodshop or call 333-1622 to get membership information.

Associated General Contractors (AGC)

The AGC can provide an excellent background for those seeking to learn about construction and construction related topics. A student chapter of a large national organization, the AGS plans field trips, presentations on construction research, and a construction service project. Tony Gooden may be contacted at 332-1717 to answer any questions.

The Association of Minority Students in Engineering (AMSiE)

The offical purpose of AMSiE is "to promote and develop activites and programs that meet the academic and professional needs of minority engineering students at the University of Illinois." To this end, the group sponsors fortnightly meetings, a resume book, an EOH project, a bowling team, a Bid-whist tournament and a newsletter. Interested students should contact Raymond Hightower at 333-3558 or stop by the office in 302 Engineering Hall.

Bioengineering Society (BS)

Open to students in both the colleges of LAS and engineering, this society presents speakers from all aspects of bioengineering to inform members of their options in this relatively new field. In addition to social functions, the group's ongoing project has been the modificaton of laboratory equipment for use by blind students. Call Loralie Ma at 359-6349 or come by 164 MEB for more information.

Engineering Council

Engineering Council, the student government for the College and a liason between the deans' office, faculty, and students, sponsors over a dozen major activites including Open House, Speakers' Bureau, Graduate Schoool Conference, and Freshman Committee. All professional and honorary societies are members of council and send their representatives to its meetings. General meetings, held monthly, are open to all students. Involvement is possible by representing a society or by working on a council committee.

Call 333-3558 or stop by 300 Engineering Hall for more information. Ask for Cindy Kirts for information about the Engineering Speakers Bureau (ESB), or Karen Swabeck at 332-2667 about the Student Introduction to Engineering (SITE). If interested in the Engineering Open House Central Committee, especially the Coordinated Project, Posters and Programs, Internal and External Publicity, and Contest committees, then contact Chris Elsbernd.

Institute of Electrical and Electronics Engineers (IEEE)

The largest of the societies, the IEEE sponsors a wealth of activities to introduce students in electrical engineering, computer engineering and computer science to their professions. They have field trips and happy hours as well monthly meetings featuring speakers from major corporations. They host the EE Honors Night, and they also support a computer interest group. Potential members should contact Mike Gold at 333-7401 or in room 247 EE.

Institute of Transportation Engineers (ITE)

People with interests in any aspect of transportation will find their niche in this group. Their monthly meetings have local speakers presenting pertinent transportation issues. They also sponsor field trips to such places as O'Hare Airport and the C.T.A. Contact Nick Vlahos in 308 EH or call 333-0884 for more details.

Internatonal Society for Hybrid Micro Electronics (ISHEM)

Formed for the purpose of sharing knowledge on hybrid circuits, ISHEM is open to any interested students. Speakers, field trips, picnics and intramural teams are some of the events ISHEM sponsors throughout the year. Contact Mike Fitzsimmons at 328-2580 for further details.

Student Branch of the American Ceramic Society (SBACS)

SBACS is a society for ceramic engineers which sponsors monthly meetings with speakers from industry and academia. They are also responsible for the publicaton of a yearbook, the Illini Ceramist. Their next meeting will be held October 18 at 7:30 in 218 Ceramics. If interested in joining the group that won the best society award at EOH last year, contact Karen Paulsen in 204 Ceramics.

Society of Cooperative Engineers (COOPS)

The Coop society works to inform students of the benefits of working in industry while attending school and to provide support for coop students. It hosts information nights, a mock interview session, and picnics. The society is also the publisher of the "Coop Survival Maunual." Interested students should call Upal Sengupta at 337-5924 or Debbie Bluemling in the Coop Office on the first floor of Engineering Hall at 333-1960.

Society of Women Engineers (SWE)

The Society of Women Engineers seeks to promote and encourage women in technical fields. They offer corporate speakers and financial planning seminars, and they put out a resume book. Call Cheryl Dudas at 333-3558 in 302 Engineering Hall for more details.

SYNTON

The amateur radio club, SYNTON, is open to all persons interested in ham radio. Members participate in contests, teach classes to potential hams, build equipment and help foreign students contact their homelands by means of radio. Meetings are held the last Thursday of every month in room 165 Electrical Engineering. Call Diane Snyder at 344-3441 for more information.

Tau Beta Pi (TBΠ)

A junior-senior engineering honorary, TBΠ is composed of those with superior scholarship from the college. They run a tutoring program and are the hosts of the Job Decision Seminar. This year they will be sponsoring the L.E.A.D.S. Conference in the spring. They also participate in many social activities.

Illinois Technograph

Celebrating its centennial anniversary in February, the *Illinois Technograph* is the magazine for students in the College of Engineering. The staff of writers, photographers, editors, and production personnel is solely composed of engineering students. Published five times throughout the school year, the magazine contains news of the college as well as information on technological research. Interested students can pick up applications at the Illini Media Company Office in the basement of Illini Hall or in 302 Engineering Hall. ■

Kirt Nakagawa

Atomic Weaponry

The recent moral and political questions facing our government leaders have thrust upon all citizens the responsibility to remain informed on the status of world weaponry. An understanding of the operation and history of the nuclear age can aid in helping to make an informed decision.

The threat of nuclear war has been with us for the past thirty-five years. The road to our current level of nuclear weaponry began forty-two years ago, shortly after America's entry into the Second World War. A brief history and overview of the development of nuclear bombs as well as a description of some of the more contemporary bombs will be examined in this article.

In May of 1942, the Manhattan Engineer District Office of the U.S. Corps of Engineers was formed, headed by J. Robert Oppenheimer. The Manhattan Project was born, and soon afterward, the first atomic bomb was developed. Less than four years later, on July 16, 1945, the world's first atomic bomb was detonated at Alamagordo, New Mexico.

A major difficulty in achieving a chain reaction remained. The reaction is the process by which a splitting (called fissioning) nucleus induces the fissioning of another nucleus, and so on in such a manner that the reaction maintains itself. When Enrico Fermi accomplished this feat at the University of Chicago in 1942, a major barrier had been overcome. With extensive Government funding, the bomb was developed in less than four years.

The atom bomb, a fission device, works on the principle of a rapid chain reaction through the fissioning of Uranium-235 or Plutonium-239. When either of these nuclides are fissioned, two or three more neutrons and about 200,000,000 electron-volts are released. Given the proper conditions, this reaction continues, producing a powerful explosion.

The key physical characteristic is the quantity of fissionable material on hand, called the critical mass. When one has a critical mass of material, the neutron flux within the mass causes continued fissioning of the material. The resulting explosion liberates tremendous amounts of energy in a millionth of a second.

The actual processes of a fission device are much more technical, but the basic principle still applies. The problem lies in combining subcritical masses together to form a critical mass. At Los Alamos, where almost all of the development took place, two types of bombs were developed: the gun-type and the implosion-type.

The gun-type bomb involves shooting, with conventional explosives, a subcritical mass into a separate subcritical mass whose resultant mass is critical. This type of weapon utilizes two single separate chunks of fissionable material.

The implosion-type bomb requires that the fissionable material be imploded, or simultaneously compressed in what is the reverse of an explosion. One way this is accomplished is by surrounding a hollow sphere of fissionable material with a larger hollow sphere of conventional explosives which are detonated simultaneously by electronic means. The explosion implodes the fissionable material and a nuclear explosion results.

Today, further developments in the explosive yield and types of energy released have come about. Chief examples of this are the hydrogen bomb and its modified version, the neutron bomb.

The underlying principle of the hydrogen, or fusion bomb, is the release of greater amounts of energy than a fission reaction is capable of creating. This is possible through the fusion of lighter elements' nuclei, particularly deuterium and tritium. For a fusion reaction to occur, extreme temperatures are required—upwards of one million degrees Fahrenheit. This is achieved by the use of a fission device; that is to say the detonation of a fission bomb is required to achieve the activation energy for a fusion bomb. In this respect, fission devices are mere fuses for fusion bombs.

Finally, to utilize neutron availability and maximize yield, a blanket of uranium-238 surrounds the area of deuterium and tritium. Upon capture of one of the highly energetic neutrons emitted in the reaction, the uranium-238 will be induced to fission and also release energy. Hence hydrogen bombs are fission-fusion-fission devices, or thermonuclear weapons.

The neutron bomb, noted for its higher yield of neutron radiation and lower yield of explosive energy, is actually a modified hydrogen bomb. The difference is in the absence of an uranium-238 blanket. The same fission-fusion process occurs, but with less blast effects due to the absence of the second fissioning. Higher neutron radiation occurs as well, as the neutrons are neither absorbed nor moderated. The neutron bomb therefore produces an intense radiation field while having a relatively weak blast in comparison to a hydrogen bomb of similiar yield. Neutron bombs are sometimes called enhanced radiation weapons.

The history of nuclear weapons is still being written, as government leaders, theologians, and the general citizenry continue to examine the political and moral questions of their development. ■

A Change of Face

Mac E. Van Valkenburg has been selected as acting head dean to replace Daniel Drucker, who retired in August.

Van Valkenburg first became a faculty member in the department of Computer and Electrical Engineering in 1955. He left in 1966 to become department chairman of Princeton University. He returned in 1974 to become an EE professor and a research professor in the Coordinated Science Laboratory.

The author or co-author of nine textbooks, Van Valkenburg is a nationally prominent educator. He will hold this position until a permanent replacement for Dean Drucker is found.

Professor James J. Stukel has been appointed head of the Engineering Experiment Station and associate dean. Stukel, a faculty member since 1968, is a professor of mechanical and environmental engineering. He received his B.S. in mechanical engineering from Purdue University in 1959 and his M.S. and Ph.D. in M.E. from Illinois in 1963 and 1968, respectively.

Stukel has served since 1980 as Director of the Public Policy Program. He has also been Director of Energy Research and the Office of Interdisciplinary Projects, the Office of Energy Research, and the Office of Coal Research and Utilization. He currently teaches civil engineering courses.

Stukel replaces Professor Ross Martin who passed away in June. Martin, who was also a mechanical engineering professor, had been head of the Experiment Station for 26 years and on the University faculty for the past forty years.

Improving Economy

The upswing in the economy seems to be very positively reflected in the engineering employment picture. The number of employed students and their starting salaries show a definite increase over last year's statistics.

Of 831 B.S. graduates last May, 54.8% were employed as of July 16. This favorably contrasts with last year's figure of 46.1%. Only 10% of those seeking work were without positions, while last year 22% were unemployed.

Those hired are also getting higher salaries than before. The average monthly starting salary is $2236, up from $2106. The most lucrative disciplines are computer and electrical engineering with average starting salaries of $2302 and $2334 per month, respectively. The highest paid graduate was a computer engineer receiving $2810 per month, a sharp increase over last year's high of $2492. Persons in civil, nuclear and agricultural engineering generally received the lowest salaries. A civil and an industrial engineer tied for the low salary of $1417 monthly which equals the low of the 1983 graduates.

The average number of interviews, 12.8, was up from last year's 10.5, while the number of offers declined slightly from 3.0 to 2.9.

Faculty Sweeps Awards

The University again displayed its academic prowess by ranking fourth nationally in the number of recipients of the Presidential Young Investigator Awards.

Presented by the White House Office of Science and Technology Policy (OSTP), these awards are given to fund research by 200 engineers and scientists who are near the beginning of their academic careers.

Those selected include: Narendra Ahuja, electrical and computer engineering; May R. Berenbaum, entomology; Tai-Chang Chiang, physics; Bruce Hajek, electrical and computer engineering; Jonathan Higdon, chemical engineering; Richard I. Masel, chemical engineering; Bruce E. Rittman, civil engineering; and Charles L. Tucker, mechanical and industrial engineering.

The awards carry an annual base grant of $25,000 from the National Science Foundation. The NSF will additionally provide up to $37,500 a year to match contributions from industrial sources, making the total possible support $100,000 per year.

The purpose behind the awards is to "help universities attract and retain outstanding young Ph.D.'s who might otherwise pursue non-teaching careers," according to the OSTP.

"It's heartening to see that our young people are doing well in this way," University Vice Chancellor for Research Theodore L. Brown said. "It shows that we're succeeding in recruiting young faculty who can build strong programs in science and engineering."

Nobel Laureate Honored Again

John Bardeen, professor emeritus of physics and electrical engineering was selected to receive the National Academy of Engineering's Founders' Award.

This award is presented annually to recognize "outstanding contributions by an engineer to both the program and to society."

A member of the University faculty since 1951, Bardeen was selected "in recognition for his remarkable creativity in engineering science and invention." He is the recipient of two Nobel prizes. The first was for his work at Bell Labs on the development of the transistor. The second came for his studies on the theory of superconductivity. He also played an integral role in the development of xerography while serving as an advisor to the Xerox Corporation.

Bardeen, along with William L. Everitt, dean emeritus of the College, was also recently named to the Electrical Engineering Centennial Hall of Fame by *Spectrum*, the magazine of the Institute of Electrical and Electronics Engineers.

Mary McDowell


THE NUCLEAR NAVY. RIDE THE WAVE OF THE FUTURE.
You're deep under the sea. There are 4600 tons of nuclear-powered submarine around you. Your mission – to preserve the peace.
Your job – to coordinate a practice missile launch. Everything about the sub is state-of-the-art, including you.
The exercise – a success. You're part of that success and now you're riding high.
In the nuclear Navy, you learn quickly. Over half of America's nuclear reactors are in the Navy. And that means you get hands-on experience fast.
You get rewarded fast, too. With a great starting salary of $22,000 that can build to as much as $44,000 after five years. And with training and skills you'll use for a lifetime.
Then, whether you're in the Mediterranean, the Pacific or the Atlantic, wherever you move around the world, you'll be moving up in your career and in the Navy.
Find out more about an exciting future that you can start today.
See your Navy Recruiter or CALL 800-327-NAVY.
NAVY OFFICERS GET RESPONSIBILITY FAST.

Reinstated Draft?

The Selective Service Act may have to be extended soon to include not women, but robots.

The Committee on Army Robotics and Artificial Intelligence has released a study stating that the newest GI Joes may be GI Trons. The committee studied the potential applications of robotics and artificial intelligence in the armed services.

The most immediate use for these new recruits would be to conserve people in jobs that are especially hazardous, repetitive or both.

One such job is that of tank ammunition loader. The task consists of lifting heavy ammunition from a rack and loading it into the tank cannon. A robot arm similar to ones used to sort parts in industry, the committee said, could probably do the same job more efficiently by giving the commander direct control over the type of ammunition selected for loading and by increasing the firing rate.

Robot sentries are another feasible application. They could be used to detect the presence of nuclear, biological or chemical weapons. Artificial intelligence (AI) systems would also be beneficial in helping personnel repair equipment when on the battlefield.

Additional uses of robotics and AI include a medical system to help doctors in treating wounds and identifying soldiers with computer chip dog tags, robots to load or unload supplies, and using them to refuel jeeps, tanks, or other equipment.

From Computer to Slides

Pictures created on the terminal screen can now become slides in a matter of seconds.

Celtic Technology has released the new VFR 2000. Locally distributed by Duo Soft Systems, this 35mm computer camera takes graphic or test images from the screen and projects them onto slide film.

The VFR 2000 has the capability of transmitting the screen image to slide film in a matter of seconds (photo by Dave Colburn).

The camera consists of a black and white cathode gun similar to those found in television sets. Three filters (red, blue, and green) are passed in front of the beam it creates in order to generate the proper exposure on the film. The VFR 2000 camera is connected directly to the computer CPU and the monitor in a daisy chain configuration.

The camera can be used on IBM, Zenith, Apple, and Toshiba computers with factory adjustments. It uses Ektachrome, Kodachrome, Monochrome or Poloroid Polachrome Instant Slide film, and retails for $2800.

Because it requires no additional software or DIP switch adjustments, the VFR 2000 is unique among its competitors, says Toshiba Technical Representative Jennifer Humphrey. She stated that the major market for the product has been to corporations for sales meetings and conferences where easily produced graphs and charts can clearly demonstrate how well their company is doing.

Geriatric transistors

The gradual decline over time in performance of a transistor may be analogous to the human aging process, a University researcher has discovered.

Electrical engineering and physics professor C. Tang Sah, head of the Solid State Electronics Laboratory, has learned that phenomena called "traps" cause aging in transistors just as "free radicals" are believed to be major contributors to the human aging process by altering vital cell components.

Transistors are made in a photographic process in which silicon is chemically etched with a circuit pattern. Impurities are added to give semi-conducting properties. In some instances, this process allows other impurities such as sodium from salty air or water molecules from moisture to enter the lattice structure of the silicon. From these impurities, traps arise.

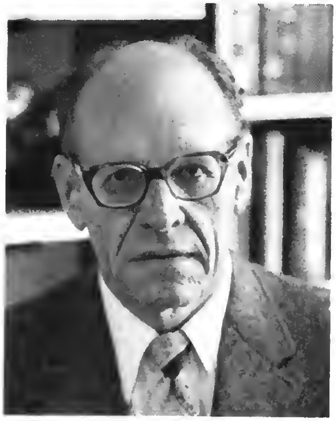
When current is passed through the transistor, the traps are able to move and accumulate in ways that impede normal operation. Electrons and holes, a localized lack of electrons, can then get caught in the traps. This situation results in a loss of normal current flow, and the transistor's performance declines.

Sah's research results will be used in the computer aided design of other, improved transistors.

"When we understand how the transistor fails, we'll be able to make transistors and integrated circuits that will fail slower. Maybe they will never fail—never reach the point where they are beyond their usefulness," said Sah.

Mary McDowell

Tech Profiles



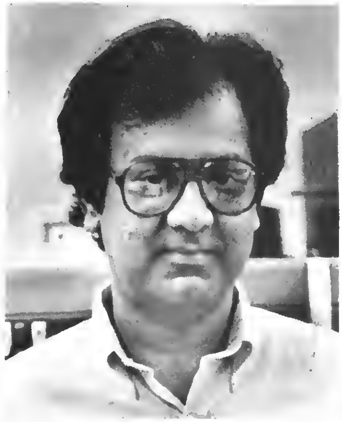
Roger R. Yoerger received his education at Iowa State University where he received a Ph.D. in a joint Agricultural Engineering and Theoretical and Applied Mechanics program.

Now the head of the University's Agricultural Engineering department, Yoerger has provided leadership for the school in the recent move to the new Agricultural Engineering Building which was formally dedicated last May.

Yoerger, who is married and is the father of 4 children, enjoys visiting his family farm in Champaign County. He was recently elected President of Phi Kappa Phi, the national honorary.

Dr. Yoerger feels the University can provide a major service to Illinois residents from the surrounding area. "Agricultural Engineering in general involves an application to engineering problems. In this geographical area, a lot of agricultrual products and heavy equipment is produced. We prepare graduates who can be a part of that," he explained.

Jim O'Hagan



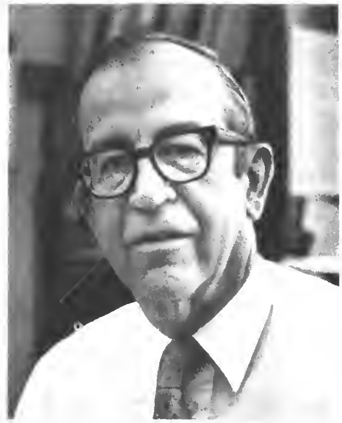
Ravi Iyer was born in India, but emigrated to Australia where he received his bachelor's degree and Ph.D. in Electrical Engineering from the University of Queensland. In 1979, Iyer came to the United States to teach at Stanford; last year he came to the University and currently he teaches EE 290, Introduction to Computer Engineering.

Now Iyer is researching projects funded by NASA and IBM. The first project involves designing reliable computer systems by experimenting on existing computer systems. This new field of research tests radical techniques and new ideas without a full theoretical explanation or background. Iyer is also doing research on designing intelligent systems capable of "learning from the past." Analogous to noticing symptoms of illness in a person, these systems are able to pick out symptoms of their own failure and correct them before any breakdown would occur.

Iyer truly enjoys teaching and likes to place great emphasis on student-teacher interaction and communication, which he concedes is difficult in a lecture of 300 students.

Iyer also enjoys squash, which he picked up in Australia, tennis, listening to music—especially classical music, and ballroom dancing with his wife.

Carolyn A. Keen



James W. Bayne, the Associate Head of Mechanical Engineering and Industrial Engineering for undergraduates, currently teaches ME 225. Outside of the office and classroom, Bayne has served as faculty advisor for $\Pi T \Sigma$, the Mechanical Engineering Honor Society, since 1955 and has previously fulfilled the duties of national secretary/treasurer and national president.

Raised in Cleveland, Bayne was sent to the University in 1943 through a World War II Navy program. He received his B.S. only 3 years later, and when he returned to the College for graduate work, Bayne discovered a great enjoyment in teaching. This made him decide to stay at the College, where he has remained since.

Married, with seven children and eight grandchildren, Bayne enjoys golfing and bowling in his free time, and plans to retire soon from his administrative duties to concentrate on teaching, which he still enjoys a great deal. Bayne says he's remained so long in this University because he likes the community of Champaign-Urbana. "I enjoy the college community. I think if the University of Illinois were in Chicago it would tend to lose a lot of its appeal," he explained. "I like the setting: there are so many things to do."

Carolyn A. Keen

from page 4

Tech Teasers Answers

1. For the gold medal, the answer is 46 possible solutions.

2. 250 Hz.

3. Even an adder would be able to multiply with a log table.

4. There are two possible solutions to this puzzle. The first is 0, since if the technology for vacationing on the moon is available, the ticketing process should all be on computer and no forms would be necessary. Assuming a downed system, 494 different tickets would have to be printed.

5. 19.

6. White meat is fast twitch, dark meat is slow.

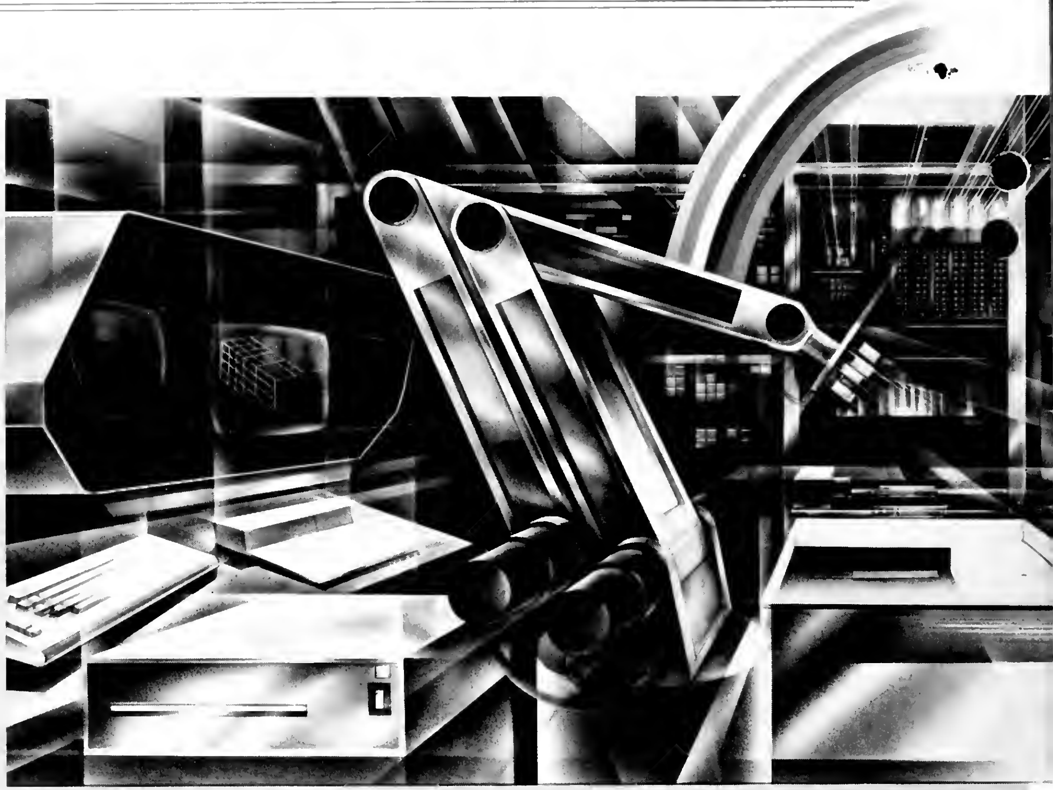
7. a) For *Technograph*'s 100 years of publishing, the method would be:

$100 = 2^2 \times 5^2$

Number of relatively prime numbers = $(2-1) \times (5-1) \times (2^{(2-1)} \times 5^{(2-1)}) = 40$.

b) $48 \times (2^4 \times 3^3 \times 5^6 \times 7^7)$.

I F · Y O U · C A N · D R E A M · I T · Y O U · C A N · D O · I T



Convert the production line into a frontier of creativity.

The cast-iron technology of the factory will soon be silicon technology.

Chips and computers transfer design information directly to the factory floor. Other chips make possible flexible robotics, programmable controllers for machine tools, automated test systems and digital inspection cameras. Local area networks tie together all these systems.

These are revolutionary changes that can result in better-made products, manufactured of new materials at lower cost.

GE is deeply involved in bringing manufacturing into the silicon age. In one plant, electronics and computer systems enable us to reduce production time of a locomotive's diesel engine frame from 16 days to 16 hours. At our dishwasher production plant, a master computer monitors a distributed system of programmable controls, robots, automated conveyors, assembly equipment and quality control stations.

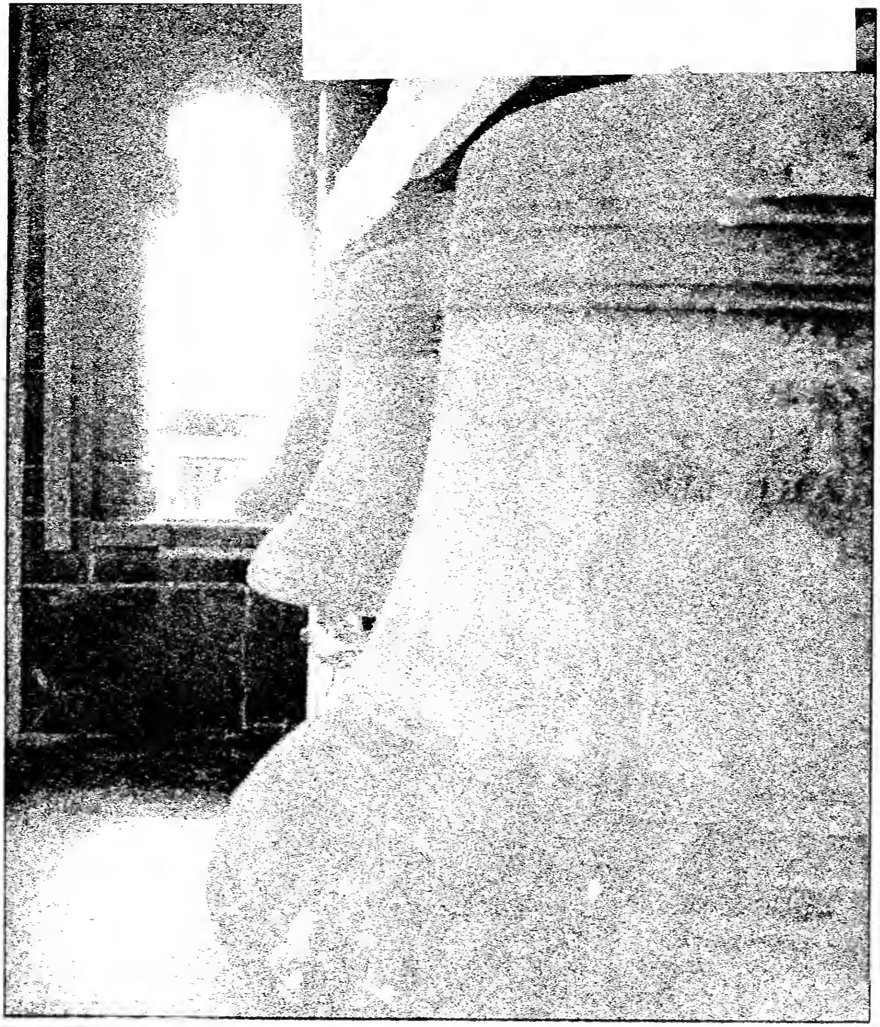
We're working on robots that can see, assembly systems that hear, and machinery that can adapt to changes and perhaps even repair itself.

This transformation of manufacturing from the past to the future creates a need for new kinds of engineers to design and operate factories of the silicon age. They have to be as familiar with the realities of the assembly line as with the protocols of software communications.

They will synchronize dozens of real-time systems whose slightest move affects the performance of every other system. The frontiers of manufacturing technology have been thrust outward. Old ideas have been questioned, new ones probed. Some ideas are now on production lines. Others are still flickers of light in an imagination.

All offer opportunities for you to seek, to grow, and to accomplish.

If you can dream it, you can do it.



The Altgeld Bells

SCIENCE/SCOPE

Artificial intelligence, the programming that lets computers "think" almost like humans, is the focus of a new advanced technology center at Hughes Aircraft Company. The facility brings research and development efforts under one roof. Scientists and engineers will work closely with universities throughout the country to develop software and equipment. Finished systems will be able to make far more complex decisions than the simple "yes" or "no" decisions that traditional software programs require. Projects will include self-controlled systems and image understanding - both of which can be used in such applications as geological surveys from space, manufacturing technology, and defense.

Satellite Business Systems will add two space craft to its constellation of four to provide U.S. businesses with voice, facsimile, teleconference, and high-speed data services. Like their predecessors, SBS-5 and SBS-6 will operate in the K band frequency range. In addition to the standard 10 channels of 43 MHz each found on earlier versions, the new spacecraft will carry four transponders with bandwidths of 110 MHz each. This feature nearly doubles the telecommunications capacity of SBS-1. The new satellites will allow SBS to serve Alaska and Hawaii for the first time. They are designed with a 10-year operational life instead of the current seven. The new spacecraft are based on the Hughes HS 376 model. This versatile drum-shaped satellite, with 30 versions sold, is the world's most popular commercial communications satellite.

Development times for semicustom very large-scale integrated (VLSI) circuits have been cut from greater than one year to 20 weeks at an ultramodern computer-aided training and design center at the Hughes facility in Newport Beach, California. Utilizing advanced design automation software, a comprehensive library of predesigned logic functions (called Macros), and preprocessed wafers, the new facility is helping engineers design chips with 2,000 to 8,000 gates and with as many as 180 pins. New 3-micron dual-layer metal HCMOS processes are applied to both standard cell products and state-of-the-art gate arrays. Skilled design engineers and education specialists at the Newport Design Center provide training and technical support for IC designers throughout the company.

Hybrid integrated optical receivers have been developed by Hughes research scientists for transmitting microwave-modulated optical signals over fiber-optic links. The receivers are part of an effort to find inexpensive links for such applications as phased-array antennas, satellite ground stations, radars, and communications systems. Each receiver consists of a high-speed gallium arsenide Schottky photodiode developed at Hughes and a low-noise amplifier using commercial gallium arsenide field-effect transistors. These receivers are designed to operate at a modulation frequency of 3 GHz with a 1 GHz bandwidth. Their advantages over discrete components include better sensitivity, lower noise, and the elimination of ripples in the frequency response caused by impedance mismatch between detectors and commercial amplifiers.

Illinois

Technograph

November 1984 Volume 100, Issue 2
Celebrating 100 years of publication

4 **Pool Hall Physics Lesson** *Carolyn A. Keen*
What may appear to be a simple but intriguing game of skill actually relies on a modern analysis of classical physics.

6 **Music Takes Toll on Altgeld Bells** *Ken Kubiak*
The University's historic chime tower undergoes some modern renovations.

10 **Suppressing Skyscraper Sway** *Michael Lind*
Wind-induced movement in modern skyscrapers can cause serious discomfort for high-rise tenants. New design ideas can provide effective, energy-efficient solutions to a moving problem.

12 **The Hard Selling of Software** *Jim O'Hagan*
Computer equipment is selling better than ever before, but without advanced marketing techniques, some firms will be left behind.

Departments
Editorial 3,Tech Teasers 3, Technovisions 8, Technotes 11, Technovations 13, Techprofiles 15

On the cover: The hourly chimes sounded from Altgeld tower are a familiar sound, but a rare sight. These bells are now undergoing a renovation to restore the condition and pitch of their earlier days. (photo by Mike Brooks)

Illinois Technograph (USPS 258-760) Vol. 100 No. 2 November 1984. *Illinois Technograph* is published five times during the academic year at the University of Illinois at Urbana-Champaign. Published by Illini Media Co., 620 East John St., Champaign, Illinois, 61820. Editorial and Business offices of the *Illinois Technograph* Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3558. Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001, 221 N. LaSalle Street, Chicago, Il., 60601. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879. *Illinois Technograph* is a member of Engineering College Magazines Associated

Tech Teasers

1. A number of less than 30 digits begins with the two digits 1 and 5 on the left: 15-----. When it is multiplied by 5, the product is the same number, except the 1 and the 5 have been shifted to the right: -----15. What is this number?

2. What day of the week is the 13th of the month most likely to fall on?

3. What was double Nobel prize winner Marie Curie's maiden name?

4. A foreign intelligence agent must send all of his reports to secret headquarters through a square chute hidden behind a picture of Whistler's Mother in his living room. The chute can accomodate any package where the length plus the greatest width (measured transversely) is not greater than 72 inches. What is the area of this chute?

5. What two integers, one the square of the other, together contain each of the digits 1 through 9 only once? There are two solutions.

6. During Hell Week, a fraternity pledge is taken to a large field and tied with a 100 foot rope to a tower that is 100 feet in diameter. His brothers tell him that he must paint as much of the field as possible in the fraternity colors. What is the maximum area the pledge will be able to paint?

7. When an electron is emitted from its nucleus, in what direction does it spin?

answers on page 16

Editorial

Discriminating Reversals

About a year ago, when a female rugby-playing friend of mine was still going to the University, I had the pleasure of joining her while she dropped by a meeting for the team captains of two rugby teams.

"What is *that*?" one of the captains asked aloud upon my entrance to the room. She immediately confirmed what my friend had told me before; she was an avowed male-hater.

It is not often that a white male gets the "opportunity" to experience even such a minor form of discrimination. After it happened, I more fully realized how important the abolishment of any type of discrimination really is.

But then I started interviewing through the College of Engineering, was introduced to reverse discrimination, and changed my attitude.

I have heard about some companies that come down here for special interviews with women and minorities only. I know that quotas are passed down from corporations' higher eschelons to their interviewers, stating how many women and minority members must be hired. I also have heard that some companies receive tax breaks for hiring women and minorities.

All this is happening because people are fighting fire with fire. In order to halt the discrimination against women and minorities, reverse discrimination has been implemented. It is a vicious tradeoff, but I think that it is the only way the situation can be handled.

Engineers Greg and Marsha are a good illustrative example as to why. Marsha is smarter than Greg, and she is hispanic. Greg went to a much better high school, has better grades and has had two summer engineering jobs. He is white. Marsha has had a more difficult time with college due to her poor primary education. Because of this, she has had to attend summer school every year, ruining her chances for a summer internship. Who should the corporation they are both interviewing with hire?

Certainly Greg, because he has better grades and more job experience. But Marsha is smarter, and may also be the best engineer ever to come into existence. Here is the basis of the problem.

The solution? Start hiring the Marsha's that apply for these jobs, because they deserve the opportunity, and may be the best for the job once given a chance. The incurred problem is the Greg's who begin to find jobs scarce, because of the growing benefits for companies who hire minorities and women.

It is unfair for today's white males to have to pay for the immoral acts of yesterday's discriminators, but it is more fair to discriminate against the people who have previously received the advantages than to continue discriminating against those who have always been unjustly treated.

Besides, eventually the score will even out, and comparatively equal numbers of all the different kinds of people will have the opportunities and educational availabilities that the white male has today. Then the corporations will once again be able to hire the person who is best suited to the job, and they will truly be "equal opportunity employers."

Illinois Technograph **invites letters in response to its articles and editorials, or any other items of interest to our readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.**

Carolyn A. Keen

Pool Hall Physics

To an inexperienced player of pool or billiards, the paths and collisions of balls on the table seem random and unpredictable. Behind the motion however, lie some fascinating applications of modern physics.

Ever since the inception of the billiards game, players have incorporated the fundamentals of classical mechanics and Physics 106 into some extraordinary shots and maneuvers with the billiard ball. To the average observer, billiard balls would appear to collide and rebound along perfect vector trajectories. But the experienced billiards player takes into account all of the imperfect conditions that Newton did not, namely the nap of the cloth, resiliency of the rails and the effects of spin on the ball.

It is this application of spin to the ball that explains the many dazzling tricks of practiced players. Susan Wrightson, three-time Big Ten pool champion and University billiards instructor, said, "Understanding this element of spin leads to the control and finesse that separates the average player from the ace."

Assume that the stroke of the cue stick is applied somewhere along the vertical line that drops through the ball's center of mass. The actual location of contact along the line has no effect on the initial horizontal velocity and momentum, which are determined simply by the time and magnitude of force imparted by the cue.

Rather, this spot on the vertical axis determines the torque which forces the ball to rotate about its center of mass. The magnitude and direction of torque is equal to the cross product of the lever arm and force, $T = r \times F$. The lever arm represents the vertical difference between the midde of the ball and the location where the cue stick hits, while foce is determined by the blow of he cue. This torque, which increases with r or F, is directly proportional to the spin of the ball by $T = I\omega$ where I represents the moment of inertia for the ball, as derived from the ball's mass and geometry, $I = {}^{2/5}mr^2$. A player who desires a non-spinning cue ball then, should strike the ball at its center because the lever arm, and thus the torque, is equal to zero.

A stroke higher on the ball creates a measurable torque and "topspin" about the horizontal axis. The force of friction on the tabletop opposes the sliding spin of the ball and tends to slow down the spin. However, since this frictional force is in the opposite direction from the player, it helps to propel the ball forward. Consequently, a ball given topspin rolls for a longer time because of the additional propulsive force of friction. Eventually topspin is eliminated by friction and the ball will roll smoothly without sliding.

"Backspin" is similarly implemented but with the cue striking toward the bottom of the vertical axis through the cue ball. In the case of backspin, friction again slows down the spin, but because the frictional force is in the opposite direction it also opposes the forward movement of the center of mass. Like topspin, backspin is soon eliminated in the course of the roll and the billiard ball moves smoothly forward without sliding. Obviously a cue ball given backspin will only run for a short time since friction opposes both rotational and translational motion of the center of mass.

A skilled player will probably implement various spins and rotations to benefit collisions with other balls, called object balls. In any collision, little of the cue ball's spin is transferred to object balls because the balls are in contact for only an instant with virtually no friction between them. Only great friction between the balls would transfer rotation.

Consider a cue ball skidding with topspin. After it collides head-on with an object ball, the cue ball will stop for a moment, but then continue to roll forward. This is because the cue ball continues to spin just after the collision even though the center of mass is motionless. Friction eventually eliminates the spin and propels the ball smoothly forward. Without the additional spin, the cue ball would have remained stationary.

This can also be thought of in terms of energy and momentum conservation. Translational energy and translational momentum are transferred in a head-on collision between the cue ball and object ball, but not rotational energy or rotational momentum. This also applies to the case of the cue ball given backspin which will return to the player after hitting the object ball head-on.

"Side English" is another spin that affects a billiard ball's motion and changes its properties during collisions. Side English is applied initially when a player strikes the ball somewhere else than along the vertical line through the center of mass. Such a stroke will result in a non-horizontal rotation or spin, but

Figure 1. **Running English causes a wider rebound angle and increases ball speed after reflection (all photos by Dave Colburn).**

Figure 2. **Reverse English causes a steeper rebound angle and decreases ball speed.**

Figure 3. **The "cling effect" causes two balls to rebound at an angle smaller than the 90 degrees theoretically predicted.**

Figure 4. **Topspin, imparted by striking the cue ball above its center, causes a large decrease in the rebound angle.**

Figure 5. **A massé shot. The sharpness of the curve depends on the amount of English applied and the speed of the cue ball.**

Figure 6. **A massé shot with considerably more English. Note that the spin is reoriented as the ball curves, and sidespin is converted to topspin.**

with the axis still passing through the center of mass. Just as before, the rate of spin is determined by the torque.

If the location of the cue stroke is below the middle and to right of center, the resulting rotation can be likened to two simultaneous motions: one counterclockwise vertical spin and one horizontal backspin. A cue ball with side English initially travels in a straight line like any other spinning ball, but once friction eradicates the skidding and sliding, the ball will be propelled by the remaining side spin, resulting in a slightly curved path.

Though a cue ball hit with side English will deviate slightly from a straight path, the main use of this spin is in its application to collisions. When a billiard ball imparted with side English strikes a rail, its behavior is radically different from that which an observer would expect. The angle of reflection off the rail can be increased or decreased, depending on whether the side English is imparted from the left or right of center.

Side English can also be created mid-shot. A cue ball with no initially applied English will rebound off the rail at the same angle it struck, as the laws of physics dictate, but the substantial friction from the rail creates torque and gives the ball English after the collision. Side English can be also obtained mid-shot when a cue ball with top or backspin hits an object ball off-center. In this case, the cue ball's spin maintains its original orientation even though the ball veers off at another angle. Top or backspin becomes sidespin, which partially deflects the ball's path from a straight line.

The most intriguing curve shot, called the massé, is used to make the cue ball go completely around another obstacle ball. The player must strike the cue ball with the cue stick in an almost vertical position. The massé shot is mainly for show or tournament play, although the massé can be easily understood using analysis similar to that above.

One can predict where the balls will go after the collision, especially when the cue ball has no English. If the collision is head-on, almost a complete transfer of momentum and translational energy from the cue ball to the object ball takes place. In a glancing collision, the two balls will separate in paths approximately 90° from each other. Actually, a small amount of energy is lost by the two balls in the collision and hence the angle between their paths is slightly less than 90°.

To predict the directions each ball will take, imagine the instant of collision and mentally draw a line between the two balls' centers. At this contact point, two forces will be acting, the first being the force of friction, which acts perpendicularly to the line between the centers. However, this force is so minute it can be almost disregarded. The second force from the cue ball is parallel to the line and pushes the object ball off in that direction, with the cue ball veering off perpendicularly to the object ball. Direction can thus be manipulated according to the point of contact and the orientation of the centers of the colliding billiard balls. Of course the situation is further complicated and predictions are more difficult as spin and English are applied in varying degrees.

Certainly academic knowledge of physics will not win billiards tournaments, but its proper application combined with practical experience will improve one's mastery of the game. ■

[redacted]

Ken Kubiak

Music Takes Toll on Altgeld Bells

The Altgeld Tower chimes and the daily chimes concerts featuring them have been a tradition at the University of Illinois since the dedication of the bells in 1920. The bells are currently undergoing restoration in order to make them easier to play.

The Altgeld Tower bells, which faithfully mark the time every quarter hour, have recently found themselves in need of renovation. Dating back to 1920, the bells were last renovated in 1955.

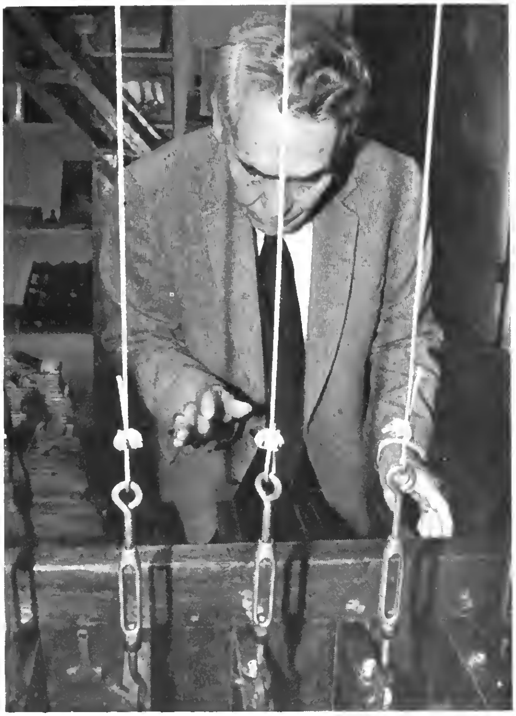
The bells, operated by a clavier located in the performing room, are located seven stories above ground level in Altgeld Tower. The clavier consists of a 7 foot long bank of 18 wooden levers which are connected to the bells themselves, as high as 68 feet above the performing room. When one of these levers is depressed, it moves a clapper inside the bell, ringing it. There is also a practice clavier in the performing room which is identical to the performing clavier except that it generates sound by hitting metallic bars, so that chimesplayers may practice in privacy.

The familiar ringing of the Altgeld chimes is accomplished with a hammer and clapper system as seen on the left. Seen above is the aircraft cable and pulley system used for moving the clapper (photos by Mike Brooks).

The range of chimes extends one and a half octaves from D to G. However, three notes, low D sharp and both F naturals, are missing from the set of bells. This is because when the bells were installed in 1920, only those bells needed to play "Illinois Loyalty" were included. Due to the limited range of the instrument and the tone vacancies, music must be transposed to those keys not containing F natural, such as D and G. Other notes are either raised or lowered an octave, replaced, or omitted.

The ringing of the chimes every quarter hour is done automatically by a clock mechanism located on the performing room roof. The electric clockwork is connected to separate hammers located on the bells' exteriors. There are five such hammers, four for the tune and one for the hourly gong.

Prior to the renovations, the clavier levers were attached to long vertical rods which extended up through the open tower. At the top of the tower, these rods were connected to chains which then wrapped over pulleys and were finally attached to the clappers inside the bells. Exposure to the elements caused the chains to rust, hindering their motion and sometimes causing them to break entirely. The rods became bent, making the chimes



Albert Marien, Head Chimesmaster at the University for over 25 years, demonstrates use of the carillion which controls the bells in the Altgeld chime tower (photos by Mike Brooks).

still more difficult to play. The rods and chains made such a clatter that they distracted the chimesplayers.

The largest portion of the current modifications involves replacing these rods and chains with lightweight aircraft cable, making the mechanism quieter and more reliable while affording the chimesplayers greater control of their playing. Dave Knickel, a chimesplayer, says this modification makes the chimes easier to play since the mechanism requires less force, is less noisy, and is not prone to the mid-concert breaking that plagued the earlier system.

While replacing the rods and chains improves the mechanical nature of the chimes, other changes are needed to improve the sound of the bells. The clappers and bells are both worn at the spot where they had been hitting each other for 30 years. This wear prevents the bells from producing the exact pitch when struck. The surface of the dented clappers must be reshaped while the bells themselves, which are anchored to large wooden beams, are spun so that the hammers and clappers hit them in a different spot. The latter is no small task—the largest bell is five feet in diameter and weighs over one and a half tons.

Other improvements will be made to the clavier itself such as attaching pedals to the lower notes of the keyboard so that they may be played with the feet.

However, there are still many unscheduled improvements that could be made to the chimes. Chimesmaster Albert E. Marien said, "Money is being collected in the U. of I. Foundation for a major renovation of the bells." Money for the minor renovation of the bells was supplied by the Panhellenic Council.

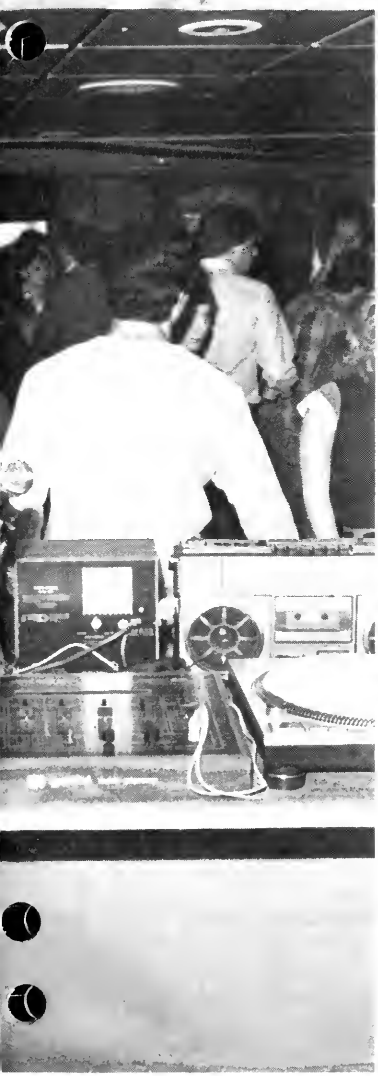
Marien began giving chimes concerts on an electric carillon while teaching at Berry College, a co-educational self-help college located in the Blue Ridge Mountains of Georgia. After joining the University staff, he was invited by Mr. Duane Branigan, former director of the School of Music, to play concerts on the Altged Tower chimes.

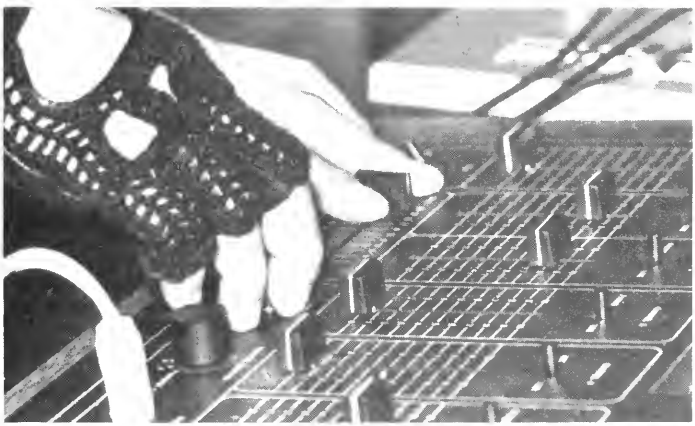
Besides sounding the time with the traditional four-note Big Ben tune, the bells are used for concerts given at 11:50 and 12:50 daily by Marien and his staff of chimesplayers. Special chimes concerts are given on Quad Day, during Homecoming week, on the Illini Union Anniversary, U. of I. Founder's Day, and on Graduation Eve following the President's Concert for Graduates. Requested songs such as "Happy Birthday" will be played during the daily concerts for a nominal charge. ■

Mixing it up with James

The dance floor is crowded and hopping. Lights are flashing and spinning to set the mood for the music. Behind the scenes making it all happen is University student James Kang—creating an atmosphere that even the most ardent non-dancer succumbs to.

Below: James cues up a song on one of his two special turntables. The computerized turntables are designed for mixing. Center: Headphones plugged into the mixing board allow set up of the next song even with the noisy background. Above right: Lights tied to the ceiling will be switched in synch by James. Below right: James combines two identical songs slightly out of phase to create an echo effect. *(photos by Dave Colburn)*



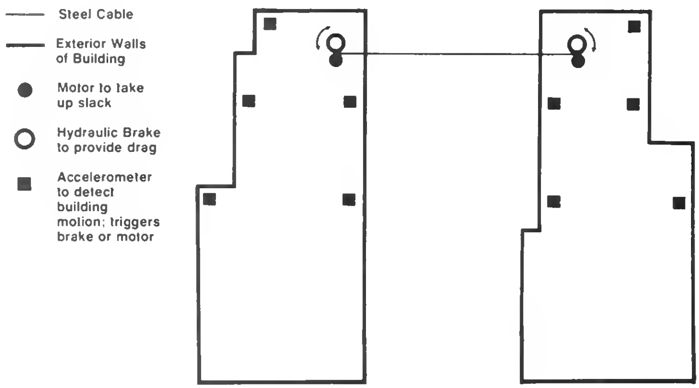


Michael Lind

Suppressing Skyscraper Sway

As skyscrapers continue soaring to dizzying heights, the challenges to maintain their stability are ever present. The engineers and architects who design these miniature worlds are always considering new techniques to reduce building sway.

Illustration of a Semi-Active System to Reduce Building Sway



Source: Michael Lind

High-rises have always presented special problems to designers. Steel columns erected on the lower floors must support the upper stories. Essential services, such as heating, cooling, water, electricity and transportation within the building must be provided to serve the residents of the building. Wind must be compensated for, as it can play havoc with a one-thousand foot high structure. In addition to solving such problems, costs must remain low.

Traditionally, the strategic use of steel has compensated for the forces of the wind. In addition to standard rectangular steel frames, engineers have successfully used internal bracing to suppress wind stress in tall structures. Thinner steel columns can then be used, but interior space is reduced.

A different approach was used by designers of the John Hancock Center in Chicago. Characteristic of this building, large X-trusses dominate the exterior walls. These trusses reduce stress on the interior walls and leave more usable space inside.

Although both methods use steel economically and efficiently, tremendous amounts of the metal must still be used. To combat this, several new methods have been developed which concentrate on controlling a building's sway, rather than just preventing excessive sway.

One method was used in the World Trade Center in New York City. There, 10,000 shock absorbers decrease building sway and increase occupant comfort.

Another technique, where large masses are installed on the upper floors of buildings, is the tuned mass damper (TMD). In the Citicorp Center in New York, an 800,000 pound block of concrete is connected to gas-charged springs, which have controllable compressibilities. The block is moved in response to wind-induced acceleration in the skyscraper. By moving the block in a direction opposite to the movement of the building, the swaying is reduced. In Boston, the Hancock Center uses a similar configuration, replacing the concrete with two seventeen-foot square pieces of lead which are each three feet thick.

While TMD's do decrease building sway, they have large disadvantages. Of most concern is the concentration of mass at the top of the building. To significantly suppress movement, a TMD may have a mass as great as one percent of the total mass of the structure. Each floor below the damper must be able to support the weight; consequently more steel must be used in the lower floors. Another problem is the amount of power required to move a TMD, which can add to the operating costs of the skyscraper.

Richard E. Klein, a professor of mechanical engineering at the University, has been studying methods of semi-actively reducing building sway which do not consume vast amounts of power. An obvious solution, though not the easiest to implement, is to exploit the power of the wind. One way to accomplish this is to use aerodynamic appendages. With little

continued on page 14

*Tech*notes

NIU to Join Engineering Ranks

Illinois may soon be joined by its northern sister school as providers of public engineering education. The Illinois Board of Regents has approved a plan that would offer an engineering program at Northern Illinois University in DeKalb, Illinois by as early as 1985.

Northern plans to initially offer bachelor's and master's degrees in mechanical and electrical engineering and later phase in an industrial engineering curriculum. Also proposed are off-campus engineering technology programs to provide options for many northern Illinois industry employees.

The proposal is scheduled for consideration by the Illinois Board of Higher Education later this year. The three year start-up cost is estimated at $1.9 million, which would provide for new faculty positions, equipment, instructional and research laboratories, and general operating support.

The proposed new course offerings would be concentrated at the junior and senior levels to make the program especially attractive to junior college transfer students who complete their pre-engineering requirements in area community colleges. If the proposals are implemented fully, NIU would have 440 undergraduates and 80 graduate students enrolled by 1990.

Northern's administrators hope to capitalize upon what they perceive as a need for more engineering education in the western Chicago suburbs and Rockford area, where there is a large amount of high-tech industry. They feel their program could be instrumental in the industrial development of these regions as there are no engineering schools in the northern part of the state.

Dean Twice Honored

Newly appointed Civil Engineering Department Head William T. Hall was presented with the Nathan M. Newmark and Ernest E. Howard Awards by the American Society of Civil Engineers. Hall is the first engineer to be honored with both distinctions.

The Newmark Award is presented for innovative theoretical contributions to the field of structural mechanics. The award was established in 1975 to honor the memory of Newmark, a prominent engineer and former Illinois C. E. department head. Newmark was a teacher and colleague of Hall's. Hall is the first University winner of this award.

This marked the third time a University researcher has been recognized with the Howard Award. It is presented for contributions to the advancement of structural engineering through analysis and design of buildings.

"To win one of these awards is a tremendous accomplishment," said Narbey Khachaturian, Associate Head of Civil Engineering. "It is quite a distinction to win both and shows the range of his activities."

A University of Kansas graduate, Hall received his master's degree and Ph.D. from Illinois, where he joined the faculty in 1949. Since 1964, he has served as principal consultant in developing and reviewing design criteria for nuclear power plants and associated equipment for the regulatory agencies and industry. He has been a consultant for the Trans-Alaska Pipeline, the Western Liquified Natural Gas Terminal, and the M-X missile system.

Harris Donates Computer

Harris Corporation has presented the Civil Engineering Department with a Harris 800 super-mini computer to strengthen the department's computing power.

The new computer will be used primarily for research in structural mechanics and engineering to aid specific faculty and graduate research projects, and for use by some undergraduates, according to William J. Hall, head of the department.

"This gift from Harris Corporation is evidence of the high regard they have for the University of Illinois," said Hall. "It is another good example of how industry and the University are cooperating to provide an important learning tool for our faculty and students in high technology areas."

The system includes a super-mini computer, disk drives, a printer, 16 terminals, and a range of programs.

"Increased computing power at the University of Illinois should enhance the teaching of advanced engineering and science," said Gene T. Wicker, vice president and general manager of the Harris Broadcast Division.

"The young men and women at the U. of I. will play a major role in furthering today's technology, and we believe this high-performance computer can help," continued Wicker. "We consider it an investment—to educate tomorrow's leaders and to further specialized research."

Computer Jocks

The U.S. Olympic Committee has established the Sports Equipment and Technology Committee (SETC) to develop improved equipment for athletes.

In the past, U.S. athletes have fared very poorly in "high technology" sports. In a study of the 1976 Montreal Summer Olympics and the 1980 Lake Placid Winter Olympics, it was found that the U.S. won no gold medals in high tech sports such as canoeing and luge. They won 10 gold medals in medium technology sports like archery and ice hockey, while winning 30 golds in track and field and other low tech sports. The committee was created in response to the athletes' expressed need to compete more successfully in high tech sports.

The SETC has a 10 point action program which includes getting feedback from coaches and athletes on superior pieces of equipment, and the problems or limitations of current equipment. The improvement in equipment will place equal emphasis on increased performance and safety.

Mary McDowell

Jim O'Hagan

The Hard Selling of Software

The computer market outlook for the future is bright. Market analysts expect the field to grow by over thirty percent a year, reaching $30 billion by the end of 1988.

Software marketing has brought quite an assortment of packaging styles to the computer consumer. (photo by Dave Colburn)

Every engineering student realizes the impact of computers on the consumer market. For uses varying from video games and recipe lists to corporate management aids and statistical analysis, personal computers and the software needed to operate them have appeared throughout the American marketplace.

With this boom, the quantity of computer packages now retailing has soared, as has the number of firms dealing in the business. With the huge quantity of software now entering the marketplace, competition for the consumer dollar is paramount. Thus enters marketing.

Early in the growth of the personal computer business, many small software companies were able to survive merely by developing advanced software designs. David Wagman of Softset Computer Products explains that this is no longer the case, as both a strong product and a strong marketing direction are now vital.

One example is Lotus Development Corporation which recently spent over $1 million just to launch its first product. This advertising budget not only made the Lotus 1—2—3 package enormously successful, but has prompted other companies to follow suit. In fact, the cost of entering a new software product into today's market is estimated at nearly $8 million by the president of Ashton-Tate, developers of the dBase II program.

This marketing has taken on several forms. The most traditional, and still important, method is simply the development of a superior product. Even this method, however, is being approached in new directions. One company, Wyly Corporation, had its staff of salesmen instruct programmers on the needs of their customers. As a result, a $20 million effort to revamp their software line was undertaken.

Other methods of selling computer products have not been connected with the technical side of computer programming at all. Hewlett-Packard recently hired a staff of market researchers from General Mills, and a former President of Pepsi-Cola now works for Apple. By bringing in professionals familiar with the subtleties of sales and advertising, these corporations hope to compete more successfully.

This large flux of marketing takes its first aim in advertising. Advertising now can be used especially well because the publishing industry has been quick to adopt itself to the growing computer industry. In 1980, there were 500 books on personal computing being published; today there are over 4200. More importantly, 300 personal computing magazines are in circulation. The November, 1983, issue of *Byte*, a McGraw-Hill published magazine for computer hobbyists, was the thickest magazine of all time with 742 pages, primarily due to advertising.

Originally reserved for trade magazines, computer advertising has grown to become a significant portion of revenue for most major magazines, and has extended to television as well. IBM has chosen Charlie Chaplin as its symbol, seeking to emphasize the humanizing appeal of a work-saving PC. Meanwhile, Apple Industries has attempted to portray IBM as George Orwell's character Big

continued on page 14

Technovations

Under the Big Top

The newest trend in roofing architecture will be used in the construction of the International Stadium in Riyadh, Saudi Arabia. A fabric roof, manufactured by the Chemical Fabrics Corporation, will be used to cover the 11.5 acre stadium. The stadium will be the largest, most complex single tensioned structure in the world; it is scheduled for completion by mid-1986.

The extreme environmental conditions found in Saudi Arabia precluded the use of traditional roofing systems. The architects also wanted to comply with international sports regulations which require available natural light for certain sporting events. Many possible designs, including a steel arch system, were considered, but the tensioned fabric roof proved to be the most dramatic and cost effective solution.

The architectural fabric is translucent in order to allow illumination of the stadium by sunlight, but it also has a high degree of reflectivity to block out excessive heat and light. This reduces the solar heat gain which increases spectator comfort. The pre-stressed fabric is coated with Teflon, making it a self-cleaning surface.

Slip Slidin' Away

The large scale erosion of miles of U.S. shoreline each year has seemed to be an insurmountable problem. Sandbags, retaining walls, and valiant Dutch boys have been the traditional solutions. Now Reservco Inc. manufactures a product called Armormat which could provide a long term, economical solution.

Invented by Raymond J. O'Neill, Armormat is a system of interlocking high strength concrete modules specifically designed for soil stabilization and hydraulic engineering structures that must resist the erosive effects of water, storm driven waves, turbulent flows, high velocity current, and sheet ice. The tri-directional interlock shape of the module provides high stability, flexibility and permeability, while its surface baffles dissipate wave energy.

The module derives its stability from alternating layers of metallic strips and compacted soil in frictional association. Because of this inherent stability, no massive foundation is needed. Armormat minimizes the buildup of foul smelling debris in waterfront installations and reduces the likelihood of rodent infestation found in open face structures.

In use since 1981, Armormat modules have been used in more than a dozen locations in New Jersey and New York. A recently completed installation in Louisiana, where a highway was being rapidly eroded by the Gulf of Mexico, withstood two major storms with no sustained damage.

Patent Processing Expedited

A new multi-million dollar system for patent application processing could speed the processing period by 7 months. This would represent a dramatic improvement in the processing time which is currently 25 months.

The Commerce Department's Patent and Trademark Office has selected a team consisting of Planning Research Corporation (PRC) and Chemical Abstracts Service (CAS) representatives to develop and install the new system. PRC will design, engineer, and integrate the system, while CAS will provide much of the software.

The system is being developed and installed in three stages. The first of the 15 areas of technology into which the Patent Office is divided will be automated by the end of this year. Following evaluation, the remaining 14 areas will be automated by 1987. In the third stage the system will be expanded to include the public search room and the Patent Depository Libraries. Future goals include links to European and Japanese patent offices.

The automated patent system will use software developed by CAS over the past 10 years for its own operations, including programs for recording and searching chemical structure diagrams, text searching, database management, and computer-directed photocomposition. Additional software will be developed by CAS and PRC, and some will be procured commercially.

The U.S. Patent and Trademark Office has 25 million documents on file and expects that figure to double by the end of the century. It receives 20,000 documents a day and under its current system can only process approximately 100,000 patent applications a year.

Lifesize Video Games

Tactical fighters and other future aircraft may have their first taste of action in a $53 million simulation center being constructed by Lockheed-California Company that can duplicate a realistic flight environment complete with enemy threats, engine noise, and storm fronts.

The new Weapons Systems Simulator Center (WSSC), designed to develop the next generation of tactical airborne weapons systems and other concepts, is expected to be fully operational by early 1987. The center will allow Lockheed pilots to electronically fly new aircraft concepts and eventually enable engineers to design high performance airborne systems using the informaton obtained from the simulations and evaluations.

The main component of the WSSC will be a tactical mission simulator where engineers can realistically simulate nearly any type of flight mission from takeoff to landing, employing advanced electronic systems and lifelike air combat situations.

Mary McDowell

continued from page 10

power, these devices can be rotated to positions that will help diminish the turbulence around a structure.

Another idea utilizes two skyscrapers with a cable stretched between them. The structures would be designed to have different natural frequencies of vibration so that they would seldom sway in identical directions at the same time. Because of the different frequencies, there would be times when the buildings would move away from each other. At these moments drag would be added to the cable, damping the acceleration of the buildings. Likewise, as the high-rises moved towards each other slack would be taken up in the cable. Overall, applying drag and taking up slack would suppress the motion of both buildings.

Klein draws an analogy between this technique and a struggle between a fisherman and a fish. The fish is difficult to reel in when it is moving away from the fisherman, so the fisherman puts drag on the line to wear down the fish. Conversely, when the fish moves toward the man, the line can easily be reeled in. Thus the fish is efficiently reeled in to the ideal position—the fisherman's hand. Similarly, the cable system could keep the buildings in ideally vertical positions.

To reap the full benefits of this technique, the buildings must be specifically designed to use it. Ideally, each structure would be non-symmetrical and have a different natural frequency of movement than its partner. Unlike a symmetrical building, the cabled ones would tend to have all of their motions coupled.

In other words, motion in one direction, such as north-south or east-west, or a twisting of the building, could affect motions in the other directions. The force applied by the stretched cable would then control motion in all directions. Skyscrapers, such as the Twin Trade Towers, could not easily be used because they are symmetrical and identical to each other, and would thus have uncoupled motions and have identical periods.

What is the future like for Klein's idea? One should note that TMD's have only been used to make the occupants of high-rises more comfortable. Neither TMD's nor Klein's idea of semi-active control have been seriously considered to provide the major means of support in a structure. As with any new technology, semi-active control must be accepted by those who use it.

Since this technique has never been tried before, it has many risks which may be impossible to determine. City building codes would have to be changed to allow the use of less steel in the skyscraper. Engineers can not yet test such a configuration because no wind tunnels exist which can create the appropriate slow wind speeds, and because the actual elastic behavior of a structure cannot be scaled down.

Klein does believe, however, that in several decades the need for skyscrapers twice as tall as the Sears Tower will be greater. This will be especially true in cities such as Hong Kong and Singapore where available land is extremely limited. Only then will these new ideas be attempted. ■

continued from page 12

Brother through a $400,000 television commercial produced by the creator of the movies "Alien" and "Blade Runner."

Another idea, adopted by Epson in an attempt to gain more shelf space for their products, consists of marketing a small television set to build name recognition. Named the Elf, the television consists of a 2 inch diagonal, color liquid crystal display (LCD) screen. By marketing it with the Epson logo, the firm hopes to gain familiarity among retailers which will in turn help computer sales.

Publicity stunts have also been attempted by some companies in an effort to gain name recognition, and thus sales. Atari, for instance, offers one 800 XL computer for 3125 Alpha-Bits cereal proof-of-purchase coupons.

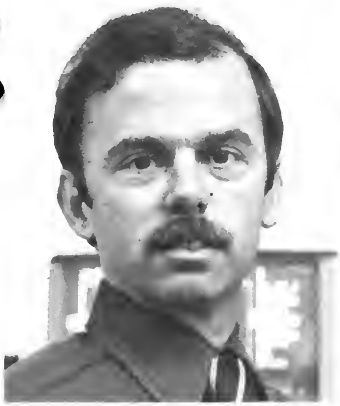
Another approach for gaining sales is the attempt to make the software easier to understand. MicroPro International Corporation does this by hiring journalists to write instruction manuals for today's less technical customers.

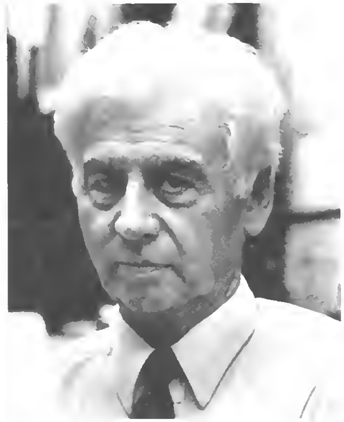
A similar effort is being made by some firms to get new software products onto store shelves. By combining efforts with book publishers, who are also entering the market, software firms have been able to take advantage of traditional book distribution channels. This makes it possible to put new products directly into established stores rather than having to compete with other firms in sales to retailers.

Yet perhaps the biggest tool which computer firms have is the influence of computers on modern teaching. When a student learns to use a computer by operating one at school, he is likely to lobby his parents to purchase the same type for use at home. Apple chairman Steven Jobs offered a free Apple IIe computer to every grade school and high school in the United States in return for federal tax credits—but Congress refused the offer.

IBM has been following a similar plan on the college level for 3 decades. By giving universities a discount rate or free equipment, it increased sales to higher education facilities. IBM then benefits when these students graduate and become influential in industrial purchase plans.

As the computer industry has expanded, the non-technical aspects of the market have received greater emphasis. Yet despite this change in priorities, the demand for quality programming has continued to grow, resulting in a promising future for aspiring firms and individuals. ■





Michael H. Pleck, an associate professor of general engineering, earned B.S., M.S., and Ph.D. degrees in mechanical engineering from the University. He currently teaches the honors section of G.E. 103, as well as carrying out research in the solid geometric modeling area of CAD/CAM.

Pleck's research concentrates on the mass property analysis and the interface between solid and boundary representations of objects. Pleck previously researched theories of decelerative metal cutting and its application to energy management systems like energy-absorbing bumpers. Pleck also did varied work in computer graphics.

Pleck, who was once a visiting scholar at Hokkaido University in Sapparo, Japan, has received several awards for his outstanding instructional abilities. Pleck was presented with the College's Everitt Award and the Jaycee's Outstanding Young Educator Award in 1974 and 1977, respectively. Pleck also received the SAE Ralph R. Teetor Award for contributions in teaching, research, and student development in 1980, and in 1983 the ASEE Western Electric Fund Award for excellence in instruction.

J. Scott Woodland

Dr. Michael C. Loui received his B.S. degree in mathematics from Yale University in 1975. He went on to attend the Massechusetts Institute of Technology where he earned his master's in electrical engineering/computer science in 1977, and his Ph.D. in computer science in 1980.

Loui came to the University in January 1981 as an assistant professor of electrical engineering. In his own words, he endeavors "to educate students to read critically, reason logically, and write clearly." He does not make students blindly memorize facts and formulas; instead he teaches concepts.

Loui is currently investigating various methods that can be used to increase the computation speed of digital computers. He has worked with sorting algorithms, array simulation, and distributed computation. In the future, he will continue his research in combinatorial optimization.

When one considers the amount of time Loui spends with teaching and research, it is surprising to find that he has time for non-academic interests. Loui the artist composes music for the piano, sings in operas, and performs in plays. He also enjoys cycling, swimming, square dancing, and ballroom dancing.

Raymond Hightower

Peter Yankwich acquired his bachelor of science degree in chemistry from the University of California at Berkeley in 1943. He received his Ph.D. at the same university in 1945.

From 1945 to 1948 at Berkeley, Yankwich was an instructor teaching general chemistry as well as a scientist researching in the radiation laboratory.

Since his arrival here in 1948, Yankwich has worked on two major research projects which have accounted for a large portion of his 80 publications. During a span of 10 years, he studied the chemical effects of nuclear transformations. His second major project, which encompassed 25 years, examined the effects of isotope substitutions on reaction rates. More recently, he has studied enzyme reactions.

Between the years 1977 and 1982, Yankwich served the University in the capacity of Vice President of Academic Affairs.

Reflecting on his former position, Yankwich feels that students should not only study subjects deeply, but also study them broadly in order to be successful in post-university life.

Pete Borowitz

from page 3

Tech Teasers Answers

1. 157,894,736,842,105,263.
2. Friday.
3. Sklodowska.
4. 353.703 square inches.
5. 567 and 321489; 854 and 729316.
6. 22,374.63 square feet.
7. In the left handed sense, i.e. in the direction that the fingers of the left hand curl when the thumb is pointed in the direction of the electron's motion.

OUR SCHOLARSHIP HELPS YOU BEGIN YOUR CAREER AS A LEADING ENGINEER.

An engineering degree will take you far in today's high-tech Army. And with an Army ROTC scholarship, earning that degree can be both less expensive and more valuable.

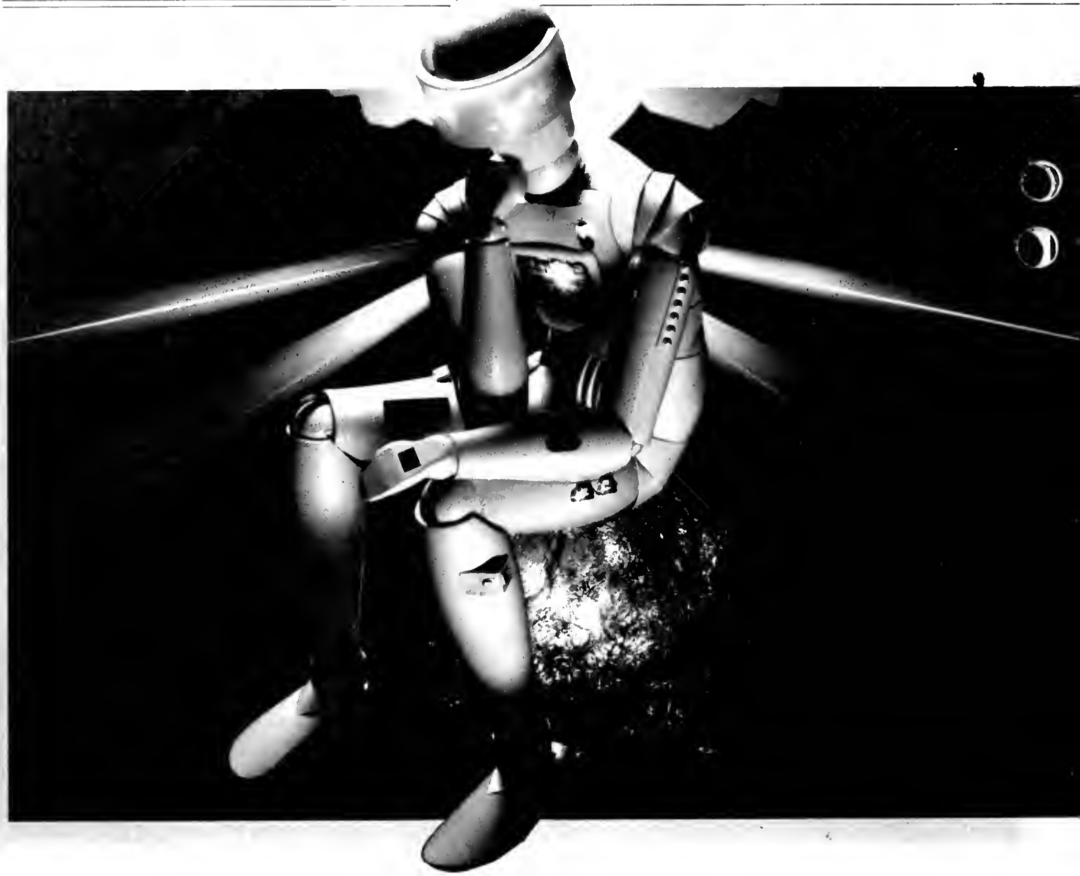
The scholarship not only pays your entire tuition, regardless of the amount, but also required fees, an amount for books and supplies, and up to $1,000 each school year for living expenses.

It's an excellent scholarship. And it gets you a lot more than an engineering degree. Along with your regular courses, you'll take Army ROTC classes and learn about motivating people, analyzing situations, making confident, informed decisions, and reaching defined goals. In short, you'll learn leadership and management skills that can't help but enhance your opportunities in the future.

And you'll put your skills to work right away, because you're commissioned in the Army as a second lieutenant when you graduate.

If you'd like an education in leadership and management to go along with your engineering degree, find out more about Army ROTC. Contact your Professor of Military Science at the Univ. of Illinois, 333-1550.

ARMY ROTC.
BE ALL YOU CAN BE.



Create computers that capture the mysteries of common sense.

The brain does it naturally It wonders It thinks with spontaneity–advantages we haven't been able to give computers We've made them "smart," able to make sophisticated calculations at very fast speeds But we have yet to get them to act with insight, instinct, and intuition

But what if we could devise ways to probe into the inner nature of human thought? So computers could follow the same rationale and reach the same conclusions a person would What if we could actually design computers to capture the mysteries of common sense?

At GE, we've already begun to implement advances in knowledge engineering We are codifying the knowledge, intuition and experience of expert engineers and technicians into computer algorithms for diagnostic troubleshooting At present, we are applying this breakthrough to diesel electric locomotive systems to reduce the number of engine teardowns for factory repair as well as adapting this technology to affect savings in other areas of manufacturing

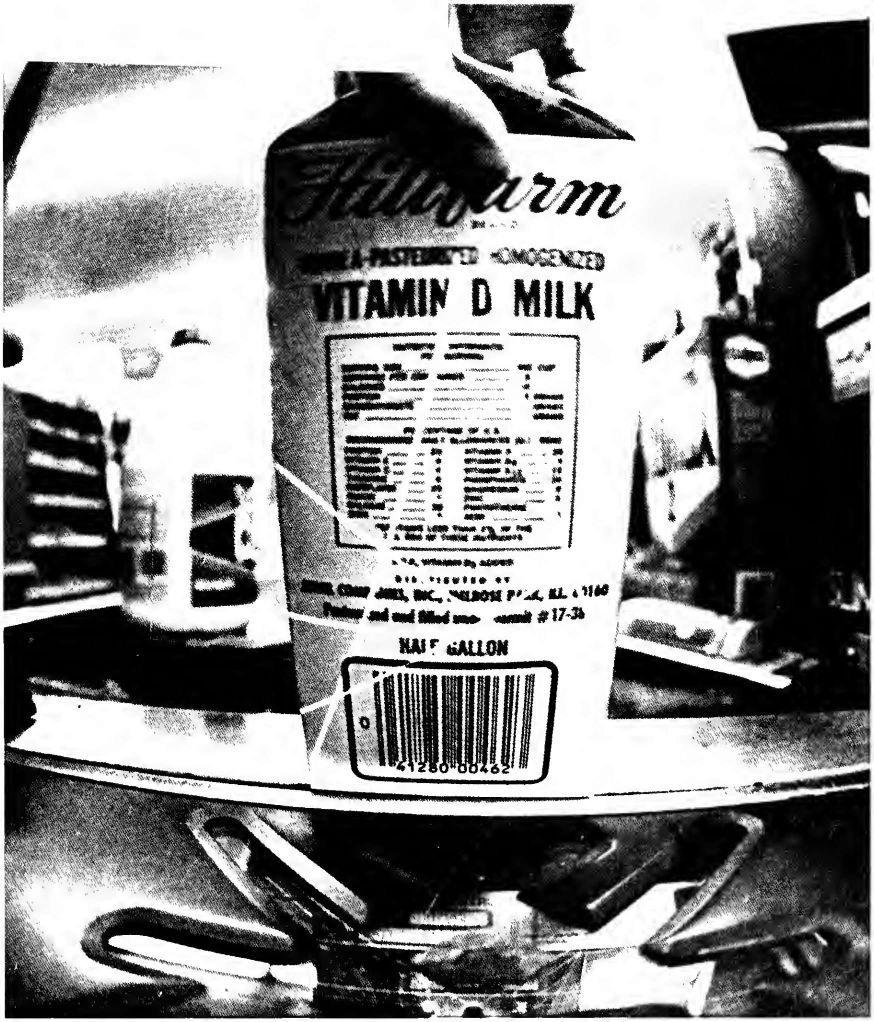
We are also looking at parallel processing, a method that divides problems into parts and attacks them simultaneously, rather than sequentially, the way the human brain might

While extending technology and application of computer systems is important, the real excitement and the challenge of knowledge engineering is its conception At the heart of all expert systems are master engineers and technicians, preserving their knowledge and experience, questioning their logic and dissecting their dreams As one young employee said, "At GE, we're not just shaping machines and technology We're shaping opportunity"

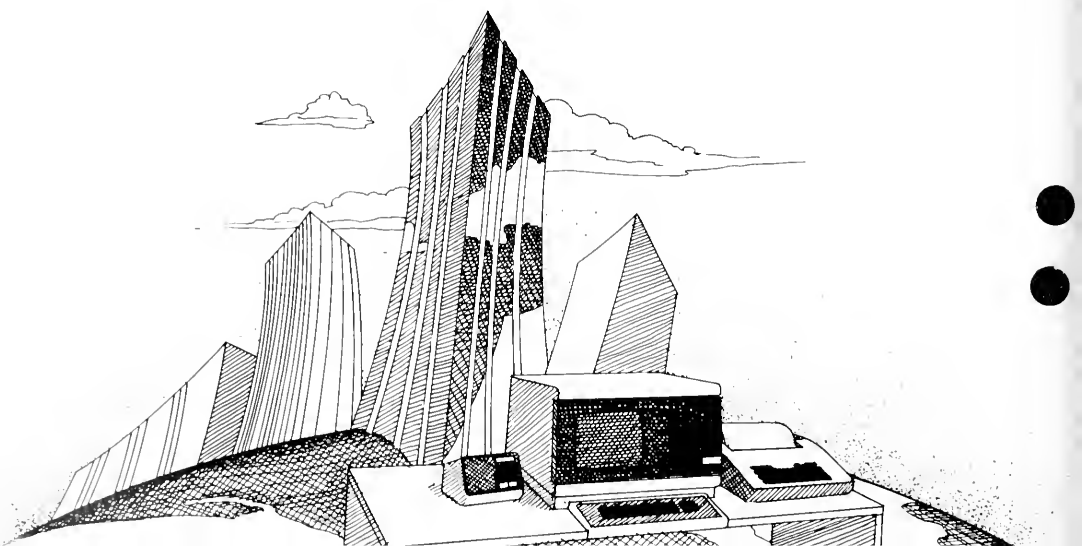
Thinking about the possibilities is the first step to making things happen And it all starts with an eagerness to dream, a willingness to dare and the determination to make visions, reality

An equal opportunity employer

If you can dream it, you can do it.



Laser Scanners



Illinois

Technograph

December 1984 Volume 100, Issue 3
Celebrating 100 years of publication

4 **Electronic Protection** *Mary Kay Flick*
Security is already a booming business, but new advances in electonics make systems more secure than ever before.

6 **Supermarket Super-Scanners** *Randy Aksamit*
Laser technology has reached the local grocery store, using advanced electronics for identifying and pricing groceries.

8 **High-Tech Piracy** *Marco Sims*
New equipment has allowed wider choice for television viewers and music listeners. Now consumers and industry must deal with the difficult legal questions of rights and profits.

10 **Is There A Need for Technical Writing?** *Pete Nelson*
The need for engineers to communicate has raised questions of the writing abilities of college graduates.

Departments
Editorial 3, Tech Teasers 3, Technovisions 7, Technotes 9, Technovations 11, Techprofiles 13

On the cover: Laser scanners reduce checkout time and eliminates the need for individually priced items—benefitting the consumer and supermarket alike. Scanner courtesy of Diana Foods, 400 S. Broadway, Urbana (photo by Dave Colburn).

Illinois Technograph invites letters in response to its articles and editorials, or any other items of interest to our readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.

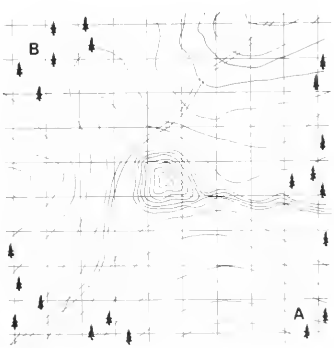
Illinois Technograph (USPS 258-760) Vol. 100 No. 3 December 1984. *Illinois Technograph* is published five times during the academic year at the University of Illinois at Urbana-Champaign. Published by Illini Media Co., 620 East John St., Champaign, Illinois, 61820. Editorial and Business offices of the *Illinois Technograph*, Room 302 Engineering Hall, Urbana, Illinois, 61801, phone (217) 333-3558. Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001; 221 N. LaSalle Street, Chicago, Il., 60601. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois under the act of March 3, 1879. *Illinois Technograph* is a member of Engineering College Magazines Associated

Tech Teasers

1. What is the least multiple of seventeen which, when divided by any of 2,3,4,. . . .,16 leaves 1 as a remainder?

2. What famous scientist is credited with saying, "Anything that won't sell, I don't want to invent."

3. Due to an EPA crackdown, Santa Claus can no longer distribute bituminous coal, readily found in the North Pole, to bad children, but must instead use anthracite coal. To find this rarer type, he sends two elves to search an area in southern Illinois so that the stockings of naughty kids might be filled. They must search every square on the map except the central square, which is a small pond. They can proceed horizontally and vertically but not diagonally, and only one elf can search each square once. The first elf goes from A to B, the second from B to A. Draw their paths so that each one passes through the same number of squares.



answers on page 12

Editorial

The Write Solution

All across the country, engineering schools are finding renewed interests in revamping their graduation requirements. The dilemma is that few schools are touching the surface, much less the roots, of the problem.

College is supposed to be a place where students take their groundwork and polish it in some reasonably specialized area. So why aren't all entering freshman at the University fluent writers and articulate orators? Perhaps because they didn't get enough liberal arts classes in high school.

Partly because of this our current engineering students are considered semi-literate. But how can this be? After all, the technical student here at the University already has to take Rhetoric 105 as well as 18 hours of humanities and social sciences electives. So why doesn't he communicate well?

Because the engineering students and faculty don't take the requirements seriously. Many advisors treat the humanities and social sciences as courses to get out of the way, so that the degree can be obtained. The students choose "blow-off" courses like Music 100 and Classical Civilizations. The unwritten rule for the engineer is "if it doesn't require any written papers, I'll take it." So how are more humanities and social science requirements going to help when they're faced with this kind of oppostion?

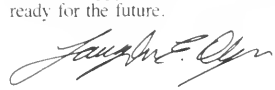
The first of four parts to the only feasible solution for all these related problems is to put more emphasis on writing, grammar, and oral communication in high school curricula. The best time to teach people how do deal with others on intelligent levels is while they are young, and not after they think they have made up their minds about their future. Once in college, they should be able to apply their already excellent communicative talents to their respective areas of study.

Number two is a concerted attempt by advisors, administration, and the students to get rid of anything that isolates engineers from the rest of the University. Specifically, this includes the abolishment of specialized Rhetoric sections for engineers only. A big part of the ability to communicate comes from looking at situations from all different angles. When you are always with engineers, you can't help but keep a technically one-sided view on life. When you are exposed to students of different majors, and are forced to compete with them for grades in subjects that are not always technical in nature, you can become more broad-minded.

Although it is necessary to learn to write and talk about subjects that are not technical, the same skills must be strengthened in the technical areas. Engineers will have to write technical reports and give oral presentations of projects, and practice is best obtained in college. There are a few engineering classes that currently require some sort(s) of paper writing or oral reporting, but *all* basic technical requirements should include some form of technical paper and/or spoken report as part of the grade.

And there is the final part of the solution: student/advisor-defined electives. Currently, most engineering curricula have space for 6 hours of free electives. Why not change the system so that these 6 hours can only be fulfilled by consent of both the advisor and the student? Ideally, the student should think about and research the various ways the free hours could be used. The student would then talk to her advisor, and they would mutually agree on what is best for the student.

The end result of this four-phased solution would not only be engineers who can write and speak well, but students who are happy with their education and ready for the future.



Mary Kay Flick

Electronic Protection

Since the Egyptians invented keys centuries ago, technology has played an important role in helping people to feel secure. Now, with the development of advanced electronics, innovative and custom-made security systems allow businesses and homeowners to protect their property.

A man dressed in black pants, a hat and gloves, and a dark sweater slithers through bushes around a modern well-kept home. He is a professional, seasoned by years of trial-and-error. The man is a cat burglar. Every night this man fights an uphill battle to earn his livelihood. However, his biggest enemy is not the law; it is technology.

The effects of the technological revolution have reached far into countless industries, including the security industry. It is estimated that 1 out of every 20 homes will be burglarized this year with a projected property loss totaling 8.5 million dollars. As homeowners become increasingly frustrated with the ineffectiveness of local law enforcement officials, they have turned to highly sophisticated electronic security systems.

This trend began in 1976 with the launching of home smoke detector sales. This year, home burglar alarms may enter the security appliance market. A widely varied market, security systems vary by the needs and budgets of security customers. Virtually endless combinations of components can be tailored into remarkably efficient entry deterrents.

Security systems employ various techniques to deter an intruder. The system's actual tactics depend on its purpose. Some systems may simply wish to give a would-be intruder the idea that a residence is occupied—thus discouraging a burglary attempt. Others actually try to catch the crook as he enters a building.

Variable light timers have been around for a long time; however, these may eventually be discerned by a determined thief. Therefore, adding the element of surprise to the power of light may create an effective barrier to a criminal. Colorado Electro-Optics, Inc. has such a system. It is a passive infrared sensor which detects changes in thermal radiation and then activates flood lights. So, when an intruder enters the 25 by 40 foot detection range, it activates external lighting as if the resident were about to come outside. It is a fairly simple system with powerful implications.

Similarly, other systems seek to warn residents of approaching persons. Metal detecting sensors can be buried underground to warn of approaching vehicles. This system consists of a sensor tied by coaxial cable to a warning device. As a vehicle approaches, the sensor sends a signal to any combination of sirens, lights, or bells. This system can be used either as a deterrent or simply to signal approaching visitors.

Buried sensors may alternatively use different detection techniques of discovery. Another system uses a sensor buried four to six inches underground which creates a shield of electrical energy that specifically detects human intrusion. The accuracy of the sensor can be increased if it is made insensitive to seismic or pressure changes, and to intrusions by small animals.

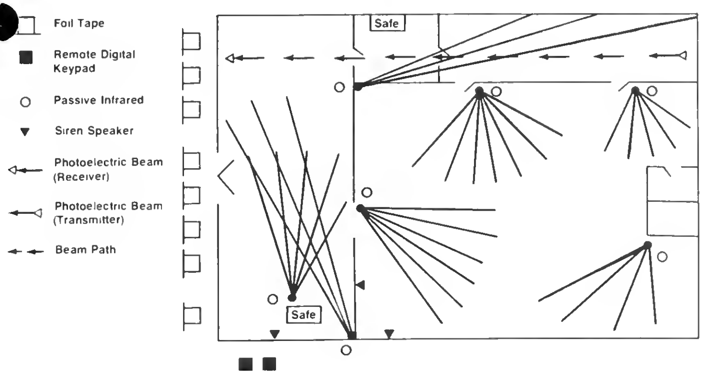
These types of security systems are set off before a thief reaches a home or business facility. In contrast, many systems are triggered only when a criminal actually breaks into a building. These devices may signal entry by detecting glass breakage, interruption of an infrared field, photoelectric beam, or electronic circuit, or simply with a closed circuit television system.

Closed circuit television (CCTV) has been used for many years. However, poor visibility in low light situations has always been a problem. Cameras have now been developed which can record activity in what is completely dark to the naked eye. Nevertheless, CCTV is still an expensive security system because of the cost of constant surveillance personnel. Therefore, it is often used with other types of detectors so that fewer people are required to monitor the system.

Such detectors may include shock detection devices. These are placed in strategic locations about windows, doors and other entry points. The first devices of this type consisted of foil strips which ran around window perimeters, or foil patches placed on windows. However, since these are easily discovered by intruders, a move was made to develop more concealable shock detectors. Therefore, small sensors, usually about an inch big, were developed to be placed on windows. The prototypes responded to changes in conditions which caused excessive false alarms. The current shock detectors respond to the frequency of breaking glass or to changes in resistance of a weighted crossbar within the sensor. These sensors may be hardwired into the rest of a facility's security system.

An alternate system to shock detectors might utilize alarm screens. The screens look like ordinary window screening, but have small wires woven into them in vertical or horizontal patterns.

Illustration of Typical Security Coverage in a Building



Source: After *Security Distributing and Marketing*, July 1984.

When a screen is cut, a circuit is broken which triggers an alarm. These devices have the advantage of being camouflaged against intruders.

Many systems simply try to control access to certain areas. Barriers are created by placing limited access control units at points of entry. These usually consist of a telephone-style keypad or an electronic magnetic tape card reader. A person authorized for entry simply inserts a card into the unit and types in his access code. The unit may stand alone or be connected with many others by a small programmable microprecessor. The system can be programmed to disallow repeated tries at entering codes, thus discouraging random code entering.

Perhaps the most invisible systems use passive infrared (PIR) devices. The systems consist of a detector unit which drops either a spoked or blanket pattern of infrared energy. When an intruder breaks the infrared curtain, he triggers an imbalance in the infrared energy, which can set off sirens, send calls to police, or alert the homeowner to the prescence of an intruder. The greatest problem with PIR systems is their susceptibility to false alarms, making them costly and bothersome. More accurate detection ability means less likelihood of false activation. In addition to invisible detection fields, most PIR units are fairly small and some companies have even manufactured them to look like ordinary room thermostats.

Similar to PIR's, some systems use photoelectric beams to detect intrusion. They consist of a photoelectric transmitter and a receiver. When an intruder passes through the beam, the connection is broken, thus triggering an alarm. Usually, several of these are used together to provide wide coverage.

However, photoelectric beams can be used other ways to provide security. A small transmitter emits a photelectric "key" which is received by a "lock." The user simply points the transmitter at the receiver to gain entry. The "key" cannot be copied at the local locksmith, and works in places that real keys and limited access cards cannot.

Although the reliability of each component is essential to the success of the system, it is the actual system which provides the security to its user. Usually a system must be tailor-made to incorporate the specific needs of a client. For example, a particular business may have shock sensors or alarm screens on windows and PIRs placed to cover doorways or display cases.

Thus, providing electronic security systems is becoming one of the most highly growing and competitive industries. The number of homes and businesses desiring security is increasing along with those companies involved with providing these services. However, questions have been raised concerning the old-fashioned values of customer service. One of these queries is whether or not home security devices will become appliances rather than services.

Whatever the outcome, the security industry is bound to become a major factor in most people's lives. This will include the life of the cat burglar whose simple tools are no longer a match for technologically advanced security systems. ■

Randy Aksamit

Supermarket Super-Scanners

The development of laser scanners for supermarket checkout lanes has brought lower prices and less waiting for American consumers. Current technology has improved the speed and efficiency of these powerful devices.

March Supermarket in Troy, Ohio unknowingly became a trendsetter when, on June 27, 1974, it became the first store to employ computer scanning of Universal Price Code (UPC) symbols. The idea of a checkout counter scanner that could read codes on grocery items was conceived in the 1950's by both Philco and Sylvania, but widespread use of supermarket scanners did not begin until 1980.

The original intent of the scanners was to reduce operating costs. Laser scanners eliminate the need for individually priced items, saving stores both time and money. Additional savings are also created at the check-out counter, where fewer checkers are needed. First estimates of total savings ran as high as 1.4 percent.

The customer also benefits from this system. The speed of the laser scanner decreases the waiting time in line. The receipt gives a detailed listing of each item purchased. Also, due to the store's lower operating costs, savings are passed on to the consumer.

The theory behind laser scanning is easy to understand. When an item is pulled over the scanner slot, a laser "reads" the code and sends it to a central computer. The computer identifies the product by matching the code against a master list and sends back price information and a description. The entire process takes only a fraction of a second.

What is more difficult to understand, however, is how the laser actually "reads" the code. As an item approaches the scanning window, it breaks a detector beam which causes a shutter inside the machine to open momentarily. While the shutter is open, a scan pattern from a Helium-Neon laser projects up through the window and sweeps across the product at a constant speed. The beam bounces off the UPC code and reflects back down through the scanning window.

Inside, a photodetector measures the amount of light reflected from both the black bars and white spaces on the symbol, since a dark bar reflects much less light than a white space. The beam velocity is constant, so the length of time recorded for each bar or space is directly proportional to its width. These signals are digitized and sent to the central computer which decodes the symbols based on their scan times.

Because this method relies only on the relative times of reflection, the code can be of nearly any size and scanned in any direction. The possibility that the symbol might be read upside down is also taken into account and corrected through the use of parity.

The first scanners were able to read only UPC codes located on the bottom of a package. Their scan pattern consisted merely of two straight lines, crossed to form an X. The next advancement introduced scanners that used moving mirrors to produce nonsynchronous cosine waves, and thus formed a Lissajous pattern. This pattern provided a greater depth of field, which had the advantage of being able to read symbols on the front of a package if it was tilted slightly towards the window.

The current generation of scanners has the ability to "wrap around" package corners, allowing them to scan the bottom as well as all four sides of the item. This task can be accomplished by one of two different methods.

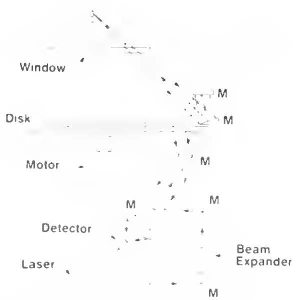
The first method involves projecting a pattern consisting of a double-X on the item; because of the beam exit angles, its scan lines are mutually perpendicular, or orthogonal, in five planes. This is accomplished by reflecting a split laser beam off a rotating mirrored polygon. The pattern is simple enough to require only small open slits in the scanning window, eliminating the need for a glass cover.

The alternate five-sided scanning pattern boasts the use of a rotating holographic disk. Optically stored on the disk are various combinations of interlaced X patterns and horizontal and diagonal lines, all with different focal lengths. When the laser beam hits the spinning disk it projects numerous short scan lines, completely surrounding the item. This is an improvement over the previous method which uses only a few long scan lines with the same focal length. The holographic arrangement also provides a much denser scan pattern, resulting in a quicker response time.

When the laser scanner was first introduced, many activists were against its continuation. They feared that grocers would have the ability to rapidly increase prices, leaving the consumer helpless.

continued on page 12

The Optical Design of a Scanner



Source: After *IBM Journal of Research and Development*, March 1982.

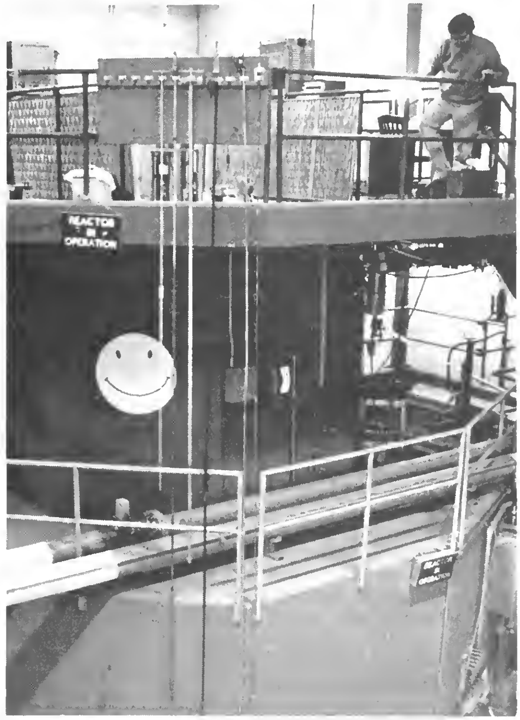
Measuring a Pulse

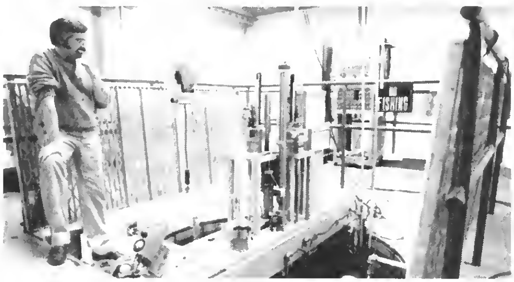
The University is home to a working nuclear reactor known as the TRIGA Reactor.

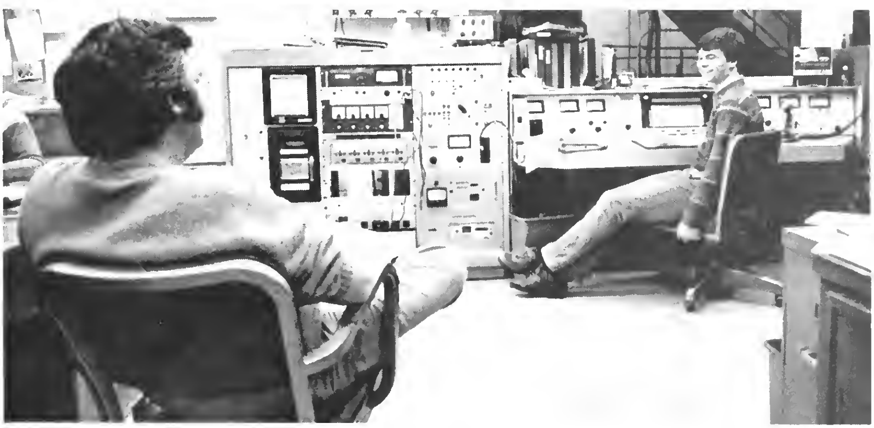
Uranium with a 20 percent enrichment of U-235 is the fuel from which the reactor derives power. This fuel is contained in control rods that can be selectively exposed to create different power levels. A control rod can be suddenly removed using air pressure resulting in a pulse of energy during which power is increased from a few watts to 6 billion watts in a fraction of a second. This pulse, seen as a flash of blue light, can be viewed from on top of the reactor core through 16 feet of water.

Nuclear engineering 390 is a class specifically designed to experiment with this reactor. In the laboratory session pictured, the flux of neutrons that occurs during a pulse was analyzed.

Below: Craig Pohlod, senior reactor operator, checks the operation of a control rod motor from a perch on top of the reactor. Right: Pohlod prepares to take data on a plotter as the reactor is pulsed. Bottom: Pohlod talks with Peter Kirby, senior in Nuclear engineering, about their experiment from within the control room. *(photos and text by Dave Colburn)*



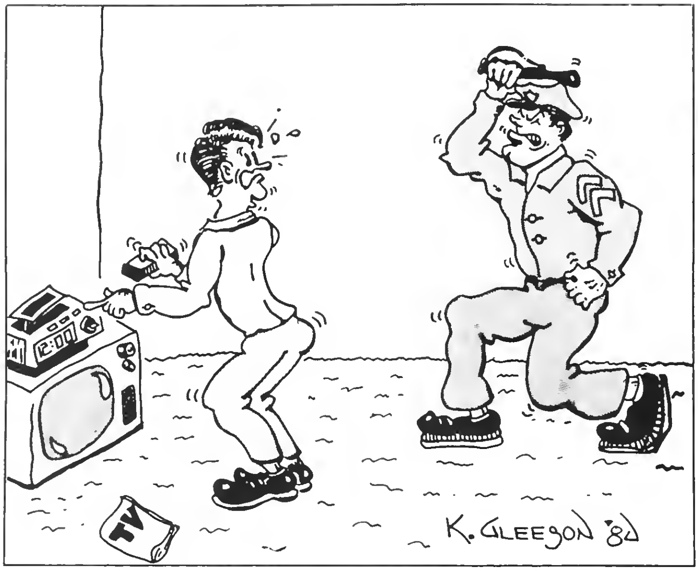




Marco Sims

High-Tech Piracy

The popularity of home cassette and videotape recorders has created a multi-million dollar industry, but the question of who should profit from this technology is still unsolved.



Quick, hide the videotapes, it's the Beta-Police!

Although home-videotaping of television programs is not illegal today, proposals have been put forth to make it so by the television and motion picture industries. Since 1976, several attempts have been made to either place a royalty on the sale of VCR's and blank tapes, or outlaw home recording altogether. So far, no new laws have been passed, but considering the number of issues involved and the adamant positions of each side, the dispute is far from over.

As the situation currently stands, Sony, a leading defender of home videotaping, has won the important battles. Sony was first sued in 1976, but the Los Angeles District Court ruled in their favor. Universal Studios and Walt Disney Productions, opponents of home videotaping, appealed, and in October of 1981, won their case, with home videotaping found to be in violation of the Copyright Act. Sony appealed to the Supreme Court, which just recently upheld the earlier ruling.

The ramifications of this and other copyright rulings are enormous considering the number of individuals they affect. At stake is not only home videotaping, but also recording of phonographic records. If the movie and television corporations could receive a royalty for the sale of blank videotapes, the record companies may press for similar funding from the sale of blank audio casettes.

While no reliable figures are available, few analysts deny that this problem of record reproduction is widespread. The situation is worse for the record industry than for motion picture and television corporations, because it's far easier and less expensive to tape an album than videotape a television show. In fact, some stores now rent records for a short time, and stereo manufacturers sell tape decks that can copy one tape from another.

The dilemma with videotaping arises from a simple question of economics. Jack Valenti, president of the Motion Picture Association of America, suggests charging a royalty of 25 dollars a video machine and 25 cents per tape. This would have generated 57 million dollars in 1982 alone. This figure, however, doesn't consider the loss in potential advertising dollars. Television executives attribute this loss to less satisfied advertisers who know their ads can be editied out of videotaped programs.

Another major difficulty in the motion picture industry is video piracy, which amounts to over 700 million dollars each year. Usually, a projectionist takes the reel home and makes a copy, but more sophisticated video pirates have connections in the studios, thus allowing them to copy a movie before the theaters have even received it. Essentially any film can be obtained, although the prices can be high.

Most movies are pirated long before they're even released to the theaters. One wealthy Saudi Arabian was watching "E.T." two months before the release, and one British pub was running "Rocky III" weeks before the official release, and was even charging admission. The motion picture industry already has the help of legal authorities worldwide on this issue, which is but one facet of the home videotaping question.

Although individuals can still record programs at home, questions that have yet to be answered are how much longer or at what price home recording can go on. And with the sale of video recorders showing no signs of slacking off, the stakes will continue to increase in the home videotaping war. Don't worry about the Beta-Police just yet, but maybe one day you'll hear an ominous knocking on the door. ■

EOH Scheduled

Plans for this year's annual Engineering Open House are well under way. Slated for March 1 and 2, the Engineering Council sponsored event has as its theme "Engineering: Methods to the Madness."

EOH features exhibits from all departments and organizations of the engineering college. In addition, there is a coordinated project which combines the talents of students from all disciplines. The topic of this year's project is food science. Students interested in working on the project should contact Fred Wiesinger in 300 Engineering Hall.

The theme for the Central Exhibit this year is "Mind Over Matter Yields Understanding." The goal is to explain an engineering principle by tracing its history and the methodology of its development. For more information on the central exhibit, contact Dan Weisberg in 300 EH.

Save a Duck

Tau Beta Pi has begun a campus-wide fund raising effort to save the Victor Shelford Vivarium, located near the corner of Wright and Healey Streets.

The area provides a home for a variety of wildlife, including two Canadian geese, a wood duck, 50 turtles, and various species of fish in two ponds. The ponds were designed in 1916, and the clay sealer at the bottom has deteriorated with age. The resulting seepage has completely drained the east pond, and the west one must be continually refilled.

Since the ponds are no longer used for educational purposes, the University will no longer fund their maintenance. Unless $10,000 can be raised for each pond, they will be filled in, stranding their wildlife.

Sporting the theme "Save a Duck," the TBII drive will attempt to raise the money necessary to preserve at least one pond. Their efforts consist of three projects. Donation booths are being operated in the Illini Union and in Engineering Hall from 10:00 am to 3:00 pm on weekdays, a benefit concert is being organized, and a fund raising contest for campus student organizations will soon be underway. Students who would like to help out with one of these projects or who have other ideas should stop by one of the booths or contact Amy Baits at either 333-3558 or 344-6582.

AT&T is Benefactor

AT&T Information Systems will give between $2 5 million and $3 million in computer equipment to the University as part of a $32 million donation program.

The state-of-the-art equipment will be given to the Computer Science Department for use in graduate and undergraduate programming classes and faculty research activities.

"This multimillion dollar gift represents an important commitment to education and research on the part of AT&T Information Systems," said Chancellor Thomas E. Everhart. "The University of Illinois is a national leader in innovative ways to use computers in the instructional process and in research.

"Ideally, all our students should learn how the power of computers can benefit their education and thus their future contributions to society. We are encouraged that AT&T Information Systems clearly recognizes this need and is making a major commitment to ensure this goal."

The donation to Illinois includes two 3B20S super-minicomputers and 58 desktop 3B2 super-microcomputers. High-resolution bit-mapped terminals and high speed networking products to link the equipment also will be donated, and installation and one year of maintenance and support will be provided free of charge.

James N. Snyder, head of computer science, said the donation will be useful in many ways, including replacement of aging equipment in the software and logic instructional labs. In addition, it may now make possible new instructional labs in other sub-fields, and will enhance graduate and faculty research programs.

Company officials said Illinois was chosen for the program because of its "developmental efforts in the computer science and electrical engineering fields," the campus commitment to future technology, and the school's "willingness to participate through the involvement of faculty, students, and administration."

Professor Honored

Robert W. Bohl, professor emeritus of metallurgy and of nuclear engineering, has been selected to receive the Albert Easton White Distinguished Teacher Award for 1984.

Bohl was cited by the award's sponsor, the American Society of Metals (ASM), "for excellence in undergraduate teaching and advice to generations of undergraduate students and service to the profession."

The award, established in 1960 by the ASM, recognizes unusually long and devoted service to the teaching of metallurgy.

A University faculty member since 1946, Bohl received the University's award for excellence in undergraduate teaching in 1979.

Mary McDowell

Pete Nelson

Is There a Need for Technical Writing?

One of the many interrelationships between science and the arts is the expression of scientific ideas and concepts. Too often, however, this art is overlooked by students in the engineering disciplines.

Blemishing the engineering education for many years has been the engineers' inability to communicate. Speaking and writing skills are in high demand in industry; ideas and breakthroughs would be meaningless if the ability to communicate them to others did not exist.

The Dean's Student Advisory Committee (DSAC) of Engineering Council is currently examining the adequacy of language arts training, specifically that received while fulfilling the Rhetoric 105 requirement. The committee feels this may not sufficiently train engineering students in technical writing. DSAC, under the direction of committee chairman Kirk Vanden, is currently questioning engineering students on the effectiveness of the Rhetoric requirement.

Vanden personally feels that training in technical writing should be taught in the senior year when students are sure of the career field they have chosen and can address the needs of their job field. He explains that the school of Aeronautical and Astronautical Engineering's offering of a required course in technical writing is a good start towards a total collegiate policy regarding technical writing courses.

National opinion seems to support this stand. A recent survey of American undergraduate schools by the American Society for Engineering Education found that over 60 percent of those schools requiring technical writing offer a course specifically for Engineering students.

Even in these schools, however, difficulties remain. Nearly 70 percent of those schools which do offer technical writing only offer courses taught by English department faculty. Only one in ten schools encourage students to take technical writing in their senior year. In some engineering programs, no writing courses are required at all, or even permitted as electives.

Engineering Council President Joe Lehman states, "we question whether technical writing and creative writing should be taught in the same course. . . we feel it would be beneficial if they could be broken up."

At Western New England College, technical writing is removed from rhetoric. Instead, it is included in every class. A campaign to improve the writing skills of graduates featured deans speaking to every class on the importance of writing, professors emphasizing writing in assignments, and even lab instructors supporting communication abilitites. A policy was begun requiring a portion of a student's grade in every course to be based on writing proficiency. The result has been a marked improvement in the ability of students to communicate their ideas.

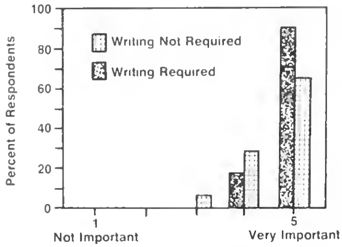
Another idea that has been suggested is technical writing workshops, to replace the traditional lecture-oriented writing courses. Students would be presented with a variety of problems which could arise in industry. They would then outline their ideas in a short paper or revise a writing sample to make it more effective for the given purpose. The instructor would lead discussion pertaining to problems which could arise, summarize points important to the project, or supplement the discussion with further handouts. The workshops would cover several topics including audience analysis, designing effective visuals and graphics, and editing, in addition to writing improvement. These workshops would then lead students in the development of their own abilities and styles.

Purdue University has already chosen an independent study program for those students who desire assistance in technical writing. An engineering writing lab provides tutors, self-instuctional materials, small group projects, and reference materials to over 5000 students each year.

The advisory committee says that if the student surveys suggest a need for a change in the writing curriculum, then DSAC will also survey the top 100 employers of University graduates. Employer survey results will determine the need for language and writing skills in the workforce and may show how to address the problem of the lack of writing skills. The University, they feel, should be committed to educating a marketable engineer.

As the demands placed on engineering students continues to grow with advancing technology, the need persists for strong cooperation between business, faculty, and the students themselves in developing communication skills. ■

Graph Illustrating the Importance of Technical Writing



Respondents included deans from American engineering colleges which were broken into two categories: schools which required writing courses for graduation and those which did not.

Source: After *Engineering Education*, November 1983.

Acid Problem Neutralized

University researchers Edwin E. Herricks, civil engineering, and John T. Pfeffer, sanitation engineering, have developed a cost efficient and environmentally safe method of treating acid mine drainage, a serious water pollutant in coal mining areas.

The new process uses anaerobic bacteria to combat what Herricks describes as "the most complex industrial wastewater treatment problems."

The discharge of acid mine water may raise the concentration of hazardous heavy metals in streams to dangerous levels, he said. The most common treatment of acid mine drainage is chemical neutralization. This, however, involves the generation of substantial quantities of byproduct sludges which contain a large number of hard to remove toxic materials.

"The principal advantage of our bacterial process over chemical neutralization is the sludge byproduct," Herricks said. "Our process produces a sludge that can be easily processed to reclaim the copper, iron, zinc, nickel or other metals present in the drainage.

Anaerobic bacteria can live where no free oxygen exists. They obtain their energy for growth by reducing surface compounds such as sulfate and carbon dioxide in the water.

The water treatment process involves four steps. The bacteria is grown in a culture of organic wastes such as municipal solid waste, crop residue, or animal manure to produce a solution that is high in alkalinity and sulfides. It is then mixed with the mine drainage. The high alkalinity partially neutralizes the acidity, and the sulfides combine with the metals to create insoluble metal sulfides. The mixture is

This research is primarily directed toward treating the source of the pollution, but it also indirectly benefits land rehabilitaton efforts.
channeled to a settling basin, and the metal sulfides are separated, forming a metal sludge from which the valuable metals can later be reclaimed.

The remainder of the solution then flows to an aeration tank where sulfide oxidaton occurs through surface aeration, further neutralizing the acidity of the effluent to an environmentally acceptable level.

Computer Dictaphone

IBM scientists have achieved a major advance in computer speech recognition: an experimental system that quickly and accurately recognizes spoken English sentences.

The system allows a human voice input to create office documents such as letters or memos. It can recognize sentences composed from a 5,000 word business correspondence vocabulary, and identifies more than 95 percent of the words in these sentences correctly.

Designed to adapt to individuals, the system trains itself to recognize a person's voice by listening to the user read a brief standard text. The system requires a short pause betweeen words during both training and dictation. A small microphone on the user's desk picks up the speech.

Once the system is trained, words, phrases, and sentences appear on a workstation screen as the individual speaks. The resulting letter or memo may be edited or amended by voice or keyboard.

The recognition is statistical, designed to find the best match between the words spoken and those in its vocabulary. It can distinguish between words that sound alike by examining the context in which they appear. It is able to compute the probability that a given word will appear in a particular context based on an analysis of about 25 million words of office correspondence.

Recognition begins by extracting a set of 20 measurements from the speech, every one-hundredth of a second. The system compares each of these measurements with 200 patterns created by the individual's voice during the training session and makes the appropriate matches. This labels the sound segments so that they can be indentified.

Next, the system examines the sound labels in their context, or their apparent relationship to each other at that instant. On this basis it chooses several candidate words from its vocabulary.

As additional sounds are uttered, new word candidates are created and the initial candidates are re-evaluated in light of these new data. The number of candidates is thus narrowed until the most probable word sequence is selected.

If the spoken word is in the vocabulary, the system chooses correctly more than 95 precent of the time. If the spoken word is not in the vocabulary, it chooses one that is; it can be changed later by editing.

The speech recognition computations are done by an IBM 4341 computer working with three Floating Point Systems array processors. An IBM Personal Computer handles the communications.

Mary McDowell

continued from page 6

Studies have shown otherwise; prices have actually fallen because of the increased efficiencies of laser scanning. After ten years on the proving ground, laser scanners have now become an integral part of everyday shopping.

Unscrambling UPC Codes

The ten digits at the base of the UPC code symbol consist of two distinct parts. The first five characters identify the individual manufacturer, while the last five identify the specific item

A Typical UPC Symbol

0 51111 00234

UPC codes may appear confusing and mysterious, but all of these little lines really do have a meaning.

being sold. The single digit located to the left of the symbol is the number system character. It corresponds to the category of the item being scanned; it is usually a zero for regular grocery UPC codes.

The stripes are merely the machine-readable version of the numbers directly below them, plus a few extras. Each digit of the code is represented by a set of two dark bars and two spaces of varying widths. Each set of bars and spaces is a combination of seven smaller "data modules." These modules are all of equal widths and can be either light or dark. Various arrangements of alternating light and dark modules make up the stripes for each digit.

Two thin guard bars on both the left and right sides of the symbol serve to set the UPC code apart from the rest of the package and to alert the scanner of the approaching symbol. The two thin lines extending down the middle make up the center bar pattern. It aids in the separation of the two halves of the code by the scanner.

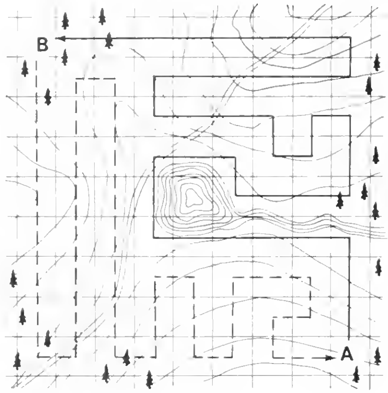
The two bars immediately inside the left-hand guard bar represent the coding of the number system character. The two lines diretly inside the right-hand gaurd bar represent the modulo check character; it has no corresponding digit in the code. Its sole purpose is to verify that the symbol was scanned correctly.

Numbers in the symbol are also coded differently depending on location relative to the center bar to further increase accuracy. All digits on the left are arbitrarily assigned odd parity, so the last data module is a space, while all characters on the right are assigned even parity, so the last data module is a bar. This assures that no set of stripes will look the same even when scanned upside down. ■

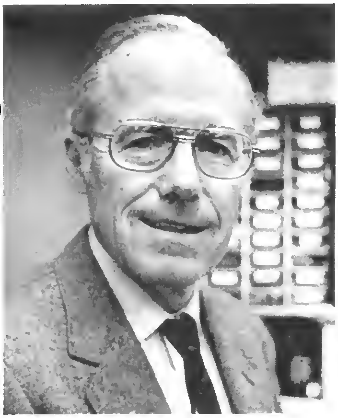
from page 3

Tech Teasers Answers

1. 7,207,210.
2. Thomas A. Edison.
3.



Tech Profiles



John Chato joined the University's Mechanical Engineering department in 1964 after receiving his Master's degree here at the University, a Mechanical Engineering degree from the University of Cincinnati, and a Ph.D. from M.I.T., where he worked as an assistant professor. He is currently involved in research, which he calls "odd-ball heat transfer" projects, that apply heat transfer techniques to areas such as Electrical Engineering and Bioengineering.

Chato holds several honors including Distinguished Engineering Alumnus from the U. of C. and the Charles Russ Richards Memorial Award given by the American Society of Mechanical Engineers. He is an ASME fellow and served for five years as editor of the Mechanical and Industrial Engineering Alumni News.

In his leisure time, Chato enjoys photography, nature study, and tennis with his wife. He also bicycles to work.

Chato enjoys the University because of the support and freedom in doing research as well as the cultural opportunities which give Champaign the "advantages of a big city without the traffic jams."

Ken Kubiak

Carl S. Larson graduated from the University with a B.S. in Mechanical Engineering in 1956, and has remained since to serve in capacities varying from grad student to Assistant Dean.

After receiving his Ph.D., Larson taught ME design classes at the College for several years and in 1974 became Assistant Dean. Larson currently instructs ME 341, Systems and Design, in addition to performing his duties as Dean. He also coordinates the New Student Program, which includes handling the admission of incoming freshmen as well as transfer students.

Larson credits the surge of popularity in engineering to the fantastic job opportunities and the way society today views engineers. "Engineers are no longer blamed for the things that went wrong in the country," he said.

Larson maintains that the Engineering College is difficult because "worthwhile things are difficult." The training and education received here doesn't limit graduates, according to Larson, but instead teaches them to learn a process of reasoning and to think and solve problems, which is applicable to everything. "The best proof of this is to look and see where Engineering graduates are five or ten years out. They're everywhere and into every conceivable aspect of life."

Carolyn A. Keen

Steve Franke is a visiting assistant professor of Electrical Engineering. Originally from Chicago, he has attended the University since 1975 and received his Ph.D. in Electrical Engineering from the College earlier this year.

As a graduate student, Franke researched low-noise microwave amplifiers for the University's Radio Astronomy group and studied wave propagation in the atmosphere and ionosphere.

Franke is currently researching wave propagation problems with emphasis on numerical modeling and simulation. This involves the use of a supercomputer to handle the enormous calculations needed to simulate a random three-dimensional medium and propagate a clean wave through it. The ultimate goal of this research is to improve and develop remote sensing techniques.

In addition to his research, Franke teaches EE 229, Introduction to Electromagnetic Waves, and is preparing material for a new course in computer-aided design of microwave circuits.

Franke plans to continue his career in academics. He enjoys teaching and the freedom to pursue a broad range of interests, including canoeing, fishing, swimming, tennis, and amateur radio operating.

Brian Castelli

The Equilibrium Solution

Rapid, reliable methods for solving chemical equilibrium equations have long been sought by scientists asking fundamental questions about systems as varied as the atmosphere, the human body, and the internal combustion engine. An interdisciplinary collaboration at the General Motors Research Laboratories has produced a breakthrough with potentially universal applications.

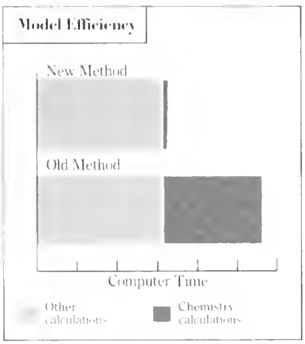
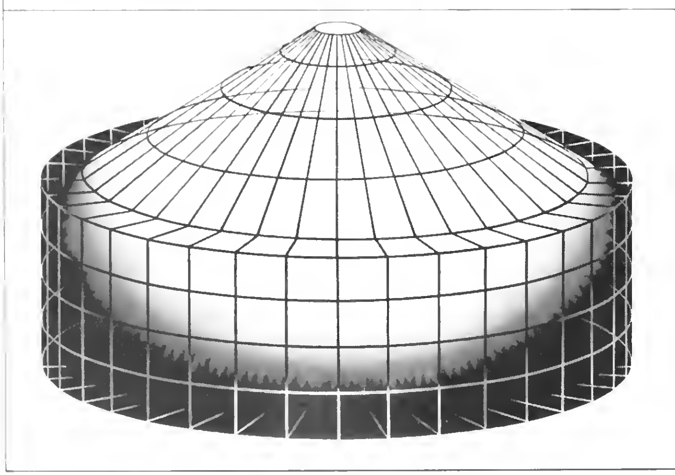


Figure 1: Computer time required by an engine combustion model. Time required for chemical calculations decreased greatly with the new methodology.

Figure 2: Artist's illustration of a chemically reacting flow. The physical space is divided by a latticed network into units of volume, and the solution must be recalculated for each grid point at each instant of time.



WHEREVER CHEMISTRY is involved, the need to solve chemical equilibrium equations arises. Although methods for solving such equations have existed for some time, they do not offer the speed demanded by the most challenging problems. For example, predicting the composition of gases inside an engine cylinder may require as many as a million equilibrium calculations per cycle. Two researchers at the General Motors Research Laboratories have developed a systematic way to reduce the mathematical complexity in these problems, thus making it possible to solve them rapidly.

Chemical equilibrium occurs when the rates of a forward and reverse reaction are equal. Mathematically, this statement usually translates into a system of nonlinear polynominal equations. Until now, there has been no fast reliable method for solving such systems. Solutions to particular problems have demanded thorough familiarity with the physical conditions. In most cases, this means partial knowledge of the answer.

Dr. Keith Meintjes of the Fluid Mechanics Department and Dr. Alexander Morgan of the Mathematics Department began their research by considering recent advances in the theory of continuation methods. They concluded that a suitable continuation algorithm could be relied on to solve the nonlinear polynomial equations that make up chemical equilibrium systems. In this insight lies the realization that the solution can be obtained without any knowledge of the physical nature of the problem.

In seeking the most efficient implementation of the continuation method, the researchers discovered that chemical equilibrium equations can always be systematically reduced to a substantially simpler mathematical form. The reduced systems have fewer unknowns and a smaller total degree. The total degree of any system is the product of the degrees of each of its equations. Reducing the total degree makes a system easier to solve. A typical combustion problem with ten equations and total degree of 192 was reduced by the researchers to two cubic equations with a total degree of nine.

The reduced systems can then be systematically scaled to fit within the limits imposed by computer arithmetic. The range of coefficients in chemical equilibrium systems tends to be too large or too small for the arithmetic of the computer. Consequently, the solution process can fail. By construction of an effective scaling algorithm, this arithmetic constraint can be eliminated. Suitably reduced and scaled, the equilibrium systems can then be solved reliably by the continuation method.

THUS, Drs. Meintjes and Morgan accomplished their original goal of developing an innovative reliable approach to solving chemical equilibrium equations. They also made a final, unexpected discovery. Certain standard solution techniques, which fail on the original systems, can be made absolutely reliable when applied to the reduced and scaled systems. These methods, which are variants of Newton's method, are also many times faster than continuation.

This research has produced an extremely effective solution strategy—reduction of the equations, followed by scaling of the reduced systems, followed by the application of a suitable variant of Newton's method. The simplification of the systems, which was originally formulated to facilitate the implementation of the continuation method, proved to be the critical factor enabling the use of fast techniques.

In one application, the chemical equilibrium calculations are part of a model which predicts details of the flow, turbulence, and combustion processes inside an engine. By using their methodology to develop an equilibrium solver for this application, the researchers greatly increased the model's solution efficiency (see Figure 1).

"It was the characteristic structure of equilibrium equations," says Dr. Meintjes, "that allowed us to perform the reduction. The unexpected mathematical simplicity of the reduced systems suggests that even more efficient solution methods may be discovered."

"Critical to this research," says Dr. Morgan, "was the dialogue between disciplines. I hope that this dialogue will continue as scientists and engineers in diverse fields explore the capabilities of this new methodology."

General Motors

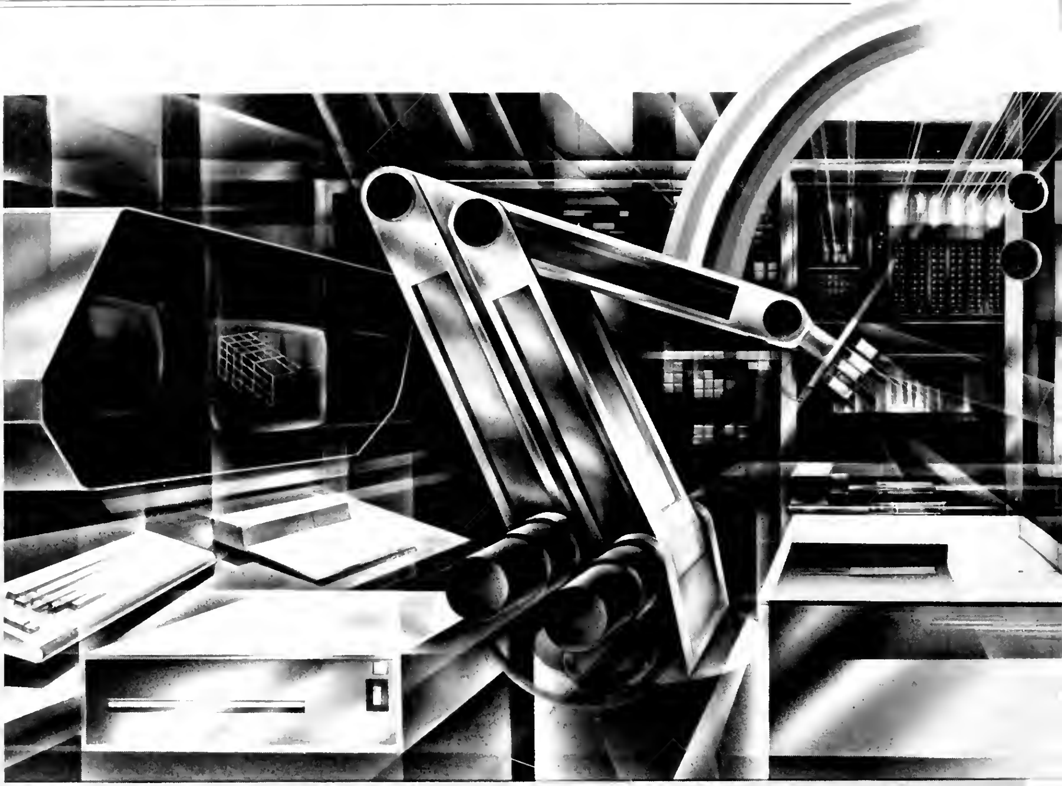
GM MARK OF EXCELLENCE

THE MEN BEHIND THE WORK

Dr. Keith Meintjes, a Staff Research Engineer in the Fluid Mechanics Department, joined the General Motors Research Laboratories in 1980. Dr. Alexander Morgan, a Staff Research Scientist in the Mathematics Department, joined the Corporation in 1978.

Dr. Meintjes (left) was born in South Africa. He attended the University of Witwatersand, where he received a B.Sc. and M.Sc. From 1973 to 1975, he taught fluid mechanics and engineering design at the university. He then went on to study at Princeton University, where he received an M.A. and Ph.D. in engineering. His doctoral thesis concerned numerical methods for calculating compressible gas flow.

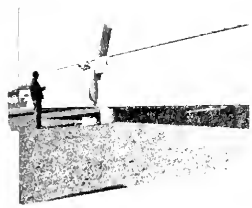
Dr. Morgan (right) received his graduate degrees from Yale University in differential topology. His Ph.D. thesis concerned the geometry of differential manifolds. Prior to joining General Motors, he taught mathematics at the University of Miami. His book, "Applications of the Continuation Method to Scientific and Engineering Problems," will soon be published by Prentice-Hall.



February 1985 Volume 100, Issue 4 Newsstand

IllinoisTechnograph

100 Years



February 1985 Volume 100, Issue 4

Illinois **Technograph**

Celebrating 100 years of publication

On the cover: A century has passed since the dawning of the University engineering magazine. Still on the horizon of technology, Technograph now looks back through itself at the history of the magazine, the University, and the country. (graphic by Karen Peters)

8 **The Birth of *Illinois Technograph*** *Bob Janssens, Jeff Hamilton, Jeffrey D. Sprandel*
The *Technograph* reported the world's technological developments to the members of a growing campus between 1885 and 1910.

12 **Technology Develops America** *Michael Lind, Denis Fahey, Lisa Reynolds*
When modern necessities were still experimental prototypes, *Technograph* covered the growth of the United States in the years 1910 to 1935.

16 **Society Changes as Campus Grows** *Dee Bartholme, Donna Ryan, Marco Sims*
Whether worldwide or local, new concepts were affecting campus residents from 1935 to 1960. New buildings, new wars, and new theories dotted the important time period.

24 **Progress and Politics** *Pete Nelson*
Since 1960, *Technograph* has explored difficult moral problems as well as technical dilemmas, and engineering has provided the groundwork for the next century's conveniences.

Departments
Editorial 5, Tech Teasers 7, Forum 7, Letters 7, Technovisions 18, Technotes 26, Technovations 30, Techprofiles 39 (Techprofiles photos courtesy of T. Naughton, University archives)

Editor *Langdon Alger*
Production Editor *Jim O'Hagan*
Business Manager *Mary Kay Fick*
Photo Editor *Dave Coburn*
Features Editor *Mary McDowell*
Copy Editor *Eric Guarin*
Design *Karen Peters*
Asst. Design *Charlie Music*

Publisher *E. Mayer Maloney Jr.*
Production Manager *Geoff Hart*

[illegible]

Editorial Staff *Randy Abrams, Richard Barber, Dee Bartholme, Ron Blum, Peter Borowitz, Mike Brooks, Brian Castelli, Richard Chi, Thomas Chu, Sally Cohen, Denis Fahey, Dennis Franciskovich, Shelly Gist, Greg Haas, Jeff Hamilton, Raymond Hightower, Bob Janssens, Carolyn A. Keen, Andrew Koepke, Ken Kubiak, Caroline Kurita, Lesley Lee, Michael W. Lind, Steve Lutz, Vata Mackevicius, Kirt Nakagawa, Peter Nelson, Lisa Reynolds, Donna Ryan, Mike Schneider, Marco Sims, Jeffrey D. Sprandel, Kentaro Sugiyama, Pam Susemehl, Tom Svrcek, Alfred Tadros, Laurie Taylor, B. Weiss, J. Scott Woodland, Joseph Wise, Jay Zeff*

SCIENCE/SCOPE

NASA's Project Galileo may provide clues to the origins of the solar system when it explores the planet Jupiter later this decade. Project Galileo is scheduled to be launched from the space shuttle in May 1986 and arrive at the giant planet in August 1988. The mission consists of two spacecraft. One is an orbiter that will circle Jupiter for 20 months. The other is a probe that will plunge into the planet's brightly colored clouds and relay data about the atmosphere. The probe is expected to operate for about 50 minutes before succumbing to temperatures of thousands of degrees, limited battery capacity, and pressures up to 10 times that of Earth's at sea level. Because some scientists believe that Jupiter's atmosphere is a sample of the original material from which stars are formed, the probe's findings will be closely studied. The probe is being built by Hughes Aircraft Company.

The "Eyes of the Eagle" will see even more with the new AN/APG-70 radar, the upgraded radar developed for the U.S. Air Force's F-15 Eagle aircraft. Under the new Multi Staged Improvement Program, the radar's memory increases to 1 million words and its processing speed triples to 1.4 million operations per second. Other new units in the APG-70 include a programmable signal processor capable of 34 million complex arithmetic operations per second, a multiple bandwidth receiver/exciter, and an analog signal converter. The new radar increases the F-15's superior air-to-air capabilities and provides air-to-ground capabilities for the Air Force's F-15E. The APG-70's air-to-ground requirements will be made by software changes, without sacrificing air superiority capabilities. Hughes builds the radar for the F-15 under contract to McDonnell Douglas.

Artificial intelligence is the focus of a new advanced technology center at Hughes. The facility brings research and development efforts under one roof. Scientists and engineers will work closely with universities throughout the country to develop software and equipment to build the so-called expert systems. Studies will center on knowledge representation, symbolic reasoning and inference, natural language processing, and knowledge acquisition and learning. Technology will be developed for image understanding for geological surveys from space, smart avionics to reduce pilot workload, self-controlled systems, simulation and training, fault diagnosis and maintenance, and manufacturing resource allocation and planning.

The first U.S. facility for making gallium arsenide solar cells on a standard production line is now under construction at Spectrolab, Inc., a Hughes subsidiary. Gallium arsenide cells, which are now being made on a prototype line at Hughes Research Laboratories, will help satellites and spacecraft become more efficient in converting sunlight into electricity. Compared to conventional silicon cells, gallium arsenide cells generate up to 30% more power and operate at much higher temperatures. The first cells are expected to come off the production line midyear. Full-scale mass production at rates to 15,000 cells per year is scheduled for January 1986.

Hughes needs graduates with degrees in EE, ME, physics, computer science, and electronics technology. To find out how to become involved in any one of 1,500 high-technology projects, ranging from submicron microelectronics to advanced large-scale electronics systems, contact Corporate College Relations Office, Hughes Aircraft Company, Dept. C2/B178-SS, P.O. Box 1042, El Segundo, CA 90245. Equal opportunity employer. U.S. citizenship required.

For more information write to: P.O. Box 11205, Dept. 9176, Marina del Rey, CA 90295

HUGHES
AIRCRAFT COMPANY

Editorial

Editorially Contagious

"There seems to be something infectious about being the Editor of the *Technograph*. When you read the old editorials you can't help but observe the symptoms: an intense desire to discuss one's opinion, a hope for reformation, and a belief in the power of the written word. . . . I'm affected with the same [disease], because even today I agree wholeheartedly with much of what the past editors said in their time. . ." *(February, 1985)*

"[Women engineers] have the ability and liking for math and science and want to use their knowledge to help others. Instead of complaining that women are oppressed, they are doing something positive like getting an education to qualify them for jobs." *(December, 1973)*

"The motorists are to be congratulated on not killing a pedestrian on Wright street between classes." *(November, 1954)*

". . . You are a product of your environment. The minute changes that occur in your attitudes every day are not noticeable, but they are there. The engineering curriculum has definitely altered your perceptions of the world around you." *(May, 1975)*

"The basic idea is true; we need the broadening influence of intimate association with people of all classes, and the experience of competing against men at their own job." *(May, 1922)*

"Society, through movies, advertising, textbooks, and schooling, has forced men and women to conform to certain roles." *(October, 1978)*

"Being an engineer or a scientist does not exempt an individual from the necessity of expressing himself in written form. We may joke all we like about Advanced Remedial Writing for Experts, (Rhetoric 200); however, in the final analysis the pen and the typewriter must be used to complement the slide rule." *(October, 1959)*

"Let us also remember that unnecessary griping only causes bad feeling and defeats our own purposes." *(November, 1946)*

". . . Engineers must be prepared to deal with the sociological consequences of their work, to consider individuals and social structures as part of the engineering problem. In most engineering problems today, the economic, social, and human factors involved are so numerous and complex that the application of engineering knowledge alone is insufficient." *(December, 1966)*

". . . The ability to get along with people and get them to do what you want them to do is not something to be absorbed by a few geniuses; it is a necessity for modern living." *(December, 1948)*

". . . Gentle reader, *Technograph* is for you." *(February, 1978)*

". . . Many excellent students have only slight ideas of what they can do with their knowledge after they have acquired it. It is really regretable, for it would be far better to say to a prospective employer, 'Well, I know this and that about the construction features of the Hetch-Hetchy project,' than it would be to say, 'For a cone, I is equal to 3/10 Mr^2.'" *(February, 1931)*

"Undoubtedly you have learned through observation that the best way to favorably impress an elephant is to offer him peanuts; he will gobble them up greedily and then grin at you most affably and cause his ears to oscillate in a most waggish manner. An instructor is just like an elephant. If you offer him exactly the type of answers he desires he will grin at you most delightfully. . ." *(March, 1928)*

"Every engineering student has had some experience at some time or another that is of general interest." *(November, 1916)*

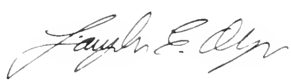
"There is more to becoming an engineer than getting good grades." *(March, 1974)*

"The main idea then, is to become as effective as possible. The best way to accomplish this is to strive for a balance between the time spent on schoolwork and activities. GET INVOLVED!" *(March, 1974)*

Copious Gratitude

This issue is an example of what can happen when people follow the March, 1974 advice above. Inexpressible volumes of thanks and congratulations are in order for all the writers, photographers, researchers, business people, and editors who have put in countless hours over the last several months to recreate the past 100 years.

All of us on staff would like to thank Assistant Archivist Bill Maher for allowing us to invade the University Archives so frequently. Special thanks are in order for Bob Chapel, the Archives' Technical Assistant, for all of the searching, patience, and knowledge he donated to us for this issue. Without him and the Archives, this issue would have been next to impossible to produce.



Tech Teasers

1. Two identical trains are traveling around the world in opposite directions at the equator. Which will wear out its wheels first, assuming they start at the same time, run at the same speed, and are on different tracks?

2. A certain number is multiplied by three. From this number, four times the number obtained by reversing the digits of the original number is subtracted. This last operation yields the number eight. What was the original number?

3. The following epitaph was found on a gravestone in rural England:

Two grandmothers, with their two granddaughters;
Two husbands with their two wives;
Two fathers, with their two daughters;
Two mothers, with their two sons;
Two maidens, with their two mothers;
Two sisters, with their two brothers.
Yet only six in all lie buried here,
All born legitimate, from incest clear.

How could this situation occur?

4. Write down an arithmetic expression equaling 71 using only the number 4 four times. Any mathematical symbols may be used. There are a number of solutions.

Answers on page 37

Forum

The Making of a Tradition

This coming year will mark the one hundredth anniversary of two well-known institutions on the engineering campus—Tau Beta Pi and the *Illinois Technograph*. These organizations have been around for so long you may assume that they have always functioned as they do today. But, like everything else, they had to start somewhere.

Tau Beta Pi originated at Lehigh University in Pennsylvania. In 1885 the liberal arts college supported an honor society, but the engineering school did not. A student at Lehigh felt that it was time for this to change, and sought out faculty and students to back up his idea.

Work progressed rapidly, and the first initiation took place before the semester's end. When the original officers graduated, however, the organization floundered. it looked as though the undertaking would become a complete failure.

Fortunately, someone saw the potential that TBΠ held, and was willing to put forth the effort necessary to ensure its perpetuation. The same kind of diligence has formed the *Technograph* into a publication noted nationally for excellence among engineering magazines.

There is nothing magical or lucky about successful projects—behind every one is a group of people who believe that what they are doing will in some way further their profession or help others.

If there is something you would like to see happen, formulate a brief plan. Any one of the many student organizations on campus is a good source for guidance. They are always in search of new ideas, and can provide experience and people to help you.

Who knows, your inspiration may mature into a one hundred year old tradition.

Amy L. Baits
President, Tau Beta Pi

Letters

Dear Mr. Alger:

Allow me to introduce myself: My name is Tim Johnston, and I served as Editor of the *Illinois Technograph* during the academic year 1979-80.

I am writing to congratulate you and the current staff of the magazine on achieving the 100th year of publication. As you may know, the first edition of the magazine was published by the Civil Engineers' Club as the *Selected Papers of the Civil Enginers Club* in 1885.

In these modern days, with time measured in nanoseconds, not many things last 100 years. Magazines bloom and die like so many annual flowers; it is great to see that the *Tech* has remained a perennial publication.

I suggest that the *Technograph* celebrate this milestone! (after all, it only comes once a century). Serving as Editor was a special experience for me, and I hold a special place in my heart for the magazine.

Sincerely,
Tim Johnston
BSGE '80

The Birth of *Illinois Technograph*

Technograph began long before most modern conveniences had been invented. Exploring the years between 1885 and 1910 reveals not only the development of an engineering magazine, but also the progress toward today's modern society.

Professor Arthur Newell Talbot served as faculty advisor for the first edition of the engineering magazine in 1885. A former student at the University, Talbot found national prestige for his pioneering work in civil engineering. (1881 photo by Thomas Naughton)

The origins of the *Technograph* date back to January 8, 1883, when the Civil Engineers' Club was formed. This organization served mainly as a discussion ground for both students and faculty in civil engineering. At every meeting members would present papers on topics of interest to civil engineers.

In 1885, two years after the formation of the club, the first skyscraper was constructed, the first motion picture film was manufactured, the first appendectomy was performed, and the first articles were written for what later became the *Illinois Technograph*. The first daily rail service to the Pacific was two years away, the first American automobile had ten years to wait before its manufacture, and the first radio receiver would not be built for another fifteen years. Engineering was still in its infancy; most engineers designed railroads, bridges, buildings, or steam engines.

A collection of the best papers presented to the Civil Engineers' Club in the 1885-86 and 1886-87 school years was published in 1887. The purpose of the publication was "to place in permanent form some of the papers read at the meetings, and also to extend the influence of the society." With that purpose in mind, the club decided to publish a similar volume every year entirely funded by advertising and subscriptions.

Professor Arthur Newell Talbot, one of the most respected engineers of his age, served as faculty chairman of the new publication. He also contributed many articles to the first issues. Talbot had graduated from the College in 1881 with a ninety-eight percent average. In 1885 he became a member of the College's civil engineering department. During his illustrious career he served as head of not only the municipal and sanitary engineering department but also the theoretical and applied mechanics department. In 1918, he was elected as president of The American Society of Civil Engineers, and in 1938, the College of Engineering renamed the old Materials Testing Laboratory in his honor. Under the leadership of such a successful man, the publication became an instant success.

The first few issues of *The Selected Papers of the Civil Engineers' Club* contained a multitude of high quality articles, many of which were reprinted in other technical publications. Among the interesting articles in volume one were: "Notes on Mountain Railroad Location," the first of several by Talbot, and "Hints to Students on the Education of an Engineer" by professor I. O. Baker. The latter article hailed the benefits of a "general" in addition to a "technical" education and warned students not to study engineering solely for financial gain.

A significant article by Talbot was published in the second volume of *Selected Papers*. It presented a formula for calculating the cross-sectional area of a body of water for bridges and culverts. The formula, which still bears Talbot's name, became widely used by civil engineers, and the article became a standard engineering reference work.

Other articles of interest in the first volumes included "Rapid Computation," in which J. B. Tscharner, of the class of 1890, prepared the most comprehensive

Bob Janssens

Jeff Hamilton

Jeffrey D. Sprandel

study on the adhesion of drift bolts; in "An Ideal System of Numbers" Talbot argued that a duodecimal—base twelve—system of numbers would be much easier to use than the present decimal system.

In 1890, the Mechanical Engineering Society joined the Civil Engineers' Club in publishing volume five of the magazine. Since the old name was now inappropriate, the publication was renamed The *Illinois Technograph*. The Architects' Club was formed on January 23, 1891, and soon it also became part of the *Technograph*. The focus of the magazine had become more general: to serve the entire engineering community of the University.

Photography made its *Technograph* debut in the 1891-1892 issue. Photographs of civil engineering instruments, the iron workshop, the dynamo room, and the drawing room were among those published. Also introduced into the magazine in this volume was the first advertisement—for the College. The humble ad boasted courses in architecture plus mechanical, electrical, civil, and mining engineering. At the time of the advertisement, engineering was one of four colleges at the University and had a faculty consisting of seventeen professors and instructors, and a class of nearly 300 students.

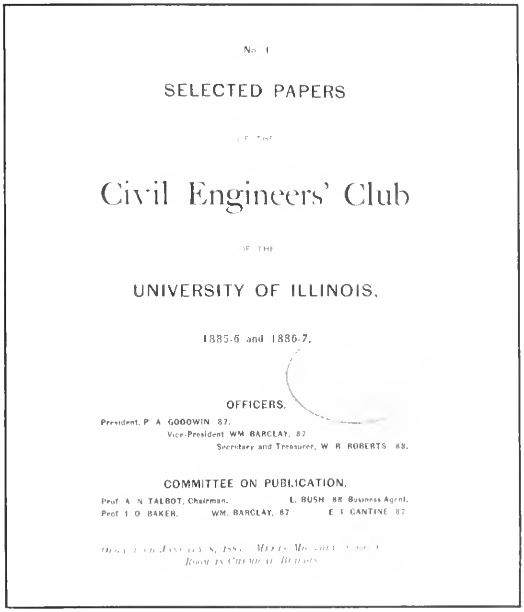
In 1893, the College erected a new engineering building designed by a graduate of the University, G. W. Bullard of Tacoma, Washington. The new building would house the electrical, civil, physics, and mechanical engineering laboratories, and the architects' blueprint room. The building, which was later named Engineering Hall, is the oldest remaining building on the engineering campus.

An article in the 1896-97 issue featured a description of the University Library, which is presently Altgeld Hall. Built in modern Romanesque style, the library was marked by a tower standing 132 feet high, mahogany doors, and a marble entrance hall. Designed by University architecture Professor N. Clifford Richer and Associate Professor James M. White, the new library contained ample space to house the University administrative offices and museums.

Later articles featured descriptions of a variety of technical achievements, ranging from the increasing importance of elevators to the development of sewage systems for office buildings.

An 1899 article described the Society of Professional Engineers. Formed in 1852, the society had 2,124 members when the article was written. A professional engineer, architect, or marine architect who was over thirty years old, had actively practiced his profession for ten years, and had directed or designed engineering works for at least five years could apply. Admission was based on these requirements and on a secret ballot of current members.

At the beginning of the twentieth century, a *Technograph* article described one of the greatest engineering projects in history: the construction of the Panama Canal. After spending three years studying possible routes of the canal, the Isthmian Canal Commision (ICC) finally narrowed the possibilities to two: the Panama route, and the Nicaragua route. The ICC eventually selected the Panama route because of its shorter distance, the existence of a railroad across Panama, fewer necessary locks, and a lower cost of operation. The



No. 1

SELECTED PAPERS

Civil Engineers' Club

OF THE

UNIVERSITY OF ILLINOIS.

1885-6 and 1886-7.

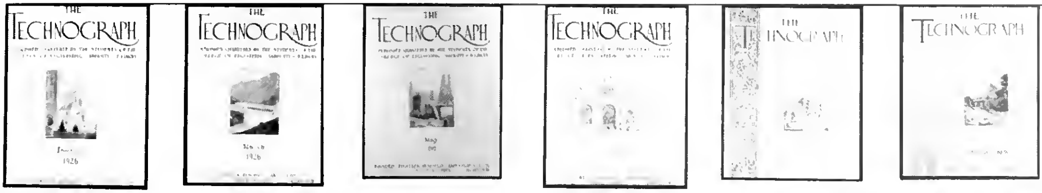
OFFICERS.

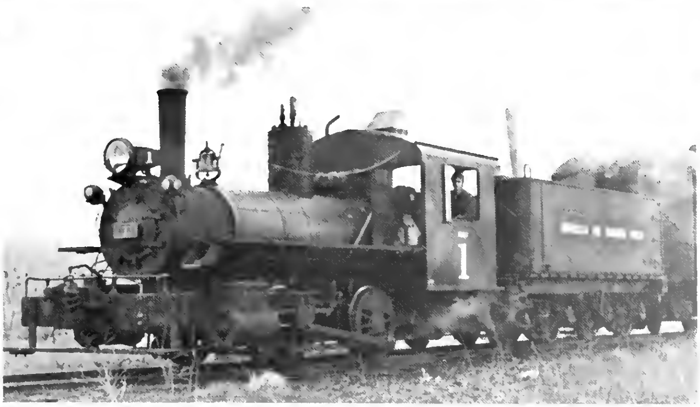
President, P A GOODWIN 87.
Vice-President WM BARCLAY, 87
Secretary and Treasurer, W R ROBERTS 88.

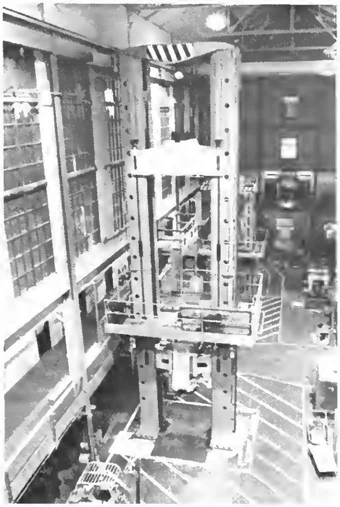
COMMITTEE ON PUBLICATION.

Prof A N TALBOT, Chairman. L. BUSH 88 Business Agent.
Prof I O BAKER. WM. BARCLAY, 87 E I CANTINE 87

The first engineering magazine featured technical reports by prestigious faculty members. The University of Wisconsin used several early editions as textbooks. In 1890, when other engineering societies joined civil engineering in the magazine's production, the publication was re-named the ***Illinois Technograph.*** **(Photo courtesy of University archives)**







The above steam engine was the important transportation method at the turn of the century. (Daily Illini file photo) The materials crusher at right was built in 1928 and installed with the applied mechanics building, now named Talbot Lab. (Photo by Steve Lotz)

construction of the canal required the employment of 15,000 men, the damming of a river, a battle against malaria, and the excavation of ninety-five million cubic yards of earth.

The technological advance which most affected the engineering profession during this time period was the increased use of electricity. Many articles pertaining to this new field of science appeared in the *Technograph*. Several of them discussed the development of wireless telegraphy. One article described underground telephone lines, and another demonstrated the possibility of transmitting both power and telephone signals over the same wires. The popularity of electric lighting continued to increase, and articles were written about the decorative lighting techniques employed at the World's Fairs in Chicago and St. Louis, and about the uses of electrical lighting in theatrical productions.

Many advances were shedding light on the University as well; the College was growing. A building for the laboratory of applied mechanics was constructed to replace the old building which was destroyed by fire in 1900. A new woodshop was completed in 1902 on the site of the old military building, also destroyed by fire in 1900. The Chemistry Annex was ready for occupancy in 1902. Other buildings completed during this period were the Agriculture Building and a men's gymnasium.

A mine rescue station was opened in 1906 by the United States and Illinois Geological Surveys and the University. The station was designed to demonstrate modern mine rescue tactics and equipment to those involved in the coal mining industry. The equipment at the station was also available for actual use at mine fires or explosions. It was used at two explosions and four fires during the first year of the station's existence. This station and several others that were established soon after made Illinois the first state to adopt modern mine rescue tactics.

During this time the engineering profession was specializing. The traditional classifications were no longer sufficient to describe an engineer's work. Along with increased specialization came a greater demand for engineers. In the three years between 1899 and 1902 the number of students enrolled in the College doubled. This crowding resulted in expansion of the engineering departments' facilities, including the construction of new buildings and the movement of the physics department from Engineering Hall to its own building.

In its first twenty-five years, *Technograph* grew along with the College and the engineering profession. Starting as a collection of papers presented at club meetings, *Illinois Technograph* became the voice of the entire University engineering community. ■

Technology Develops America

1910-1935: A period of discovery, adjusIment, and exponenlial growth.

In many ways, the world as it is known today grew its roots between 1911 and 1935. Many items now taken for granted were first reported in the *Illinois Technograph* during this period. The University campus changed and developed, while the *Technograph* also evolved into something resembling its present format.

Many of the "new developments" reported in the *Technograph* and other magazines several generations ago have become commonplace. Air conditioning began to emerge as an alternative to folded-paper fans in the early thirties. "Martha Washington," a dining car put into service on the B & O Railroad in 1930, was the first to offer the comfort of "conditioned air" to its passengers. Soon after, construction began on Radio City, a massive building housing RCA headquarters, NBC offices and 30 broadcast studios. Without air conditioning, the many windowless portions of the building would have been useless. Improvements in technology prompted market analysts to predict that every building on earth would use air conditioning.

Television is another development that was reported early in the *Illinois Technograph* which has permeated today's society. In 1985 many people take large screen color televisions for granted; but few TV rerun connoisseurs have any idea how long the television has existed. The Chicago Daily News obtained the first television broadcast license in 1929, allowing them to transmit pictures, although they were quite inferior by today's standards.

The poor quality was due largely to the technology at the time. Back then, a bright light shone through a spinning disk containing a spiral of holes. The scanning light beam reflected off the person being televised and was converted to electrical impulses by a phototube. After transmission over conventional radio stations, a receiver with a similar spinning disk and a neon glow tube produced a picture typically four inches by five inches in size. Even with such primitive technology, a three or four foot square picture was often obtained by adding projection lenses.

Today, communication by light waves via fiber optics is heralded as the newest method to relieve communications bottlenecks. Nevertheless, the transmittance of telephone conversations through lightwaves is not an entirely new technology. In 1932 for instance, scientists shattered the six mile record for transmitting voice with a light beam. An electric arc lamp with a two-foot diameter reflector transmitted voice-encoded light to a phototube mounted on a three-foot reflector twenty-two miles away.

The phototube found work in the streets as well as in communications. Intersections of major thoroughfares and minor streets have caused special traffic control problems since the introduction of the automobile. Traffic lights maintained adequate order at such intersections, but frequently many cars had to wait for a red light on the major street while the minor street was deserted. Successful experiments in the early thirties used phototubes to detect autos on the sidestreets and change the light when necessary. Maintenance problems occurred, but the phototubes were a viable solution to the frustrating crossroads dilemma.

Besides reporting on traffic solutions, the *Technograph* also revealed the discovery of new energy alternatives. In the Chicago area, a seven-room house in the forest preserves was insulated and heated with gas, instead of the usual wood. During the 1925-1926 heating season, the fuel bill was $110. Without the changes, it would have cost $350.

An energy alternative often used today is solar power; sunlight was converted directly into electricity for the first time in 1935. Four iron disks covered with a thin layer of selenium produced enough electricity to drive a motor the size of a little finger.

Despite the Depression, the desire to break technological records remained. Transport over land reached a record speed of 276.816 miles per hour. Transport over water improved with the construction of the San Francisco-Oakland Bay Bridge. This 8.25 mile long suspension bridge was the world's deepest water bridge and would carry 45 million people each year. The Empire State building, for years the tallest in the world, was built during this time.

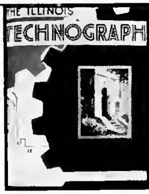
With the construction of taller buildings, elevators consumed many valuable square feet of floor space. To make skyscrapers more economical, one idea proposed that two or more elevators share the same shaft. Operating each on a regular schedule and using three separate safety devices prevented collisions.

Lighter-than-air transport, such as the Hindenburg, was another idea which never succeeded. Despite elegant cabins and grand plans for regular trans-oceanic flights, the airships were eventually phased out.

Problems created by technology began to expose themselves and seek solutions during this time. Experts warned about the danger of carbon monoxide as early as 1935. One million cars traveled the roads emitting hazardous levels of CO, impairing the judgement and endangering the lives of their occupants.

Traffic control also began to attract attention. Few city planners of the day recognized the need to provide public parking spaces. Often their solution to traffic jams was to add traffic

Michael Lind
Denis Fahey
Lisa Reynolds



Since its inception in the early 1930's, fiber optics technology has found a wide spectrum of applications ranging from communications to medicine. (Photo by Dave Colburn)

lights, causing more complications. Since the left-turn arrow had not yet been imagined, "no left turn" signs were used to eliminate the problem of waiting for cars wishing to turn left.

Due to an increase in road construction and increased auto traffic, there was a need for standardized regulatory signs in 1925. Each state had a different system, causing much confusion when traveling interstate. There were several proposed codes for marking warning signs. One system which involved shapes and symbols, the Mississippi Valley Highway Association's proposal, was gaining favor and is in use today.

With traffic and construction projects came noise to the cities. One solution which reduced construction noise was arc welding. According to the January, 1930 *Technograph*, "The application of electric arc welding to structural work continued, during 1929, to be the activity arousing greatest interest, both popular and technical." While this may seem silly when compared with the amazing developments occuring today, the reduction in noise, savings in weight and automation of the building process improved upon old methods of using only rivets.

Economic problems in the early thirties were the most serious in the history of the United States. Engineers were one group of scapegoats during the Depression. Society attacked the engineering community for reducing employment and in general ruining the economy. Railroads, products of engineering, suffered like other businesses. Not only did the Depression strain them, but new technologies threatened their strangulation. Highways were usable by everyone and generally cheaper for all, the pipelines were more efficient than railroad tank cars, and railroads could never surpass planes in terms of speed.

New forms of entertainment revolutionized leisure time. "The talkies" combined the senses of sight and sound in the theater. New recording processes, evolved from experiments at Bell Labs, included the waxed disk and film methods. When using the waxed disk, a record-like platter was synchronized to the film, while the film method encoded the sound photographically on the film.

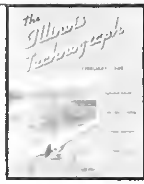
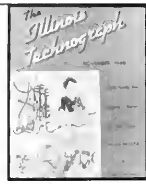
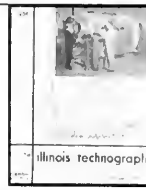
Football fans rarely endure a season without hearing the argument that football inside domes is not the same as the old outdoor games in the rain and snow. Actually, the first indoor game occurred in 1931 in the Atlantic City Auditorium filled with two and a half million pounds of dirt. Washington and Jefferson College tossed a white football with Lafayette before 20,000 fans dressed in formal evening clothes. After the game, many couples attended a dance elsewhere in the auditorium.

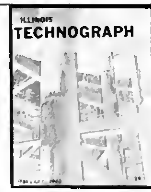
Many changes were made to the University and the College during this quarter century; 1912 was especially busy. The Electrical Building, not to be confused with the present Electrical Engineering Building, which prior to the summer of 1912 housed both the power plant and the department of Electrical Engineering, was made available entirely for instructional purposes. Lecture and recitation rooms, a designing room and many pieces of laboratory equipment were added to the building.

Similar changes occurred in other departments. The department of Architecture added to its drawing room equipment. Shop laboratories were inspected and revamped, reaching new heights in operator safety.

An area between Mathews and Goodwin north of Green Street was acquired to build a new transportation building. The fireproof structure would house the department of general engineering drawing and the department of mining engineering.

Growth of the College slowed because of the First World War, but by 1920 it was suffering from post-war growing pains. Engineering enrollment was double that of 1917, but there was a



smaller teaching staff and an inadequate supply of equipment and classroom space. Instructors had also left the University for higher paying jobs. One Civil Engineering teacher, paid $1500 per year, found a job paying $4500 per year outside the University.

The war also affected the physical appearance of the campus. In 1921, plans were made to build a stadium in memory of the sons of Illinois that died in the war. Construciton of Memorial Stadium began in the fall of 1922 after a fund-raising drive. In order to erect the steel structure during the winter, the plans called for pouring the concrete that fall. The forms for the walls and stands would be put in place in the spring.

Three novel engineering features were used in the construction. Instead of stairways, the stadium would have ramps. Each wall was cut eight times vertically and horizontally to allow for the expansion and contraction of the concrete. To drain the stand during wet games, a system of gutters completed the stadium. By November of 1923 the stadium, one of the few large stadiums to have a balcony or upper deck, was finished.

Beginning a construction boom, several new buildings were raised in 1924 at a cost of ten million dollars. Included were McKinley Hospital, the Graduate Library, the Agriculture Building and the Commerce Building. In 1929, Lincoln Hall Theater was constructed following guidelines on acoustics described in a *Technograph* article. The stage reflected sound toward the audience and the upholstered seats minimized excessive reverberation. Construction on the skating rink began in 1931, with football profits paying for most of the $300,000 cost. After 157 days, work was completed without any serious injuries.

Physically, the University changed greatly, while socially, the engineering students followed cycles. In 1913 and 1914, successful engineering dances were held. By 1923 an engineering day was held. The events included a parade in which each department had a float describing its field. Afterward, speeches were made by the deans and everyone proceeded to the Engineer's Dinner and Dance.

Some habits were deemed unacceptable by the *Technograph*. In 1925 an editorial asked students to quit smoking in order to give the University dignity and insure against fire. Another reason was the 35 year old University rule against smoking.

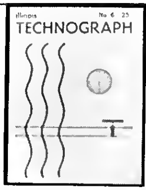
One writer in 1931 disapproved of the wearing of corduroys on campus because of their "dressiness." Although he respected the desire to maintain a neat appearance, he thought that students should not always look like typical engineers. Corduroys belonged at the Corduroy Cotillion, which was to be held in the near future, and not on the engineering campus.

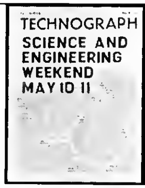
After extensive fundraising, construction began on Memorial Stadium in 1922. Ramps, gutters, and an upper deck were among the unusual attribules of the new facility. (Daily Illini file photo)

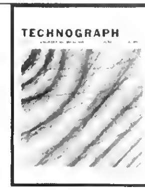
By 1933, the College was again socially dead. The Engineering Council was inactive and a dance had not been held since the Corduroy Cotillion. Not until spring of 1934 did the College again come alive with the first Saint Patrick's Day Ball. Over 250 couples attended the first social event in three years. "Erin go Bragh," inscribed on the Blarney Stone, was translated to mean "Saint Patrick was the first engineer," adopting Saint Patrick as the patron saint of the engineer.

Clubs did manage to stay alive during this period of erratic social behavior. Radio amateurs joined together in 1926, forming Synton to promote interest in radio at Illinois. Among their plans were talks given by authorties about radio. Another campus organization, the flying club, gained practical experience in 1931 by constructing a glider. Pulled by a car to launch, the aircraft was a simple, open cockpit affair used to help train future pilots.

In several ways, the College changed its attitude toward the students. The language requirement gradually began to disappear. Prior to 1922, engineering students had to take eight





The Quad in the 1930's barely resembles the area's appearance today. Extensive construction of new laboratories and classrooms was a hallmark of the University during the era. (Daily Illini file photo)

hours of a language, but that year a new policy allowed two years of language in high school to fulfill the requirement. By 1931, the requirement to take one year of geology replaced language in the Civil Engineering department.

The quest for the perfect grade-point system was not ignored. The year 1934 brought a new system to the college of engineering. The range was from three points for an A to zero points for a D, with an E earning no credit. In all, 136 points were needed to graduate.

While the College regulated the grade point system, the University deregulated class cutting. The University-wide class attendance rules were eliminated in 1931. Instead, instructors held the responsiblity to administer punishments for students who did not go to class. A challenge was then issued by the *Technograph* to students to attend classes regularly and to teachers to use their new power not to rule over their students, but instead evaluate their teaching using class attendance.

With the many changes in the University and advancements in technology, one could never assume that an engineering magazine could not change with the world. In 1911 the *Technograph* began publication as a quarterly instead of an annual as in previous years. Work on the "high plane" of educated faculty members was no longer featured; articles more understandable by students replaced them. The magazine began to take on the form of a more news oriented periodical, with editorials, ads and notes of interest. After a two year lapse in publication, in 1920 the magazine was published close to its present size and had even adopted glossy paper. Features were added, and by 1930 the magazine had expanded to a monthly publication.

Providing some entertainment became important with the addition of features like "Technolaffs," the monthly joke column, "Bucket and Shovel" and the "Ball and Chain Club." "Bucket and Shovel" honored students and faculty members for their actions. The shovel symbolized digging for dirt while the bucket caught the dirt. Scandals such as the wearing of a bobby pin by a man or tripping in the lab and making a mess highlighted this column. "Ball and Chain Club" followed a similar theme. Acccording to the first installment, "This club was conceived to honor those poor suffering engineering creatures who have added to their woeful worries with entangling skirt alliances." In other words, if someone was suspected of having a girlfriend (only two women were enrolled in the College in 1934, so boyfriend was not mentioned) chances are the details would be revealed in the *Technograph*. Of course, while he was planning a romantic interlude with his sweetheart, he could consult the *Technograph* for information on the possiblities for a quiz in his TAM class. ■

Society Changes as Campus Grows

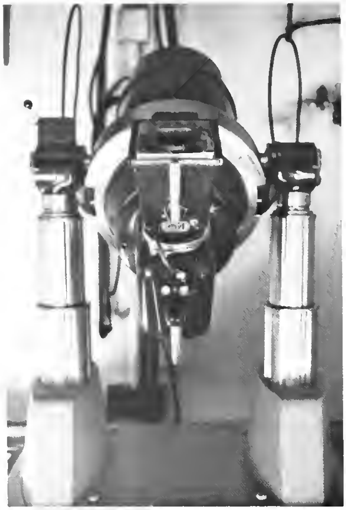
Technograph **reported changes in both world maps and campus maps to the College community in the years between 1935 and 1960.**

The 1930's were years of depression in the United States. In other parts of the world the decade was marked by renewed wars, loss of national independence, and acceptance of totalitarian dictators. Until the late 1930's Franklin Roosevelt was concerned more with his New Deal than with Adolf Hitler's New Order.

As the school year of 1935 began at the University and the *Illinois Technograph* began its second fifty years of publication, the College suffered through some problems of its own. Rumors circled the campus that distinguished members of the faculty were leaving for enticing offers from other institutions. Fortunately, these concerns proved false and the College drew its largest enrollment since the depression, with the mechanical engineering curriculum attracting the most students.

Graduation requirements in the 1930's were somewhat different from those of today. One past requisite was the senior inspection trip—a visit designed to acquaint the student with large industrial enterprises. Furthermore, prior to 1913 undergraduate students were required to write a thesis on an approved research topic. Due to the rapidly increasing number of students in the engineering curriculum however, the College was forced to drop this requirement.

The growing number of students required more facilities. *Technograph* reported in 1936 that the erection of the Mining and Metallurgy Building began at a cost of $50,000 for both the building and its equipment. The highlight of the facility was the Metallography Lab which



This deep therapy x-ray machine was purchased and installed in 1959 when Burrill Hall was built. The machine operated until a tube was damaged last year. (Photo by Pam Susemiehl)

was to have twenty Metallurgical microscopes, a grinding room, and a dark room.

In 1937, many of the problems confronting television were nearing a solution. Most experts believed that television was soon to be a reality. However, only a few programs would be presented and the variety would be limited to a few available channels. Also, there would be room for only a few stations, except in the very high frequency spectrum.

In 1939, a University student presented an interesting theory of heat. Realizing it would be helpful to understand the relationship between light, energy, and heat, this student attempted to show how light and heat could be composed of particles. He believed this theory offered an explanation for the conversion of water into steam. *Technograph* reported his theory; "when enough heat particles are attached to water molecules, the force of repulsion of the heat particles overcomes the force of attraction of the water molecules. The water molecules are pulled apart, causing volume expansion and the conversion of water into steam." This idea was criticized by some members of the Physics department.

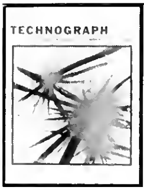
Hoping to really determine what holds the atom together and keeps it from collapsing, physicists from the University investigated the nucleus of the atom by bombarding it with high speed particles obtained from a cyclotron. This instrument was capable of producing energies of 2 million electron volts which gave the particles a velocity of 12,000 miles per second. Though small in comparison to other cyclotrons, this instrument was sufficient enough to form boron from beryllium.

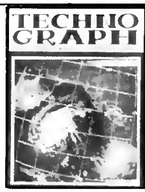
Following the bombing of Pearl Harbor in 1941 and the United States' declaration of war on Japan, many advances such as radar detection and improved techniques in the shipyard took place. Campus also experienced progress, and the magazine quickly reported the changing environment.

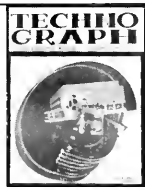
Enlisting in the Reserve Officers Training Corps (ROTC) proved to be a popular choice among engineers on campus during World War II. In fact, the curricula offered at the U.S. Military Academy was almost identical as that offered in the College. Engineers were the third largest unit in the brigade. The Seabees, part of the navy's civil engineer corps, also became an important portion of the navy during wartime. The Seabees were responsible for construction and maintenance of naval shore establishments.

The University became the first school to own an electron microscope in 1943. Housed in Noyes Lab and costing

Dee Bartholme
Donna Ryan
Marco Sims





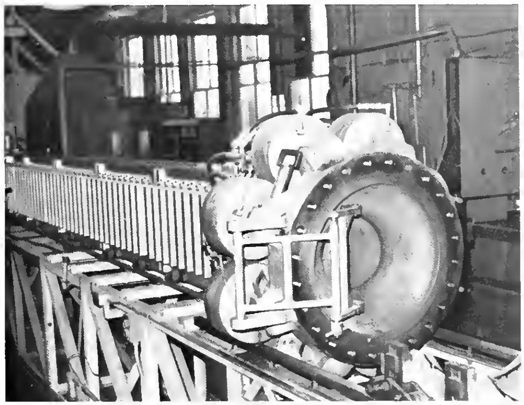


$10,000, this microscope produced an image on a fluorescent screen which converted the electron image to a light image. This device became a great asset to science for its ability to produce an enlarged image of a minute object by means of a focused beam of electrons.

As technology advanced, the need for more specialized workers increased. To satisfy needs, the University added the department of aeronautical engineering and designed a 136 hour curriculum in the program. At this time the University was also constructing the Willard Airport. Upon completion this airport served as a base where studies were performed on pilots under various conditions. The results were used in standardizing navigational equipment.

Due to the great increase of women in the labor force between 1930 and 1940, many women became interested in obtaining a greater education in liberal arts as well as in technical science. In 1945, a group called "Association of Women Student Architects and Engineers" became organized on campus, making it the third such organization in the country. The purpose of the group was to promote friendship and understanding among the women engineers, the faculty, and the profession.

Changes continued to be made on campus, especially the engineering campus. In January, 1947, plans for the new Mechanical Engineering Building were discussed. Also, the Electrical Engineering Building was under construction at the corner of Green and Wright. This construction necessitated the straightening and rechanneling of Boneyard Creek. Furthermore, ideas were being discussed for the new Chemistry and Chemical Engineering Laboratory. When completed, it would be the largest in the United States. In October, the University built a branch



This shock lube, completed in 1952, was designed to simulate the effects of shock waves on an air foil. (Photo by Andrew Koepke)

campus on Navy Pier in Chicago which consisted of 4000 students and 276 faculty.

Even in the mid-forties, engineers were accused of lacking the writing skills required of the field. Engineers, it was emphasized, needed to communicate clearly to fellow engineers in industry. Many companies felt that although graduating engineers had great technical skill, they were ill-prepared for management positions; they claimed engineers should be educated in business, economics, management, and fundamental accounting. At the time, a beginning engineer earned about $300 a month while a management engineer in non-technical areas received nearly $900 a month. To compensate for the engineer's lack of a perspective of the world in which he lives, larger corporations began pressuring schools to give students five years of training instead of four.

When the war ended, many Americans were concerned only with their own security, not the nation's. Wartime wages had doubled from their prewar level, as had the gross national product. A great increase in car sales created problems of overcrowding in many cities. With the passage of the 1956 Highway Act, the construction of interstate highway systems began. The Edens Highway became a solution to Chicago's traffic bottlenecks. The highway had six lanes and was designed to handle cars traveling at 70 mph. *Technograph* predicted that by 1971 there would be $50 billion worth of these new expressways.

As the Cold War began to get hot and the North Koreans invaded South Korea, President Truman stationed the Pacific fleet off Formosa and ordered American aircraft to support South Korean forces. Meanwhile, many changes were being made on the homefront.

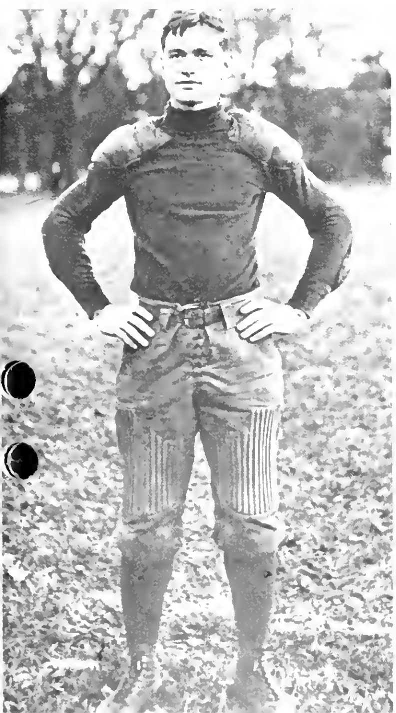
The annual Engineering Open House, reported *Technograph*, was a bit more extravagant in the fifties than it is today. The festivities began when a rumble in Boneyard Creek erupted into a twenty foot geyser which spurted kelly green water. It was claimed that this event signaled the arrival of the Blarney Stone

Football Guards

In the early days of the *Techno-graph*, a football player was a relatively unprotected athlete. Helmets were made of leather and offered no face protection. Shoulder pads were thin and didn't distribute the force of a blow as today's pads do. Jerseys, made of wool or cotton, were hot during warm weather.

The ball also has undergone drastic change. Originally, it was stuffed with straw and was much larger than today's ball. Damage was not a problem because kicking was not originally an aspect of the game.

Below, a ball from the mid 1940's. Right, Illini great Red Grange, still in shoulder pads, holds up his 1924 Jersey *(photo courtesy of the Athletic Association)*. Bottom left, a 1910 player *(photo courtesy of Wham postcards, Strauch's student life series)*. Bottom right, a player 12 years later *(photo courtesy of the 1922 Illio)*. Top right, players from left D.R. Mills, F.H. Walker, J.A. Timm and F. Lanum from the 1929 Illinois football squad. Bottom right, Red Grange wearing a leather helmet in 1927 *(photo courtesy of the 1927 Illio)*. *(text by Dave Colburn)*

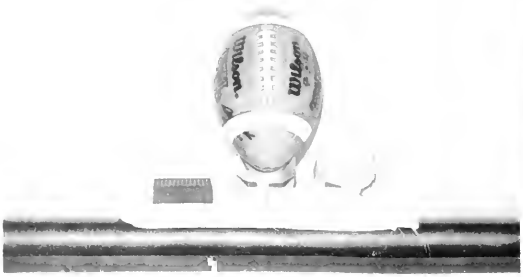


Technology Adds Safety

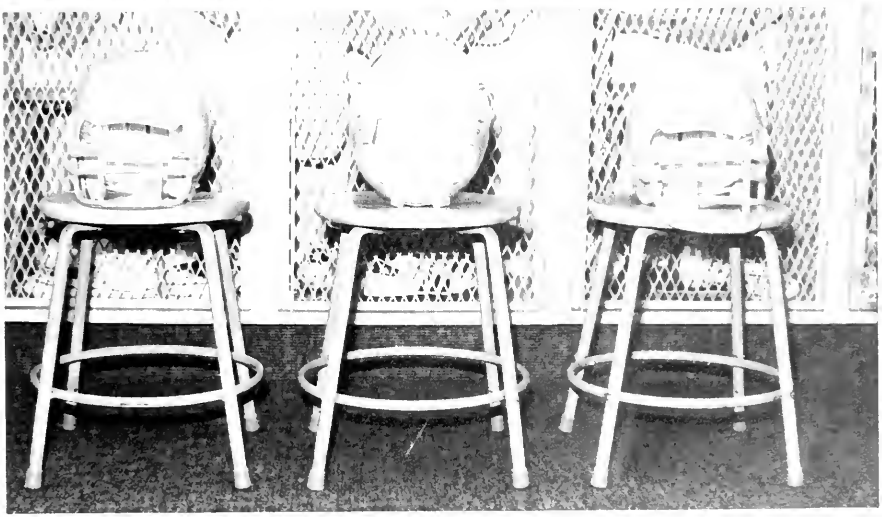
Relative to athletes of the past, today's football player is well protected. Helmets feature a hard plastic shell that is padded to transfer the impact of collision to less vulnerable areas of his head. Shoulder pads vary for different positions and are also designed to transfer energy away from the weaker points of the player's body.

Varieties of shoes exist not only for different positions, but also for different playing surfaces. The increased importance of kicking has led to different kicking tees of varying thicknesses and design.

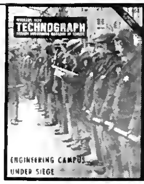
Below: Some of the different kicking tees and a modern football. Right: A glimpse of the 1984 Illini versus Iowa game gives a comprehensive view of today's equipment. Below right: Various types of shoes are used for various playing surfaces. Above far right: Shoulder pads change in size and protection to fit players' individual needs. Below far right: Helmets also change with the wearer's position. Not only do they have different padding for different positions, but the face guards change from helmet to helmet. *(photos and text by Dave Colburn)*

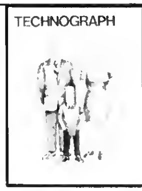


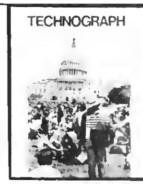

35




THE NUCLEAR NAVY. RIDE THE WAVE OF THE FUTURE.
You're deep under the sea. There are 4600 tons of nuclear-powered submarine around you. Your mission– to preserve the peace.
Your job– to coordinate a practice missile launch. Everything about the sub is state-of-the-art, including you.
The exercise– a success. You're part of that success and now you're riding high.
In the nuclear Navy, you learn quickly. Over half of America's nuclear reactors are in the Navy. And that means you get hands-on experience fast.
You get rewarded fast, too. With a great starting salary of $22,000 that can build to as much as $44,000 after five years. And with training and skills you'll use for a lifetime.
Then, whether you're in the Mediterranean, the Pacific or the Atlantic, wherever you move around the world, you'll be moving up in your career and in the Navy.
Find out more about an exciting future that you can start today.
See your Navy Recruiter or CALL 800-327-NAVY.
NAVY OFFICERS GET RESPONSIBILITY FAST.







of St. Patrick, patron saint of engineers. On Friday afternoon, the traditional St. Pat's Day parade took place with each engineering society contributing floats. Many engineering facilities were open for public tours and numerous displays demonstrated the various aspects of engineering.

In 1955, the U.S. employed the first guided missile to be used in defense, a supersonic anti-aircraft rocket called NIKE. This two-stage rocket was capable of intercepting and destroying enemy aircraft regardless of evasive action.

The same electronic principles that guided missiles were hoped to be applied to the operation of artificial limbs and braces. An electronic firm attempted to find a method of electronically releasing and controlling the energy required to operate an artificial limb or brace at the will of the wearer.

With the development of new technological areas such as atomic energy, antibiotics, jet propulsion, and electronics, the demand for engineers skyrocketed. It was stressed that an increase in the number of engineers was critical to the nation's welfare and security. Unfortunately, nearly a twenty percent shortage of engineers existed. Nevertheless, Dean Walker of Pennsylvania State University believed that women should not become engineers. Although he admitted that "under certain circumstances" women could have distinguished careers in engineering, he thought most women lacked the basic capabilities required. In addition, since most women wished to get married and have a family, companies didn't feel they could afford the risk of investing in a woman engineer.

Dean Walker did not express his views without opposing comment from *Technograph* articles and readers. Many people felt that the great demand for engineers made women a logical choice. In 1959, male engineers were warned about

Electrical engineering professor Paul Coleman displays what he terms a vest pocket microwave accelerator and what textbooks designate as a ribatron. Developed by Coleman in 1946, the ribatron can generate up to 2,000,000 volts—a still unmatched record. (photo by Jay Zeff)

the "slide rule carrying coeds" who were uniting in trying to gain membership in the Society of Women Engineers. The society's objective was to involve more women by informing the public of the availablity of qualified women. By 1960, the general outlook on women in scientific professions began to change; at this time there were sixteen women enrolled in the College and companies were becoming interested in employing women engineers.

As the excitement heightened in the dream of conquering space, many students wanted to learn how activities in space could be accomplished. Hence, a "Rocket Society" developed on campus. In the summer of 1959, progress was made when an aircraft climbed over 100 miles into outer space. This flight provided information on both prolonged weightlessness as well as control and stability at high speeds. The aspect of human capabilities in space were also considered. For example, many people wondered if man's chemical composition could tolerate changes in his environment such as high acceleration, weightlessness, cabin pressure, temperature, humidity, decompression, solar and cosmic radiation, and boredom from isolation.

Despite the characteristic world turmoil of the years between 1935 and 1960, the *Illinois Technograph* continued to adapt to the changing society. While technology and the University developed over time, the *Technograph* reported the newest directions of research in the fields of engineering. ■

Progress and Politics

The modern era of 1960 to 1985 brought to *Technograph* new directions of thinking for both the field of engineering and the American society.

The agricultural engineering building is the most recent addition to the College's laboratories. Continual updating of campus facilities has been a hallmark of the College for much of the past century. (Photo by Phil Messersmith)

The latest quarter century heralded many technological landmarks, while the *Illinois Technograph* and the University at large similarly underwent considerable changes. Because *Technograph* evolved with both society and the University, patterns of change in both can be traced simply by studying the magazine's history.

Among the most obvious of the changes in the University setting could be seen in the presence of new buildings. The new Civil Engineering Building was finished in 1965, while Loomis Laboratory pre-dated it by only a year. Also in the mid-sixties, the design for the Undergraduate Library was proposed and approved by the Board of Trustees, although it was not the first underground library to be built.

The University of Illinois-Chicago, called Circle Campus because of its location near a cloverleaf in the Expressway, was also constructed during these years. The new campus was the subject of many *Technograph* articles throughout the early seventies. Circle Campus boasted a thirty story office building for its faculty, and a suspended walkway interconnecting the principal buildings. At the time, it was considered one of the most appealing urban college campuses in the country.

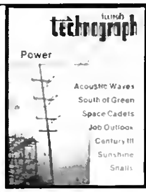
Though building construction progressed rapidly both on the Champaign-Urbana campus and in Chicago, some aspects of University life remained the same. Boneyard Creek continued to serve as the depository for unwanted hardware and waste in the College. A 1961 *Technograph* story described the Annual Boneyard Fishing Contest. Many lucky entrants angled various pieces of a mainframe computer the University had discarded. One student discovered a suicide note in a bottle, and others found notes attached to sliderules. A short time later, many articles appeared in the magazine requesting a thorough clean-up of the polluted creek.

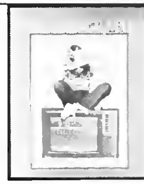
The University's adjustments to social changes were noteworthy and significantly affected the *Technograph*. Both the magazine and the College grew to accept women in engineering. The final article of a long series in opposition to women in the engineering curriculum appeared in 1971. Since then, opinion changed and *Technograph* frequently asked, "Why aren't there more women in engineering?"

Changes in social trends became further defined through advertisements. Bethlehem Steel ran a series of advertisements in the sixties depicting a pouting woman, neglected by her boyfriend while he closely studied a pamphlet called "Career Opportunities with Bethlehem." Later, in the early seventies, Bethlehem ran a similar ad with both men and women studying the pamphlet. The caption read, "This book replaces *Playboy*." During an engineering shortage in the middle sixties, many corporations used full-page advertisements to solicit prospective employees. Graduates were faced with deciding which company could provide a job giving them the most benefits. Companies would use lucrative selling points, including the proximity of the plant to the beach, the availability of women, and various other non-technical aspects of employment. These ads were aimed at a narrow cross-section of society, the male engineer, who frequently fell prey to such recruitment tactics.

Early in the 1960's, *Technograph* also went beyond its traditionally technical forum format. The magazine featured photos of attractive female undergraduates in a section called "Technocuties." Similarly, "Technocracks," a jokes column,

Peter Nelson





was discontinued in 1965, as a greater percentage of *Technograph* was devoted to strictly technical matters.

The prevalent fears and concerns of the Cold War also found a place between the magazine's covers. The first issue published during Kennedy's Administration contained an article on the construction of bomb shelters, and later issues included several smaller articles on life inside the Soviet Union. During the late sixties, the magazine's political views culminated in reaction to the controversial Viet Nam war. In 1969, numerous anti-war editorials were published as well as a reprinted telegram to the editor from local congressmen, concerning the riots at Kent State. Soon after, political lobbyist Ralph Nader, who believed engineers lacked a social conscience, wrote a letter addressed to the engineers at the University. This occurred during the major court battle concerning automobile safety which produced his book, *Unsafe at Any Speed*.

As well as becoming more politically aware, engineers began to take a greater concern with their self-image. An English major at the University wrote an article titled "Crossing Green Street." His critique of engineering society was grimly received by the readers of the *Technograph*. The author claimed that he found a concentration of excellent students who had little on their minds beyond their studies. Even the slang terms used to describe an engineer during the sixties—"slide-rule king" and "poindexter"—only seemed to further alienate engineering students from the non-technical students.

The seventies returned *Technograph* to its traditional format following the brief affair with politics and volatile non-technical topics. Society's misconception

Changing Times

Among the societal issues displayed in *Technograph* was the battle for women's rights. This type of recruiting advertisement, the "Technocutie" feature, and a series of articles against women in engineering all disappeared from between the covers of the magazine in the early 1970's. (Advertisement from *Illinois Technograph*, 1966)

that engineers were responsible for what went wrong in the world was replaced with a surge in popularity and respect for the engineering profession. Once again, engineers expressed their pride for being at the forefront of technology. The celebrated space program gave society new confidence; American ingenuity had landed men on the moon and returned them safely to earth. Computer-guided satellites orbited the Earth and provided a major breakthrough in communications networks.

The campus, country, and *Technograph* alike were amazed at the advances in microelectronics. The sliderule, a major engineering tool, was replaced by the pocket calculator.

Automobile design of the sixties focused on greater horsepower and faster acceleration while different priorities in the seventies changed those concerns to fuel efficiency and accident safety.

The computer age also developed, and with it the increasing demand to quickly process information and store large quantities of data. The University greatly expanded its own computer facilities during the seventies. By 1976, the Programmed Logic for Automated Teaching Operations (PLATO) system began its career in education. The campus doubled its computer facilities for faculty and students and provided new emphasis on computer related classes and curricula.

Now, late in the twentieth century, *Technograph* remains largely unvaried from the digest form it was conceived as 100 years ago: a journal for the technically minded, written and produced by students in engineering. *Technograph*'s century of survival can be accredited to its ability to adapt along with the technology it reports. Unlike the sliderule, the magazine has adjusted to gradual modifications and continued to serve as a benefit to the engineering community at the University.

Changes in society have been numerous over the past twenty-five years, and the technology has changed accordingly. Space flight, computers, lasers, and other new technologies have only begun to shape today's society as automobiles, electricity, and railroads shaped life in *Technograph*'s earlier days. The success of the *Illinois Technograph* over the last 100 years is due not only to the commitment of the College's students and faculty, but also to the importance of technology in developing American society. ■

The University and the country in which it resides are dynamic in nature. The *Technograph* has always followed the alterations of our society, as the following direct quotations from past issues illustrate. The italicized dates at the end of each excerpt is its original date of publication.

Stereotypes Can Be Cured

"The various engineering societies at the University of Illinois are in need of a coordinating body. The individual organizations within themselves carry on active and successful programs, but there is no formal means of cooperation between these societies.

"In an article about the St. Pat's Ball, it was stated that Illinois has long been known as 'the deadest engineering campus in the country.' This statement may be a little harsh, but the students in the College of Engineering have done little to disprove it. The general public looks upon engineers as a group of rather 'queer' men, married to their slide rules, and so absorbed in their work that they hardly know that the rest of the world exists. We know that is not true and it is up to us to prove to our 'public' that engineers are as normal as any other person. The first step in that direction is to form a united front.

"Several years ago there was an engineering council on campus. It was composed of representatives of all the engineering societies. It acted as a directing body for all combined activities. An organization of this nature would not in any way infringe on the individual rights and functions of the societies but would provide a permanent, united group to coordinate the efforts of the societies when such action is necessary." *(April, 1947)*

Digging History

"From nearly every standpoint, the design and construction of the Panama Canal is the most difficult engineering project and the most important work ever undertaken by a nation or individual. The failure of previous attempts to carry out this great undertaking have only served to show the variety and magnitude of the obstacles to be overcome. But since the U. S. has taken upon itself the task of building the canal, the success of the enterprise is assured.

"Panama grants to the United States 'in perpetuity the use, occupation, and control of a zone of land ten miles wide,' and grants a monopoly of traffic across the isthmus. This treaty insures not only the construction of the canal, but our undisputed management of it in our own way for all time to come." *(1904-05)*

Architects to Be Licensed

"Illinois is the first state to enact a law requiring every practicing architect to obtain a license from a board of examiners. This law is of interest to architectural students, since it insures that all who hereafter practice architecture in Illinois must be versed in scientific knowledge and technical training. The law will be of great benefit to the public, since it protects citizens from injury or loss by incompetent architects, fixes the responsibility for dangerous structures, and tends to rise rapidly the attainments and position of the profession." *(1897-98)*

Expanding Capacities

"The new laboratory in the EE Department is practically completed. . .it will accomodate two sections of thirty men each. One section will work with alternating current apparatus and the other with direct current machines.

"The new radio broadcasting station WILL is under construction. The tower and studio will be located on Illinois field." *(March, 1926)*

Electricity Wins Over Water

"A new building of modified Georgian design is now in the initial stages of construction on the corner of Wright and Green streets. Replacement of the Health station and former president's home by this structure for the electrical engineering department of the College of Engineering is to contain recitation, laboratory, shop, and office space for about half of the present electrical engineering students and staff. It will cover an area extending 213 feet along Green Street and 141 along Wright street, and is therefore of large enough proportions to necessitate straightening and rechanneling the famous Boneyard Creek to a position a few feet north of its present location." *(March, 1947)*

German Skyline Dwarfed

"Buildings over twelve stories in height have been prohibited in Germany by order of the German government. In some provinces the maximum height is limited to ten stories, and dwellings in no part of the country can exceed five stories." *(May, 1930)*

Dancing Engineers

"This year for the first time, we engineers will strut our stuff in an open house and engineer's dance, all the same weekend! Let it be understood moreover, that the Slide Rule Shuffle is to be no ordinary one. The Dance Committee, under the direction of Spencer Brown, is making arrangements for the dance itself, but it is up to you, and you, and you to show the rest of the University a social affair that will be one of the high spots of the semester social whirl. . . . It isn't an accident that this banner event is to be. The whole thing was given an initial acceleration by the Engineering Council—'The Voice of Engineers'—which was reorganized last fall after a year's lapse." *(March, 1941)*

No Stadium Sway Here

"Why does the Illinois Stadium stand the mighty roars and stamping feet during the thrilling moments of a football game? W. A. Slater '06 is probably responsible for he kept a watchful eye on all the concrete that went into it. . . . He has received three degrees from Illinois." *(January, 1929)*

Rolling in Money

"The initial salary by engineering graduates is well typified by the class of 1924 with reported median low salaries at $110 per month and median high salaries at $175 per month." *(May, 1926)*

A Longer Day's Journey Into Night

"The progress which has been made in the past decade in the matter of illumination is little short of wonderful. . . . night work has come to stay; in other words, modern communication demands a longer day than that afforded by daylight. . . . important developments. . . . have actually forced the consumer to demand protection from eyestrain." *(November, 1913)*

Technograph Alterations

"There has been a feeling prevalent among the students and the engineering faculty of the University of Illinois, that the Technograph in the past few years has not completely fulfilled its mission. Last year it was only due to the extraordinary efforts and success of the Technograph Board with the aid of the faculty that the journal survived. Due to these conditions

Altgeld Hall was originally constructed as the University's library in 1897, while the Illini Union was constructed on the site of University Hall in 1941. (Photo by Phil Messersmith)

Dean Goss early in the term, called a conference consisting of a faculty committee and representatives from the several societies to consider its reorganization. It was decided that the Technograph as an annual publication was not feasible nor was there a demand for it. Plans for a complete reorganization were then presented by the Technograph Board which included a new constitution and by-laws. It was the general consensus of opinion that a live quarterly publication would be more representative of the growth in size and importance of the College of Engineering." *(March, 1911)*

WPGU Tunes In

"After two months of preparation, the first program was broadcast from WPGU at 7 p.m. on December 6, 1953. Facilities for the studio—first located at 1340 Arbor but later moved to its present location at 1241 Euclid in the Parade Ground Units—were donated by the University housing division." *(November, 1954)*

Library to Be Dedicated

"We present to our readers the university library, [Altgeld Hall,] which is to be completed the first of June. The style of the structure is Modern Romanesque—a style derived from that manner of building which prevailed throughout Western Europe fron the fall of the Roman Empire until the rise of the Gothic Style, and was directly or indirectly inspired by Roman examples.

"The building will be dedicated the coming Commencement Week, which is an especially appropriate time, because ground for it was broken with due ceremony on last Commencement Day." *(1896-97)*

The Feminine Mystique

"It seems that Marjorie Voight was lonesome over in Ceramics and talked a fellow townswomen into enrolling in the clayslingers' school. Martha Schultz is the freshman miss who will have to be nonchalant in a classroom of boys. . . . Martha's settlement on the north campus keeps the population at two, since Dorothy Segur has deserted us." *(December, 1934)*

Mind Games

"Students of engineering subjects, whose chosen profession will require a constant use of figures, often fail to appreciate the value of rapid methods of computation. Even when thay have a conception of the amount of time which can be saved, and of the means to be employed to that end, they neither make use of their knowledge in everyday work, nor try to increase their store. It requires practice begun in early days of school to make one skillful in handling the simple operations of addition, subtraction, multiplication, and division; and too many are content to stop even before this point is reached. They are ever striving to master those devices which effect a saving of time in the 'field,' and lose sight of the equally important subject of rapid 'office work.'" *(1889-90)*

Women Set PreSWEdent

"A new venture in student organization is being launched on our campus. At one time, architecture and engineering were considered fields for men only. However, this is no longer the case, but many of the old misgivings and predjudices remain. In order to help overcome these and obtain for themselves the recognition that they feel they rightly deserve, the feminine architectural and engineering students on the campus have organized.

"The group is known as the Association of Women Student Architects and Engineers. The announced purpose is 'to promote friendship and understanding among women engineering students, the faculty, and our profession.' This is to be primarily a professional organization, but it is hoped that in the future a system of awards and recognition for scholarship and activities can be instituted. Any feminine architectural or engineering students are eligible for membership, and feminine chemistry, physics, or mathematics majors may obtain associate memberships." *(March, 1945)*

Engineers Find a Home

"This handsome building, [Engineering Hall,] for which $160,000 was appropriated by the last legislature, will be ready for use by the first of next fall term. Plans were asked for by the trustees from the graduates of the architectural department of the University of Illinois. The first prize was awarded to Mr. G. W. Bullard of Tacoma, Washington, who was made architect of the building. It is a matter of pride to the University that one of her graduates should have furnished the plans for the imposing building." *(1892-93)*

The Pre-OPEC Dream World

"Fuel is so cheap that except for those who cover large mileage, the difference between 25 miles and 40 miles per gallon is not in itself a matter of prime importance.

"America is more and more becoming a country where the average well-to-do family has more than one automobile, or would like to have a second car." *(November, 1930)*

Aviation Interest Soars

"Thus is expressed the enthusiasm of this generation for that new branch of engineering, and of life—travel by air. Airplanes have come and they have come to stay. The enthusiam for them, while in part is just a fad, nevertheless is earnest, and very essential in the development of aviation, and finally, the enthusiam is not going to dwindle until finally, travel in this manner is accepted as the usual thing." *(January, 1930)*

Atomic Energy Has Potential

"At approximately 8:14 a.m., August 16, 1945, Hiroshima time and date, the rest of the world became aware of the potentialities of atomic power.

"This field of atomic energy, now in its infancy, holds excellent employment opportunities for graduates with degrees in chemical, ceramic, metallurgical, and mechanical engineering. Not only is the work most fascinating, since the materials under consideration are quite unique, but the opportunites for advancement are great since a graduate could 'get in on the ground floor' of this new industry!" *(October, 1948)*

If They Could See It Now...

"A new era began for the College of Engineering when the cornerstone of Engineering Hall was laid on December 13, 1893. Since then six more cornerstones have been laid for Engineering College buildings and now the Illinois student of a decade ago would scarcely recognize his surroundings were he suddenly thrust among them." *(1901-02)*

Ground Laid for Agriculture

"The newest curriculum offered, agricultural engineering, was announced at the beginning of the second semester this year. It is intended to prepare young men to handle problems relating to design of farm machinery, land drainage, and conservation, and to the building of farm structures. Already 6 students have enrolled in the curriculum." *(April, 1934)*

Sidewalks Rolled Out

"The university grounds were further improved, last fall, by the laying of a cement walk leading fron the streetcar line to the main building and to the chemical laboratory." *(1890-91)*

Speedy Highway Construction

"Pier engineering students are taking a keen interest in the construction of Chicago's first superhighway—the Eden's Superhighway—now being rushed to completion. Destined to replace the heavily traveled Skokie Highway (U.S. 41), Edens is 15 miles in length and will ultimately be a part of the comprehensive expressway system planned for Chicago and Cook County. This new superhighway follows the Skokie Highway although it deviates slightly form the old road in the residential areas where the required right-of-way width could not be secured." *(December, 1950)*

Road Materials Lab Established

"A Road Materials Testing Laboratory has been installed recently in connection with the Engineering Experiment Station for the purpose of practical aid to the State Highway Commission by testing all kinds of road material. Equipment for testing brick, stone, and gravel has been set up and is now in use. The laboratory is under the direction of Professor I.O. Baker, head of the civil engineering department." *(1905-06)*

EES a Turn-On

"The wireless telegraph, high frequency demonstration, telegraphone, 100,000 volt transformer, singing arc, foulsen arc, and the static machines and other apparatus exhibited by the Physics Department [at the Electrical Engineers' Show] drew appreciate attention from all the various classes of visitors, while those well versed in matters of science found them of real value." *(1906-07)*

New Campus Hot Spot

"Since February 8, the new Illini Union Building has been the popular spot on campus. The colonial beauty and modern efficiency of the $1,505,000 needn't be told; it is in evidence. But our analytical minds can't let the glamour of the place possess us entirely, so we search for the engineering behind all of it." *(March, 1941)*

Deliverance from Livery

"The growth of the automobile manufacture has never been exceeded, if paralleled, by any other industry. . . . One firm alone proposes to build forty thousand cars for the season of 1910. . . . The average retail price of these cars will certainly not be less than one thousand dollars. . . . It is only a question of time before the larger portion of the delivering, in the cities, will be done with automobiles." *(1910-11)*

Constructed in 1912, the Railway Wheel Lab played a major role in exploring improved methods and machinery for the railroading industry. Although the importance of rail transportation has since waned, research on the possibilities for today's rail industry still plays an important role at the University. (Photo by Mike Brooks)

Money for Railway Department

"In the last session of the legislature there was appropriated to the University $200,000 for new buildings for the College of Engineering. In accordance with the plans, this money will be used to erect buildings suitable for the work of the Railway Engineering Department." *(1911-12)*

Romance on the Rocks

"The first [freshman] engineering lecture was given by Professor A. C. Callen, head of the Department of Mining Engineering on 'The Romance of Mining.'" *(November, 1930)*

State-of-the-Art

"By the help of the 'Thomas computing machine,' every arithmetical problem. . . . can be solved with surprising rapidity. The writer added a column of 10 numbers each consisting of 10 digits in a little over two minutes. . . . The cost is about. . . . $225." *(1892-93)*

Draft Opposed

"The Technograph strongly supports the Senate proposal to abolish the draft and establish an all-volunteer professional army. The bill was introduced by a bipartisan group of nine senators in 22 January, 1969. The bill is a new version of a plan advanced by Senator Mark Hatfield (R-Oregon) in the past two years.

"To graduating seniors who are now making plans for their future, the Technograph staff wishes you the best of luck and condolences where appropriate!" *(February, 1969)*

Compiled by Sally Cohen, Dennis Francisicovich, Shelley Grist, Lesley Lee, Nata Mackevicius, Alfred Tadros, and Joe Wyse. Edited by Mary McDowell.

Although the universe is relatively unchanged from 100 years ago, the products of our world have. As with this issue's "Technotes," the following "Technovations" are taken directly from past *Technograph* issues.

Talkies Credited to Illini Prof

"Professor J. T. Tykociner, Research Professor of Electrical Engineering at the University of Illinois, conducted research over a long period of years on photo-electric tubes and their applications. Sound cinematography, or 'talking pictures' is one of his contributions to our American way of life." *(March, 1941)*

Not Just Hot Air

"A balloon borne electronic system that can bring radio, television, and modern telecommunications to people on emerging nations is undergoing final tests by TCOM (Tethered Communicatons) Corp. At least 15 conventional broadcast and microwave towers would be required to provide the coverage achieved by a single balloon-borne system." *(May, 1974)*

Talking to the Man In the Moon

"By combining the recent advances of electronics and rocket power, a compact 'rocket radio' capable of carrying a 100-watt transmitter the 250,000 miles to the moon in about 60 hours has been forecast by Associate Director J.A. Hutcheson of Westinghouse Research Laboratories. With 50 pounds of storage batteries and less than 50 additional pounds devoted to an ultrashort wave transmitter and associated clockwork, signals could be sent to receiving stations here on local conditions on the flight to the moon and for several days after it has landed there." *(December, 1946)*

Will It Ever Think, Too?

"A new student matriculated at the University of Illinois last September. This student, commonly referred to as a 'brain,' can work problems in five hours that would take a skilled mathematician all his working life. Of couse, we are speaking of the new electronic digital computer now housed in the Engineering Research Laboratory here on the University campus." *(December, 1952)*

Whad'ya Say?

"Although hearing aids have progressed extensively since the hearing horns of several decades ago, the hearing impaired still suffer from difficulties such as static feedback, unstable response, and amplification of unwanted noise. All these could be solved, however, with a new device developed by researchers at the University of Wyoming.

"The basis of the computers used in the hearing aid is digital-signal-processing (DSP). A central processing unit handles digitized data to acquire designed programmed results. Software programs handle information fed into the computer by instructing the CPU on how to handle the input data.

"The new device improves upon its predecessor through its ability to adapt to changing signals by using a microprocessor, by suppressing noise better, and by responding more quickly to necessary changes." *(April, 1984)*

Send Me a Signal

"At the present time, however, because the volume of traffic is so great, the distance traveled by individual vehicles so long, and because of the fact that many of the drivers are traversing the road for the first time, it is imperative that there be some adequate method of furnishing the drivers with information which will enable them to use the highways with maximum convenience, speed, and safety.

"It is highly desirable that the entire system of marking signs be standardized." *(January, 1926)*

Expanding Television

"It was brought out at this time [September, 1948] that the field strength required for UHF television would be 10 times that of the standard VHF field, with the coincident requirement for a tube capable of power output much higher than any previous tube of this type. . . . However, it was disclosed that, in nearly all other respects, UHF range was equal to or superior to the VHF band for television. With this latest result in mind, an intensive program of tests and experimentation was begun by the television industry in an attempt to perfect commercial UHF television." *(March, 1952)*

Bottom Heavy

"In their efforts to design higher skyscrapers, architects are limited by an enormous dead load of flooring. . . . A new type of floor paneling has been invented by steel engineers. . . [which] is designed to act as a solid steel girder embracing the whole girth of the building, preventing tortional quirks and reducing the danger of high wind or earthquake action. . . . For a 75 story building, it is calculated to save 2,000,000 pounds of dead load. . . . Thus, the dreams of a 100-story building may become a reality." *(March, 1930)*

Ski Resort Insurance Created

"Fluffy, white snow fell for the first time out of man-made ice clouds in General Electric's laboratories and promises to reveal new facts on icing on aircraft and determine effects of snowstorms in producing static in airplane radios." *(January, 1947)*

Laser Etch-A-Sketch

"The discovery of a new photochemical process at the IBM Thomas J. Watson Research Center now makes it possible to use lasers for etching organic polymers and biological materials without the occurence of heating effects. Called ablative photodecomposition by its discoverer, R. Srinivasan, the process has potential for application in the photolithographic creation of integrated circuits as well as in the precise removal of biological material for medical and dental purposes." *(November, 1983)*

Wires Go Underground

"The rapid growth of metropolitan cities throughout the United States has made it necessary for telephone companies to improve their facilities for doing business. The large expenditures for repairs and the trouble experienced with storms are the principal reasons why companies are placing their wires underground." *(1905-06)*

EE's Hit Prime Time

"Television progress is being made at the University of Illinois with construction of a new electronic television system incorporating the most recent developments and technical features. This project is under the supervision of Professor H.A. Brown of the Department of Electrical Engineering. The amateur radio station license, W9YH, of the department permits television transmission within certain limitations and restrictions. The equipment will be used mainly for experimental purposes, but is expected to stimulate considerable interest and provide entertainment for visitors during the next Electrical Engineer's Show sponsored by the department. The image produced by the television is approximately 1 ½ inches square and is remarkably clear and well defined." *(March, 1941)*

Some researchers have found the versatile modern laser to be a necessity. Here, a laser is used by graduate physics students Erramilli Shyamsunder and David Fung to study the dynamics of the protein myoglobin at low temperatures. (Photo by Dave Colburn)

Blinded by the Light

"It should never be possible for the direct rays from the electric bulb or other bright source to enter the eye of the one using the light. Churches should recognize this principle and discontinue the practice of wearing the audience and handicapping the preacher because of lamps exposed to view for at least a part of the services." *(November, 1913)*

Fission Products Measured

"Presently, research headed by Professor Bernard W. Wehring in Nuclear Engineering is being carried out that will allow accurate measurements of all fission product yields. He and his graduate student, Gino Dilorio, have developed a fundamentally new experimental method to directly measure the fission product mass yields in thermal neutron fission. A fission fragment mass spectrometer, HIAWATHA, which has achieved 0.5 amu mass resolution has been constructed for this purpose, previous to which the best mass resolution achieved was 3 amu." *(April, 1976)*

You Could Hear a Pin Drop

"The science of the acoustics of auditorium is of comparatively modem development, beginning with the classic work of Wallace C. Sabine about

1900. . . he showed that the time of decay of sound depended directly on the volume of a room, on the loudness of the sound and inversely on absorption.

"Ideal acoustics may be found with conditions resembling the open-air Greek Theatre." *(November, 1928)*

Gutter Watcher

"An electronic umpire that can't dodge bottles or change decisions has been developed by General Electric for calling bowling fouls.

"Actuated by electric eyes mounted on the foul line of any alley, the automatic instrument sounds a bell or buzzer and flashes a light to indicate which of the sixteen alleys have been 'fouled.'" *(October, 1949)*

Marcus Welby Via Satelite

"A new beam transmitter operated on a shortwave of 14 meters can be focused on any country from the radio station in Rome. A minimum wave length of 40 cm is used so that thunderstorms, elevators, and all types of electrical equipment will not interfere.

"By use of this beam, you may sit in a theatre and see events which are actually happening thousands of miles away. Every hospital will be able to transmit and receive by x-ray photographs the best medical advice in the world." *(February, 1935)*

Mass-Spectograph Created

"Dr. E.B. Jordan, Associate in Physics, has designed and built what is referred to as a mass-spectrograph, a basic research tool. . . . Only five such units are in existence in the world, Dr. Jordan's being the largest and most powerful, six times as powerful as any other. . . . It is a machine used principally for determing atomic masses or weights of the elements, but can also serve to determine the amount of energy released when the nucleus of an atom is disintegrated by the popular atom-smashing machines. The design and construction of the mass-spectrograph is entirely new and original. The entire machine is supported on a concrete vibration-proof pier weighing thirty-two tons." *(December,1940)*

A Shocking Demonstration

"A twelve-foot induction coil has been constructed under the supervision of R.E. Hart, '15, and with it he plans some very interesting and marvelous demonstrations. The coil gives 2,500,000 volts, which will generate a spark ten feet long. . . . The ten foot spark will be passed between two people who, it is hoped, will live to tell their grandchildren of the marvelous feat." *(April, 1915)*

Cool Heating Process

"The same microwaves that are used to send radar messages and television pictures can now cook a complete meal in 90 seconds or 40 complete meals in one hour. A megatron produces the 2,450 megacycle waves which cook the food in a cool, tightly-sealed oven. Only the food is heated." *(November, 1962)*

Microchips Arrive

"The IBM 5100 portable computer announced today uses an advanced Metal Oxide Semiconductor Field Effect Transistor (MOSFET) Read Only Storage (ROS) circuitry.

"The circuit density achieved on each chip is 48K bits. Each chip is approximately 0.23 inches square." *(December, 1975)*

Science's Light Side

"Today's version of the photophone sends beams of laser light through thin glasslike fibers. The technology involved is called fiber optics and finds applications in many fields other than communications. Medical technology uses fiber optics to look inside the human body. Some mechanical devices utilize a fiber optic device to detect notation of as little as one thousandth of a degree per hour. Many other sensing and monitoring devices based on fiber optics are under development or in use." *(April, 1984)*

Remember When. . .

"The new memory device, which combines the feature of high speed with a potentially huge information storage capacity. . . . consists basically of 10,000 tiny ring shaped magnets woven on thin wires.

"It can 'memorize' or 'recall' a bit of information in a few millionths of a second.

"It can store 10,000 bits at any one instant. It potentially has a very high degree of reliability.

"It promises to be relatively cheap, as memories for computer go." *(October, 1953)*

People Chutes

"How many times did you leave the ballpark before the exciting game was over, just to beat the crowd and get outside the stadium before everything got jammed up? This problem might be solved by a new and revolutionary development—the moving sidewalk.

". . . . The belt is capable of transporting 15,000 passengers in an hour. Passengers step on and off as if it were an escalator, and it gives them the option of riding without any effort or of adding their own walking speed for a quick trip." *(May, 1955)*

Saver of Bent Bodies

"A 'wrist computer' to help divers avoid the bends has been invented by two GE scientists with a common hobby, scuba diving. The wrist inclinator will guide swimmers in the stop and pause ascent

Abbott power plant provides the University with its primary source of electricity and steam. Constructed in 1941, the plant continually improves its safety and efficiency. (Photo by Dave Colburn)

from deep water which raids them of nitrogen absorbed by breathing high-pressure air. This routine prevents the bends, the formation of nitrogen bubbles in the bloodstream which cause internal pain and can result in crippling." *(December, 1973)*

Manhattan's Lightning Rod

"The Empire State Building is itself Manhattan's lightning rod because it reaches nearly a ¼ mile into the sky. It's well grounded by massive steel work. Experiments have been carried on with 5,000,000 volt bolts of laboratory lightning in the research department of General Electric." *(May, 1931)*

Look Before You Send

"To facilitate better framing and as a necessity for quick focusing, each [television] camera has its own viewer which is a small television screen in front of the operator mounted in a removable section on top of the television camera. By watching the viewer the operator always has a clear picture of the image he is transmitting." *(April, 1953)*

Power Plant History

"The prime purpose of this article is to acquaint the reader with some of the major causes which incipiated the construction and subsequent development of the Abbott Power Plant.

"Electrical loads exceeding 2500KW had already taxed the then existing power supply to its utmost. . . a better standard of illumination was necessary for the existing buildings and also for the recently constructed buildings including the Illini Union, Gregory Hall, McKinley Hospital, Men's New Residence Halls, Geological Survey Laboratory, etc.

"In addition, air conditioning systems were planned for the Student Center and new classroom building. . . heating requirements for the next ten year period indicated an increase to 200,000 pounds of steam per hour.

"Construction of the new plant began in January of 1940 and was totally completed in February of 1941. Temperatures in the [steam] tunnel attain values of 90-100 F (thus affording an excellent substitute recluse for annual Florida enthusiasts)." *(May, 1944)*

Whirlybird

"Three U.S. inventors have completed a 'rotor airplane.' This strange craft without wings is lifted by means of metal spools two feet thick which whirl on spindles. . . The inventors claim that their plane can lift ten times the load of any other plane of equal weight and that it's speedier and more economical to house." *(December, 1930)*

Nucleus Filled With Electrons

"Thus the elements may be arranged in a series beginning with hydrogen which has one electron per atom and ending with uranium which has ninety two. There are a few gaps in the series, but eventually they will be discovered to fill all the gaps.

"In the nucleus, which is the minute center of the atom where most of the mass resides, there are electrons embedded, and in all but a few atoms the number of electrons is an even number. Apparently, the electrons go into the nucleus two by two as the animals went into the ark." *(January, 1926)*

Large Screen TV

"You've seen television. Now you'll see it in its finest form—giant projections of special events, transmitted only to theatres on private wires or radio beams to make movie going more fun." *(December, 1950)*

Versatile Petroleum

"The use of crude oil on railways and highways is attracting the attention of the engineering profession all over the country. Oil was used primarily as a preventative of the destroying and disagreeable dust so frequently encountered on both wagon-roads and railroads. Its field, however, is by no means limited to that alone, as many advantages to its use have been discovered." *(1900-01)*

Atypical Equipment

"Within the last month there has been installed in the Laboratory of Applied Mechanics at the University of Illinois a 600,000 pound testing machine of the vertical screwing type. This new piece of apparatus is of special interest not only because it is the largest ever built, but also on account of certain novel features of its design." *(1904-05)*

Dolby Sound—Almost

"There's no doubt about it, 'talking movies' have set the motion picture world by the ears. Most of the leading producers

have announced their intention of using sound in their future productions, either in the form of musical accompaniment or the human voice.

"According to reports about 400 theatres in the country are already showing these sound pictures, at least 1,000 will be doing so by the end of 1928." *(November, 1928)*

Into The Dark Side

"A new infared-sensitive motion picture film will permit motion pictures to be made in the dark with infrared illumination, or in the semi-dark without, has been announced by the Eastman Kodak Company.

"With this film, successful motion pictures were made of audience reactions when house lights in a theater were dimmed to 1/70th of normal room illumination." *(December, 1952)*

Lengthy Railways

"One of [the enterprises underway] is the railroad across Siberia 4,525 miles long, another the railroad from Cape Town, South Africa to Cairo, Egypt, which is 1,000 miles longer than this Siberian road. The Pan-American Railroad, which is intended to connect North, Central, and South America, is a much greater enterprise than either of these and almost equals their combined length." *(1904-05)*

Sticklers for Accuracy

"The first atomic clock, accurate regardless of age, temperature and pressure, and independent of the earth's motion for its method of time keeping, has been developed by the National Bureau of Standards at Washington." *(April, 1950)*

Printed Circuits Developed

"Tremendous gravitational forces are exerted on miniature radio equipment when fired in a shell from mortar or artillery weapons. This force approaches 10,000 G's in some cases, and components wired into the circuit in a normal manner are thus subject to being torn from their mountings. This was sufficient reason for the development of printed circuits, but probably of equal importance were the greater ease of mass production and the smaller size.

"Since the war, the National Bureau of Standards and Centralab Division of Globe-Union, Inc., and a few other private companies have continued development of the printed circuit technique with a view to its use in the manufacture of commercial radio receivers and transmitters. . . . Printed circuits will most likely find their widest application in low-power, high frequency radio equipment where small size is an especially important factor." *(October, 1946)*

Engineering is Everywhere

"Major league batters soon may be swinging with a piece of magnesium instead of ash. Bats made of magnesium with a plastice covering are said to be as good as wood, and the sting following a hit is eliminated." *(May, 1962)*

Sunless Beautification

"This bundle of loveliness [woman] is benefitting from simulated sunlight produced by the 20-watt fluorescent sunlamp developed by Westinghouse engineers. The tubular lamp emits a concentrated band of radiations in the mid-ultraviolet region of the spectrum (2800-3200 angstroms), which is the erythemal, or suntan-producing wave length." *(March, 1951)*

Auto-Adjustment

"Designed to reduce accidents caused during night driving trips, the Techtronic Eye relieves the driver of the tedious task of dimming and brightening headlights. It functions whenever, and only when, the car's 'open-road lighting' equipment is sent into action. The driver is completely relieved of the task of manually switching lightbeams. Accidents caused by temporary blindness due to headlight glare become minimized." *(November, 1953)*

High-Tech Production

"A new design for high energy atom smashers and a new way to plan and pretest them by using an electronic computer were revealed here at the University.

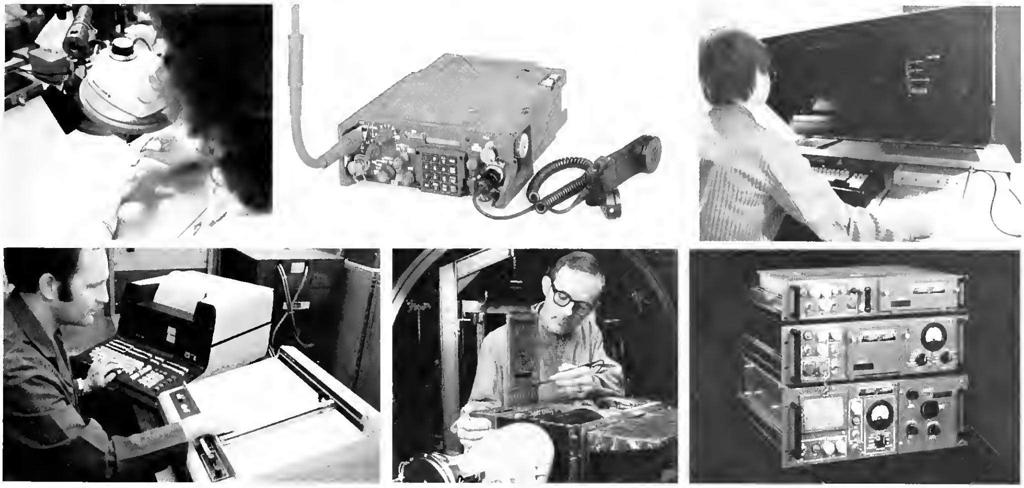
"Precise design and mathematical pre-testing are given credit for this by Professor Donald W. Kerst who supervised construction of the machine.

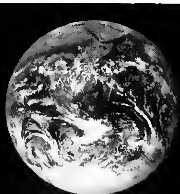
"Most of the mathematics for the new machine was done with the ILLIAC, the University of Illinois electronic digital computer." *(October, 1957)*

Energy Alchemy

"The direct conversion of the chemical energy of gases into electricity—long a dream of scientists and for years a laboratory curiosity—has been accomplished here with the development of the first fuel cell capable of economically producing thousands of watts of power. Using hydrogen and oxygen as fuel, the new silent source of power has been developed by scientists at the Research Laboratories of National Carbon." *(October, 1957)*

Compiled by Sally Cohen, Dennis Francisicovich, Shelley Grist, Lesley Lee, Nata Mackevicius, Alfred Tadros, and Joe Wyse. Edited by Mary McDowell.





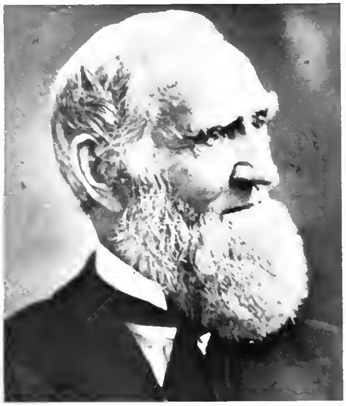
From page 7

1. The train traveling against the spin of the earth will wear its wheels out more quickly, since the centripetal force is less on this train.

2. 64.

3. If two widows each have a son and each marries the son of the other and has a daughter by the marriage, this series of relationships would arise.

4. $(4! + 4.4)/(.4) = 71$.



Jonathan Baldwin Turner led in the movement to ratify the Land-Grant Act which created the University.

Born near Templeton, Massachussets in 1805, he attended Yale College and studied the classics. In 1833 he became Professor of Rhetoric and Belles Lettres at Illinois College.

While in Illinois, he became an ordained minister. He also married Rhodolphia Kibbe of Connecticut, with whom he had seven children. His strong religious views led him to be a very vocal opponent of slavery. The trustees of Illinois College, afraid that he would offend some of their generous Southern patrons and thereby upset the college's delicate financial situation, forced him to resign in 1848.

He became a full-time farmer and began advocating "A Plan for a State University for the Industrial Classes," which he first presented in May, 1850. He felt very strongly that the children of the working class deserved an education that was tailored to their aptitudes and interests. Said University President Edmund James, "He early came to recognize the necessity for a scientific education of the practical man, if he was ever to take the place which belonged to him by virtue of the importance of his occupation."

Turner was undeniably a key figure in organizing support in the Midwest for the Land-Grant Act, and some feel his friendship with President Abraham Lincoln, who signed the bill, may have been instrumental in gaining Lincoln's support.

Turner worked to establish his vision of an industrial university in Illinois. He spoke at the opening ceremonies of the University, but would accept no position in the new school.

Mary McDowell

Stillman Williams Robinson was the first dean of the College of Engineering. He assumed his office in February, 1878, when the University was divided into colleges.

A native of Reading, Vermont, Robinson was born in 1838. He worked as an apprentice in a machine shop from 1855-59. He wanted to study mechanics, but no such curriculum existed at the time. Deciding that civil engineering would have to suffice, he traveled by foot the 600 mile distance to the University of Michigan to begin his studies.

He joined the faculty at Michigan in 1866, and in 1870 he became head of the mechanical engineering department at Illinois. In this position, Robinson was the creator of the third mechanical engineering program in the country, preceded by the Massachusetts Institute of Technology and Worcester Polytechnic Institute. He was an unorthodox yet effective educator and set the pattern for future engineering education. He allowed his students practical lab experience and helped establish respect for engineering education among older engineers who thought that their profession could not be taught in a classroom setting.

Robinson left in 1878 for Ohio State University, where he taught mechanical engineering and physics.

Robinson died in 1910, leaving as memorials the clock for the class of 1878, which was originally in University Hall and is now in the Union, and the steam engine in the Mechanical Engineering Laboratory, which he designed and his students built. It provided energy to the University for 25 years.

Mary McDowell

When the Classes of '83/84 chose the top 25, they counted on Harris.

In a recent nationwide survey* of over 2,600 graduating engineers, Harris was consistently named among the top 25 companies most preferred as employers.

The Reasons?

Maybe it's because our broad product line reflects a comprehensive approach to information technology... an approach few others can match.

Or perhaps, it's because of our reputation for boldly applying state-of-the-art technologies. Here are just a few examples:

- Harris developed the world's first 16-bit microprocessor based on CMOS technologies.
- Harris is a leader in the development of a third generation digital PBX switch.
- Harris developed and implemented one of the world's largest domestic satellite communications networks, involving 38 earth stations.
- Harris has played a major role in the unfolding drama of Artificial Intelligence and the development of the Fifth Generation Computer.
- Harris has more than 55,000 word processing workstations installed... second only to IBM in the stand-alone product category.

No wonder Harris Corporation has enjoyed a powerful growth record of close to 20% a year for the past ten years. Today, we are a Fortune 200 company with sales close to $2 billion. And the outlook for tomorrow is even more promising. New technological breakthroughs, new challenges and new opportunities for growth.

Be a part of it. Career openings exist at Harris in California, Florida, Georgia, Illinois, New York and Texas for graduates with Bachelor or advanced degrees in EE, ME, IE, ChE, Computer Science and Physics.

Each of our 30 divisions operates autonomously, so the potential for career growth is practically unlimited. Whether your goal is technological leadership or executive management, Harris is committed to your success.

Why not rate Harris for yourself? Contact your Placement Office or write: Director, Corporate College Relations, Harris Corporation, 1025 W. NASA Blvd., Melbourne, FL 32919

We are an equal opportunity employer M/F/H/V

*Graduating Engineer—Second National Engineering Student Employer Preference Survey.

If It's Happening In Electronics, It's Happening At Harris.

HARRIS

Volume 100, Issue 5

Newsstand

Illinois Technograph

Boomerangs Return

April 1985 Volume 100, Issue 5

*Illinois***Technograph**

Celebrating 100 years of publication

On the cover: National champion boomerang thrower Paul Sprague demonstrates the flight of a boomerang. The ancient sport of 'ranging has recently found returning popularity (photo by Dave Colburn).

4 **What Makes a Good T.A.?** *Caroline Kurita*
Nearly every student has experienced both helpful and pitiful teaching assistants, but exactly what attributes a good instructor should exhibit is a difficult question to answer.

6 **The Return of the Boomerang** *Langdon Alger*
Boomerangs have been fascinating tools since their development thousands of years ago. Now, they are making a comeback on campus as local students examine their appeal and structure.

10 **Fighting Water Pollution** *Michael Lind*
New technologies and development of water treatment methods have produced promising progress in the fight against hazardous wastes.

Departments

Editorial 3, Tech Teasers 3, Forum 8, Technovisions 9, Technotes 11, Technovations 13, Techprofiles 16

Tech *Teasers*

1. Two animals of the feline species are on opposite sides of a steeply slanted roof and are about to fall off. Which one will endure the longest?

2. The middle pearl on a string of 33 is the largest and best of all. The others are selected and arranged so that, starting from one end, each successive pearl is worth $100 more than the preceding one. From the other end, the pearls increase in value by $150 up to the large pearl. The entire strand is worth $65,000. What is the value of the large pearl?

3. After a particularly severe mid-term exam, several students dropped the class. The number of people who dropped was equal to the square root of half the number of people in the class originally. Of the original people in the class, 8/9 are sitting in the lecture room diligently taking notes. Two students are blowing off class to play frisbee on the quad. How many people were initially on the class roster?

4. An eccentric millionaire's will stipulated that his fortune of exactly $1,000,000 should be divided among his 16 Lhasa Apsos as follows: every gift must be either $1 or a power of $7, and no more than six dogs can receive the same amount. How was the money apportioned?

5. Poindexter, a creative engineering student, devised a scheme to revolutionize the business world. "I can take 4 from 4 and leave 8," he said. "That's impossible!" replied Biff, a business major who had survived the rigors of Math 111 and who knew that his friend couldn't be right. How did Poindexter prove his point?

Answers on page 12

Editorial

From Start to Finish

Are you ready for a technical challenge?

"Man, I wanna be in second grade."

"Whatever for? How can you *say* that?"

"Well, back then I had a set schedule. I'd come home from school, go out and mess around until dinner, watch some TV, go to bed, and then do it again."

"You really want to be there again now? Besides, once you graduate you'll be able to have a set schedule again."

Picture yourself in a world-wide company with emphasis on the individual

"It's gonna be so cool! I'll get a house, a car, a piano, an excellent stereo. . .and I'll eat really good food for once!"

"Yeah, but you only need cigarettes and ice to live."

"So you say, but I don't see you turning down large plates of stroganoff for cigarettes."

For a career that can't be duplicated, work with an original

"So how'd the interview go?"

"I dunno. Pretty bad, I think."

"How come? What happened? You prepared for it a lot!"

"I don't know. . .I study up for an interview, eat right, take vitamins, talk a lot about who I am, what I want, and what I can offer, and it gets me nothing but a callous bong letter. Then, if I walk cold into an interview after only about three hours sleep and with an apathetic attitude, they offer a plant trip right there. Pretty weird."

Your first 18 months. . .can make the past 4 years pay off

"I had a lousy interview today. I also decided I'm addicted to caffeine."

"I bet you didn't have a good breakfast to start out your day right."

"No. I had a bottle of pop. I can't be my usual jovial and entertaining self in the morning for someone I don't know unless I have caffeine first."

"Yeah, I understand. I wonder what would happen if you had a few beers before an interview?"

If you thrive on responsibility, the opportunity is here!

"I don't want to graduate. I'll have to go to a new place with nothing and slowly build my life and credit up, so that when I'm too old to enjoy life I'll have lots of money and materialistic joys."

"Really. Why don't we, as society, give *everything* to the young and take it away gradually so that when you retire you have nothing? I mean, I'd have a lot more fun with a million dollars now than I would in 50 years."

The people behind advanced missile engineering seek perfection

"You know what's really scary to think about?"

"What's that?"

"Kid's shoes."

"Yeah. Look man, I gotta go. . ."

"No, seriously. Think about buying shoes for your kid that you and your wife have brought up together. You gotta get shoes for it that it will grow up in. Don't you think that's scary?"

Imagine the career you want

"I think we should post all our bong letters on the wall."

"Why? Everyone does that. It's kinda silly. Besides, I'd be embarrassed."

"But then we would have a physical projection of our bitterness and unyielding hope, displayed in a quasi-artistical form. Besides, all those companies' letterheads look cool."

Rising professionals—career advancements are within your reach

"Do you think they have fun in the real world?"

"Nah."

From finish. . .to start

[signature]

What Makes a Good T.A.?

Special talents are required of teaching assistants to convey their knowledge and experiences to students.

Attending any Big Ten school can mean that students will often learn from teaching assistants in addition to or in place of professors. Although this may not be a drawback, both good and bad teaching assistants exist just as good and bad professors do.

The University does not always obtain ideal teaching assistants, which is a situation, according to Professor H. G. Friedman of the computer science department, that is "inescapable." If all teaching assistants are not created equal, then what makes one teaching assistant better than another?

Finding teaching assistants encompasses a search similar to that of finding employees for any job. Ads are distributed through national outlets, applications are received, and the most qualified applicants are finally chosen. Friedman explained that although the knowledge and intellect of the teaching assistant may be perceivable from the application, a good teaching assistant has an "undefinable talent that only students can tell." This talent includes a sensitivity to the students' needs and desires.

Professor Sylvian Ray, also of the computer science department, further explained that the humanitarian aspects of the individual cannot always be seen in new people, creating a sad problem. Although this makes it difficult to find the ideal teaching assistant, most applicants are found acceptable and, once hired, are rarely disposed of.

Ray believes that a good teaching assistant must interact well with students. "There is a fine line of decision between knowing when to take charge of the situation and knowing what is sensible in terms of how the instructor wants to run the course," he said. For Ray, the key aspect of a qualified teaching assistant is a balance of trying to obey the professor, accepting the general philosophy of the course, and using some initiative of his own. According to Ray, a good teaching assistant will possess "an attitude of noblesse oblige with respect to the students." A teaching assistant who displays egotism by cutting down others who are less knowledgeable than he, or one who is not helpful toward the students, is the opposite of what Ray prefers to see. He further explained that teaching assistants should not show off how much they know but rather have a general attitude of mercy toward the students. On the more technical side, a teaching assistant should know the subject well and be able to explain it clearly. "It is when the humanities part and the technicalities part balance nicely that makes a super teaching assistant," he said.

According to mathematics professor Wilson M. Zaring, "a good teaching assistant has two different jobs—one to teach and the other to study." Teaching includes certain intangibles such as an outgoing personality, interest in others, and a motivation to teach. As a student, Zaring feels that a teaching assistant should also have "a proper background, intelligence, drive, motivation, and desire." There have been teaching assistants in the past which have not worked out either academically or as a teacher. They either lack the ability to communicate or don't prepare for teaching their class. Zaring feels that if the teaching assistant does not have a feel for what the students want, he is not a good teaching assistant and never will be. "The issue of success has to do with drive, motivation, and ability," said Zaring.

Teaching, to Friedman, runs in a circle like all other skills. "If you like teaching you're better at it, and if you're better at it you like it more," he explained. Friedman feels that a good teaching assistant should "have the ability to communicate—he should know the subject and have a good command of the English language." However, he pointed out, this does not include all American teaching assistants and does not exclude all foreign teaching assistants.

Zaring added to this with one experience of hiring a teaching assistant. A student applied to become a teaching assistant, but because his English was marginal, Zaring was hesitant in hiring him. He explained to the teaching prospect that students tend to have a negative reaction to accents. The prospect understood, but still wanted to teach. He told the professor this and also that he would write everything out, pass out handouts, and speak slowly. Because the motivation and desire to succeed were largely present, the prospective teaching assistant was hired and eventually generated a positive response from the students. Zaring believes that this particular teaching assistant went over well because he wanted to succeed and, because of this strong desire, made an extra effort.

Amra Serdarevic, a teaching assistant for Physics 106, explained that being a teaching assistant is not an easy job and requires a lot of time. A good teaching assistant will find this time and use it to prepare for class, grade the students' work, conduct office hours, and have time for students outside office hours. She felt that the students should be told what is expected of them with an attitude of wanting to teach them something, rather than punishing them for not doing things.

Jenny Karloski, a teaching assistant for Chemistry 102, has a positive attitude about teaching. She explained that a good teaching assistant should care about the students and be willing to take time with them. Two other important factors are that the

Caroline Kurita

teaching assistant should know what he is talking about and be able to present the material in an organized fashion.

Being prepared and writing clearly are just some of the qualities that Jerry Scappaticci, a Math 242 teaching assistant, considers important. He also feels that using homework to check the students' understanding of the material, grading fairly, and being considerate of the students are important.

"In order to be a teacher, you have to want people to learn and be excited about learning," said Lu Ann Duffus, a teaching assistant for Economics 101. She stressed that the key word necessary to be a good teaching assistant is enthusiasm. "If you're not enthusiastic, you can't expect the class to be." Even if a teaching assistant is not partial to a certain section, enthusiasm must be developed in order to teach it well, she explained. Just because a person is knowledgeable, he is not necessarily a good teacher.

Kim Kerry, a Chemistry 102P teaching assistant, felt that there are basically two different responsibilities of a good teaching assistant. One is to teach something by covering the required material, and the other is to give the students something they can swallow. The teaching assistant must find out what the students know and don't know, as well as what they expect to learn. She explained that the material should be presented clearly and questions should be answered. A good teaching assistant should care about whether the students are doing well or not, rather than just go through their papers.

Dennis Youn, a teaching assistant for Chemistry 102 lab, explained that the job of teaching for lab work is less difficult than for a discussion section. His role is to explain the technical problems of the lab and to give quizzes. A good teaching assistant will do these things plus make himself available for questions and show students the amusing aspects of labs. He should also be open-minded and have a flexible personality.

"Teaching is the best thing I've done since coming to this University," said Brian Igarashi, another Physics 106 teaching assistant. It has given him the opportunity to interact with a lot of people simultaneously, in addition to making him organize his ideas and prepare them in a clear and understandable format. He feels that it is important that a good teaching assistant "be able to understand the material from the perspective of the students, not that of a Ph.D. candidate."

The ideas of students on which attributes determine a quality teaching assistant also vary. Joe Lehman, a senior in Agricultural Engineering, feels that a good teaching assistant should know the teachings and applications of his subject and be able to tell why it is important. Such a teaching assistant should also be a good communicator and relate well to the students.

Mechanical engineering junior Kevin Baxter explained that a good teaching assistant should know his subject well enough for a clear presentation in a logical manner. He feels that teaching assistants should be reasonable graders and not test the students on material that was not covered in class.

Karen Lindholm, a sophomore in electrical engineering, believes a good sense of humor helps one to be a good teaching assistant. A good teaching assistant should be prepared for any questions the students may ask and be able to answer them without going off track, in terms understandable to the students.

Freshman Brian Davison feels that there are many qualities that a good teaching assistant should possess. These include a good knowledge of the material, good speaking skills including communication and organization, and accessibility to the students. He also feels that teaching assistants for discussion sections should attend course lectures for knowledge of what is being covered.

Some safeguards are available to protect students from a less-than-ideal teaching assistant. In 100 level classes there are two instructors, both a professor and a teaching assistant, to provide two good chances for the student to find someone that he can relate to and learn from. Friedman explained this using as an example the course evaluation questionnaires given at the end of a course. In the long-hand comments, one student said that he had a terrible teacher but a good teaching assistant, while another student said just the opposite—he had a terrible teaching assistant but a good professor. Although both reacted differently to the teachers, each could adjust to one. Some teachers will get their message across better than others, and students' responses vary to different approaches. ■

The Return of the Boomerang

Although often considered an Australian pasttime, the boomerang has gained universal appeal through its bizarre and curious flight path.

As illustrated by this sampling from Paul Sprague's collection, boomerangs do not have a singular shape, unlike many other flying objects (photo by Dave Colburn).

Deep down in a dark basement of corporate America, a crackerjack team is trying to determine the world's greatest feat of engineering. What remains unrealized is that the item they are attempting to discover is being used by people internationally and slowly gaining popularity.

The boomerang, frequently known as a "'rang" or "boom," allows individuals to get outdoors and enjoy themselves, without becoming over-exercised. 'Rangs are available in a myriad of shapes, sizes, materials, and weights for both right-handed people and southpaws.

"The returning boomerang just doesn't go straight, and therefore was not an effective weapon," metaphyses Paul Sprague, national boomerang champion, boomerang craftsman, Boomerang Club president, and University journalism student. "So Zog's kid picked it up, and said 'Hey! This is great!'" Other experts on the subject believe boomerangs developed naturally from date palm stems, because they have the characteristic shape and airfoil of a boomerang. Whatever the steps leading to its invention, the oldest 'rang found so far is over 20,000 years old.

Boomerangs have a flat bottom, and a top that is curved in the shape of a traditional airfoil. Traditional 'rangs have two arms separated by slightly over ninety degrees, although acutely angled boomerangs work superbly. Multi-bladed 'rangs come in more interesting shapes, such as Π, a tomahawk, alphabetic letters, and a pinwheel.

The best returning booms are those which are handmade, due to the fact that commercial versions never seem to work. Sprague is a co-partner of AbOriginals, a company that makes all types of booms. Building them "is mostly trial and error. You have to know the basics, like how the mass should be distributed and stuff like that, before you can make a working boomerang," he explains. Usually, booms are made of plywood or laminated strips of pine, birch, or oak, which are glued or cut into shapes and sanded down.

The process of building a boomerang is quite simple. After selecting the kind of wood to be used, the basic shape is formed. Then the airfoil is developed by rasping or sanding down the top of the boomerang. The leading edge, or the edge of the 'rang that cuts first into the air during flight, should always be the fatter part of the airfoil; the trailing edge should be sharper in comparison. This will create a curve which gives the top greater surface area than the bottom.

Once the initial airfoil is created, the builder must go out and tune the boomerang. This is done by repeatedly test-flying the 'rang, and sanding it down in the right areas until it returns. Once the 'rang flies properly, it can be finished with spray paint, enamel, boat-building epoxy, or another finisher.

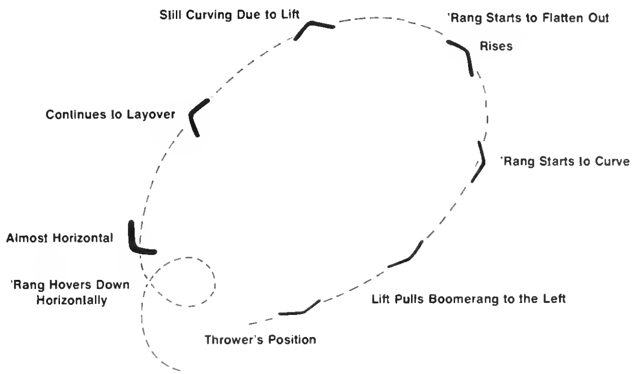
Tuning a new boomerang is best understood by comprehending why a tuned one returns. There are three reasons a boomerang returns to the thrower: lift, spin, and gyroscopic precession. Although some students have obtained Ph.D.'s with theses discussing the boomerang flight path, it is not difficult to obtain a reasonable understanding of the forces in action.

Lift is brought about by the airfoil on the boomerang arms because of the expression $\rho A v = \dot{m}$. $\dot{m}$, or mass flow, must stay constant by the laws of nature. ρ is the air density, which stays the same during flight assuming the boomerang doesn't change atmospheres. A is the area of the surface the air is flowing over, and v is the speed of that air. The surface area of the airfoil's top, or the curved side, is greater than the flat side of the airfoil; thus the air moves slower over the top of the 'rang. Since the air flows faster over the flat side of the 'rang, the pressure is greater there than over the top, which pulls the airfoil, and subsequently the boomerang, upwards.

The second aspect of the boomerang's flight, the spin, is imparted on the

Langdon Alger

Top View of a Typical Boomerang's Flight Path



Source: Paul Sprague

boom when launched and provides stability. It also starts the airfoil moving, which initiates the flight of the boomerang.

The final and most complicated part of the flight is the gyroscopic precession. This phenomenon is defined by Sprague as "the tendency of a rotor's axis to move at right angles to any perpendicular force applied to it." Thus the spin axis, which starts out parallel to the horizon, rotates clockwise in response to the lift force until the spin plane is horizontal.

The overall pattern of flight is choreographed beautifully. The 'rang is thrown vertically, and given a snap so it spins on a horizontal axis. Since the airfoil is oriented sideways, the lift is directed to the left of a right-handed thrower. This lift force is what precesses the spin axis. This process continues, with the spin sustaining it, until the axis has precessed nearly 90°. Then the boomerang is in an equilibrium state, and if the airfoil is shaped correctly, the 'rang will come directly to the thrower with an almost vertical spin axis.

The airfoil's effects can be enhanced by warping the boomerang arms. This is accomplished by steaming or heating the 'rang, and then holding the arms twisted until they cool. The effect of the warping is to accentuate the lift that the airfoil creates, or create lift in 'rangs that have no airfoils. In pinwheel 'rangs most of the lift is provided by upward warp on the ends of the pinwheel arms. In boomerangs made from cardboard, the creation of an airfoil is nearly impossible, so the lift comes only from the arms' warp.

With these many forces and warps, it would seem that operating the boomerang is a difficult skill to learn. Indeed, boomerangs can be quite temperamental; for example, the boomerang refuses to return if the wind is blowing over seven miles per hour.

When facing the wind, the boom should be thrown between 45 and 90 degrees to the right. A clockwise tilt in the spin plane can compensate for too little wind or a slightly strong wind. In the latter case, "it'll come in kinda fast usually, because the wind is blowing harder at you. But if you know what you are doing you won't hit anybody with it," claims Sprague. The secret is to snap the 'rang, imparting a high amount of spin to it. The throw rarely requires any brute force, but it does necessitate fairly strong wrists.

An ideal flight will find the boomerang making a few small circles near the thrower after its large return loop, and the 'rang will have flattened out so that it hovers overhead for a moment. Catching the 'rang takes courage, practice, and callouses, but the best way to catch it is by slapping one's hands together, trapping the boomerang between them. In the case of the pinwheel, the catch basically consists of providing any surface for the center pin to spin on. Sprague "landed a pinwheel on a judge's head one time. . . . It just settled down on [him] like a butterfly."

Such bizarre events are not unusual in the boomerang world, due to the fact that the people in 'ranging are unique and always attempting to determine new ways of throwing boomerangs. One Australian-born astronaut once decided that throwing a 'rang in deep space would result in a return time of many years: a new maximum time aloft record. A booming engineer was recently working on a 'rang that carried a timing device and a shiftable weight to achieve the maximum gain from the precession. However, the tried and true method for proficient throwing of boomerangs is still, under the advice of Sprague, to "throw them as often as possible." ■

Forum

The Best Years of Our Lives

This was really going to be a hectic day for me. I had an exam at eight, an interview at nine-thirty, and I had a problem set due tomorrow that I had yet to look at. All of these thoughts raced through my head as I sat in the Illini Union vending room studying for the exam. It was 3 a.m.: six hours until exam time. I just knew that things couldn't get worse.

By the time the fourth morning hour had come, my brain cells were hollering, "SLEEP!" Soon, I would listen to the call within my cranium. Soon, I would allow my head to drop to the table. I didn't even have time to think my next thought. I snored.

I felt something poking me in my side, and I woke up. It was the janitor. "Get outta here," he said. "I gotta clean up after you slobs."

I would have knocked his teeth out, but his leery smile told me that someone else had beat me to the punch. I got up and left.

When I had gotten back to my apartment, I reached into my pocket only to find a hole were my keys should have been. I didn't panic. After all, I'm an engineer, and breaking into an apartment should be an easy task for someone with my background. I was climbing the rain gutter towards my bedroom window when a voice called out from behind me, "You—come down from there."

"Officer," I said excitedly. "I'm glad to see you. I locked myself out, and. . ."

"Well, I'm glad to see you, too!" he said, as he slapped his handcuffs on my wrists.

It was eight o'clock before I convinced the police that I had lost my keys and that I was breaking into my own apartment. Eight o'clock was exam time, and I could picture the instructor walking up and down the aisles handing out the booklets. I managed to make it to the examination room by eight-thirty; that meant I had thirty minutes to finish a sixty minute exam. Great.

Nothing would discourage me. I went through that exam like nothing I had ever done before. At 8:45, I had made it to the half-way point, and I was sure that I would be able to finish. It was at that point that the instructor said, "May I have your attention, please. You will have to hand in your exams now."

The instructor went on to say that the clock in the exam room had stopped, and that it was really 9:25, not 8:45. Well, at least that explained why I had gotten so far in such short time. I handed in my exam, and I prepared to walk home. I was sure that nothing else could go wrong. And then I remembered—the 9:30 interview!

JCN, Inc. expected to interview me for an entry level engineering position within the next five minutes. I never had the chance to change into my suit, and I smelled like I had spent the night in the vending room. Thank you, Mr. Policeman. What could I do?

I resolved to do the only honorable thing. I went to speak with the representative from JCN, and I told him the whole story. He gave me a long, pensive stare, and then he spoke.

"Mr. Hightower, the story you have just told is a very interesting one. Now let me tell you something about JCN, Inc. We made fifty bezillion dollars last year. Did you hear me? Fifty bezillion dollars. We didn't get to be that large by hiring goof-offs. I'm sorry, Mr. Hightower, but JCN, Inc. does not hire engineers who make mistakes."

I would have knocked his teeth out, but his leery smile told me that someone else had beat me to the punch. I got up and left.

At this point, I was sure that negative events could never again touch my life that day. I decided that I was in need of rest.

I picked up a magazine in the hallway of the EE building and I started reading. I learned that within the next ten years, the engineering profession will be obsoleted by advances made in artificial intelligence. I was shocked! JCN, Inc. had even revealed plans for a device, known as the Wishbox™ that combined the technologies of voice recognition, artificial intelligence and speech synthesis. The person who speaks into the Wishbox™ can design virtually anything without technical expertise.

And what was to be done with the obsoleted engineers? Two plans were outlined. Some engineers would be shipped to Hollywood to star in movies about nerds. The rest would be re-trained as accountants, since engineers and accountants have similar personalities. How flattering.

I felt anger boiling within me. You mean to tell me that I've gone through four years of engineering school to become a movie star? What about those nights when my veins were filled with more caffeine than blood? What about all the parties I've missed? What about. . .

Suddenly, everything around me was out of focus, and I felt something poking me in my side. It was the janitor; I was still in the Illini Union vending room. I was dreaming.

"Get outta here," said the janitor. "I gotta clean up after you slobs."

I had no desire to knock his teeth out. Nothing had gone wrong; I had just made a temporary departure from reality. I got up, shook his hand, patted him on the back, and I left.

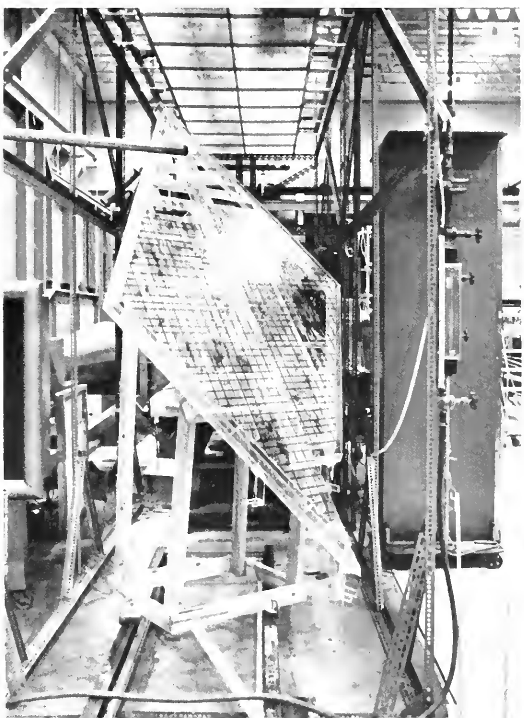
When I got back to my apartment, I reached into my pocket only to find a hole where my keys should have been. . .

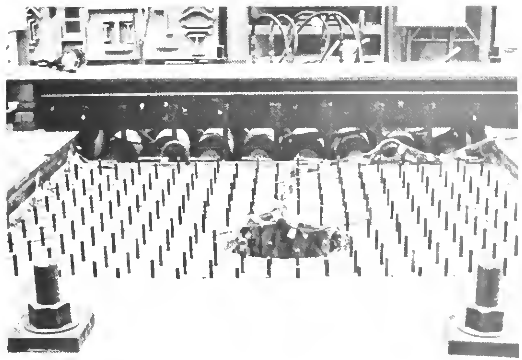
Raymond Hightower
President, Association of Minority Students in Engineering

Water, Water Everywhere . . .

Though we often take water for granted, civil engineers dealing in hydrosystems and environmental engineering decide on the best ways to deal with this most important substance.

Left: Nina Johnson, a graduate student in civil engineering, measures the pH of a sample of treated wastewater. Below left: This machine tests the strengths of tunnels, including those used for the distribution of treated water and the collection of wastewater. Below: A model of the roof of One Park Place in Chicago which was used to simulate the runoff generated by a heavy rainstorm *(photos and text by Mike Brooks).*





Fighting Water Pollution

Engineering and industrial development has often been criticized for its adverse effects on the local environment, but modern water treatment has applied engineering principles to obtain a cleaner and healthier ecosystem.

With the Industrial Revolution came a great rise in the level of pollution in the world's waters. Humans have always polluted the Earth to some extent, but in this case industry dirtied the water faster than humans working without machines could ever have. Many types of water pollution exist, ranging from simple suspended solids to highly toxic materials. Fortunately, the same engineering which in part created the problem is also capable of solving it.

One group of pollutants which can easily be treated is suspended solids. Often detectable as individual particles or cloudiness in water, suspended solids are inexpensively removed. By flowing water slowly through a large tank, most large particles will settle to the bottom and form sludge by the time they reach the end of the tank. After being cleaned out of the tank, the sediment or sludge is then disposed of in a safe manner.

Any particles not removed by sedimentation can be removed by filtration. Though highly efficient, filtration incurs additional expense because the filters must stay clean. To eliminate the need to constantly change filters, the system may flush water through the filters backwards to loosen trapped particles.

Organic waste in sewage, which includes human waste, often causes more problems than simple solids. This type of pollution looks bad, smells bad, and consumes oxygen which is necessary for the survival of fish. Two commonly used biological methods which effectively eliminate most organic waste are activated sludge and fixed film.

Activated sludge uses a combination of organic consumption and sedimentation. Water passes through two tanks. The first contains microorganisms which thrive on unwanted organic materials in the water. After passing through the first tank, the water contains many suspended organisms and must undergo

Abraham Chen, research associate for the department of Civil Engineering at the University, tests a sample of waste water treated by ozonation activated alumina adsorbtion (photo by Mike Brooks).

sedimentation in the second tank. The system then recirculates the settled organisms for reuse in the first tank.

Fixed film also uses microorganisms to consume organic waste. Instead of being circulated through the system, they grow continuously and attach themselves to surfaces in the system. Older techniques used rocks as the growing medium, but newer methods use plastic treated with carbon black to prevent deterioration in sunlight.

Two different types of organisms can be used in activated sludge and fixed film systems. The first, and more commonly used, is aerobic organisms. They consume oxygen to undergo their normal biological processes and therefore must have a sufficient supply of oxygen to be effective. Few problems are caused by this since air can simply be pumped into the water, or the water can be churned up at the surface to aerate it.

The second class of organisms is anaerobic, or non-oxygen consuming. Anaerobic processes are cheaper in the long run because it is not necessary to pump oxygen into the system, and less sludge is produced. Anaerobic organisms also produce methane gas, which can be used to run a treatment plant.

continued on page 12

Michael Lind

Protecting Chips

January 7 marked the invocation of the new Chip Protection Act. Administered by the U.S. Copyright Office, the law makes it illegal to copy topographical patterns on integrated circuits introduced after July 1, 1983.

Drafted to combat widespread industry piracy and because chip development costs are incredibly high, the act makes reproduction of registered semiconductor patterns illegal for 10 years after its registration or introduction on the market, whichever comes first. It does not protect circuit designs or software, which are already protected under patent and copyright laws. Only U.S. residents or foreign nationalities whose countries have similar laws can register integrated circuits (IC's) under the act.

According to Intel General Counsel and Secretary Tom Dunlap, IC piracy has been a problem in both the United States and Japan. "The Japanese are currently drafting and reviewing a similar chip protection law, and we anticipate similar movements in other foreign countries," Dunlap explained.

To register a chip pattern, a company or individual must submit documents that uniquely describe the layout of the chip. Only original layouts can be protected. Registration must occur within two years after the chip is first introduced.

New Leadership

University professor Charles W. Gear has been appointed head of the department of computer science. Gear will assume his position on August 21, replacing James N. Snyder, who asked to be relieved of the administrative assignment.

A professor of computer science, electrical and computer engineering, and applied mathematics, Gear has served on the faculty since 1962. He has "an internatonal reputation in the development of computational methods and software for ordinary differential equations applied to complex problems," said Mac E. Van Valkenburg, acting dean of the College.

Gear earned bachelor's and master's degrees from the University of Cambridge, England, and a master's and doctorate from Illinois. He was an engineer with International Business Machines Corporation British Laboratories from 1960 to 1962. He has served as a visiting professor at Stanford and Yale Universities and is a consultant to Argonne National Laboratory, Brookhaven National Laboratory, the Langley Research Center of the Nationnal Aeronautics and Space Administration, the National Bureau of Satndards, and the Korean Institute of Science and Technology.

"We are indeed fortunate to have Professor Gear to call upon in this period of enormous growth in the field of computer science," Van Valkenburg said. "His reputation, intelligence, and vigor will serve the department excellently as it enters this exciting era."

Student Achievers

AT&T Information Systems Laboratories has given Achievement Awards to four undergraduate minority students.

Receiving $500 scholarships are Arthur B. Howard, a sophomore in computer science, Tracey L. Johnson, a sophomore in computer engineering, Eric J. Minor, a junior in electrical engineering, and Stephanie E. Woodson, a junior in electrical engineering.

According to Paul E. Parker, assistant dean in charge of the Minority Engineering Program, these scholarships were the first the firm has provided for minority students at Illinois.

Christmas Toys

The College celebrated a belated Christmas this spring as it became the recipient of millions of dollars in corporate and government endowments.

The foremost gift came from the National Science Foundation to establish an advanced scientific computing center; $43 million, the largest single federal grant ever given to the University, will be used to purchase a Cray X-MP, which is currently the fastest supercomputer commercially available.

Other holiday gifts for the College include a CAD/CAM system from IBM and microwave measurement equipment from Hewlett-Packard.

The College was one of only 20 schools to receive the IBM system. It will be used for teaching and research by the departments of Aeronautical and Astronautical, Civil, General, and Mechanical and Industrial Engineering. The CPU will be housed and operated by the Computing Services Office (CSO).

The Hewlett-Packard equipment, valued at $140,000, will be used by the electrical and computer engineering department. The University was selected on the basis of the department's proposal to emphasize newer microwave design techniques in its curricula. The company also gave preference to programs "that would ensure maximum student use of the equipment, rather than emphasize research."

Mary McDowell

continued from page 10

Though not widely used now, the process will be more popular in ten years, explained Bruce Rittmann, an associate professor in civil engineering at the University.

Some pollutants are pathogens. These disease-causing organisms must be removed if the water is to be consumed by humans. Fortunately, most pathogens do not survive sedimentation. They also prefer environments similar to the human body and therefore do not survive long in activated sludge or fixed film methods. When removal of pathogens is especially critical, chlorine is used. However, chlorine must be used with discretion because it is harmful to fish.

Sewage is not the only contaminator of the water supply. Industrial discharges also cause pollution, mainly through toxic organic compounds, heavy metals, and lubricants.

Three different methods are used to remove toxic organic waste, and the biological processes outlined earlier for ordinary organic waste often work for the hazardous substances as well. Some materials are volatile, meaning they are easily absorbed by the air, so air blasted through the water easily removes them. Activated carbon removes many substances quite effectively, but it is not widely used because it is expensive.

Heavy metals, such as cadmium, zinc, and lead are some of the hazardous substances which need processing in industrial waste water. If only small concentrations exist in the water, sedimentation or biological processes remove the substances adequately. Both methods work because the metals tend to attach to both solids removed in sedimentation and to microorganisms. When large concentrations exist, chemicals can be added to the water to cause the metals to precipitate out. Used in conjunction with each other, these two methods remove 90 percent of the hazardous metals.

Oils and greases used for lubrication and other processes in industry form yet another waste removal problem. Oil flotation takes advantage of oil's density being less than water. In flotation, the opposite of sedimentation, oils come to the surface of a holding tank for removal. For added efficiency, the process is often followed by a filter.

Despite the attention industry receives in the area of water pollution, some forms of pollution are caused by agriculture. The runoff of plant nutrients such as nitrogen and phosphorous sometimes encourages algae growth in lakes, which adversely affects game fishing.

This nitrogen and phosphorous can be removed by various processes. Certain microorganisms thrive on nitrogen or phosphorous. Nitrogen, which often shows up in the form of ammonia, can be removed by stripping the ammonia out of the water and into the air. Phosphorous can also be precipitated with lime and aluminum.

Obviously, the technology exists to remove pollution from most controlled sources of discharge, but there is still much work to be done in other areas. One such area is the treatment of storm runoff. The same substances that pollute ordinary discharges also taint runoff, but runoff is more difficult to treat because it comes in large quantities for short periods of time. Large retention basins are needed to hold the water for treatment, making treatment a problem for many municipalities.

Another form of water pollution which has received much public attention lately comes from landfill runoff. The methods discussed so far remove waste from controlled discharges, but landfills leach substances uncontrollably. Drains built under landfills have proven workable for new landfill sites, but no solutions have been developed yet for existing sites. According to Rittmann, controlling waste flow from landfill sites should be one of the most active areas in environmental engineering.

The future appears promising for the cleanliness of water, and Rittmann believes that the quality of the America's water supply will continue to improve. However, engineers must continue to address their responsibility for the environment with new solutions to the water problems. ■

From page 3

Tech Teasers Answers

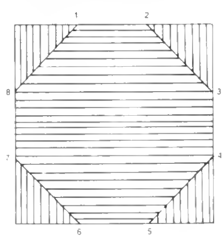
1. The one with the greatest "mew" (μ = coefficient of friction).

2. $3,000.

3. 72.

4. Converting the fortune to a base 7 representation shows that: 1,000,000 = 11,333,311. Therefore, the digits of the number yield the following distribution: 1 received $1; 1 received $7; 3 received $49; 3 received $343; 3 received $2401; 3 received $16,807; 1 received $117,649; and 1 received $823,543.

5.



The Lighter Side

The world's shortest light pulse was generated by IBM scientists at the Yorktown Heights, New York facility. A pulse of 12 femtoseconds, or 12 quadrillionths of a second, was made using a laser and a light compressor.

The pulses can serve as a strobelight to slow or freeze the apparent motion of molecules, atoms, and electrons so that their extremely rapid interactions can be studied in detail. This achievement could help researchers better understand some fundamental physical processes important to the development of the ultra-fast computer components in the future.

A femtosecond (fs) is almost unimaginably brief. There are as many of them in one second as there are seconds in 30 million years. In two seconds, light travels from the earth past the moon. In 12 fs, it moves only five microns, roughly one-tenth the width of a human hair.

The light compressor flashes 800 12-fs pulses per second, made by alternately stretching and compressing laser light. In the light compressor, 100-fs pulses from a dye laser are sent through the minute core of an optical fiber which is less than two ten-thousandths of an inch wide.

Interactions between the laser light and the fiber increase the light's bandwidth and separate the colors so that the longer, "redder" wavelengths are ahead of the shorter "bluer" wavelengths. This timing change is known as chirping.

After the pulse leaves the fiber, it bounces between two diffraction gratings which scatter colors in different directions. In this pair of devices, the front and rear portions of the chirped pulse act like race cars moving at the same speed but on different tracks. The red car starts in front, but the blue car takes the inside shorter lane. In the end, the two arrive together. This results in a compressed pulse that is shorter and more intense than the initial one.

This discovery will help to understand the chemical and physical processes that occur too rapidly to be studied in great detail. Instead of only knowing what the initial reactants are and what the product is, scientists will be able to learn about the interim processes to advance their knowledge rapid reactions.

Waste Not, Want Not

A rotary reactor and a newly developed Environmental Vault, patented by Rollins Environmental Services, may provide a solution to the problem of hazardous waste storage.

The vault, an above-ground structure, covers about an acre and a half and is 20 to 25 feet tall in typical installations. It protects the waste from both precipitation and ground and surface water. Meanwhile, polymer liners and porous layers protect the ground from wastes and leachate. The vault is equipped with a monitoring system, and the top has a storm water runoff system.

The vault/reactor system provides several advantages over traditional methods of waste containment. Since it is completely above ground, any leakage or deterioration can be quickly detected and repaired. The system is not dependent on the geology or hydrology of the location, and all the monitoring and leachate systems are gravity-driven and independent of mechanical devices.

Speech Clarity

Bell Laboratories has developed a new speech synthesizer which can code and store one second's worth of speech with only 9,600 bits of memory: one third that of other synthesizers. In addition, the speech quality is considerably improved over the speech currently emitted from talking cars, toys, and cameras.

The basis of the new synthesizer is the Multi-Pulse Linear Predictive Coding (MPLPC) algorithm, developed by AT&T for digitally coding and decoding speech patterns. This program permits the synthesizer to compose high quality speech with fewer bits of information than similar speech simulators require. By cutting down on the amount of memory required, the algorithm reduces the cost of synthesizing speech.

The synthesizer consists of two microchips, both developed by AT&T. The MPLPC algorithm is coded into one of the chips: a digital signal processsor that executes 2,500,000 instructions per second. This converts the stored digits back into high quality speech. The second chip is a dual-port Random Access Memory (RAM). This chip can be accessed simultaneously by both the signal processor and a host computer or controller. The host computer stores the coded messages for the synthesizer to process, transferring the appropriate bits of information to the dual-port memory as required. The bits are then retrieved from the RAM by the digital signal processor and turned into spoken sentences.

Possible applications for this synthesizer include uses in the telephone network for announcing changed numbers and in easing information exchanges with computers via telephone.

Mary McDowell

The Reflective Vision

A highly advanced design tool developed at the General Motors Research Laboratories uses computers to generate visual images from mathematical data with such accuracy that, soon, in-depth aesthetic evaluations of new concepts may be made prior to creating a costly physical model.

Interactive Display

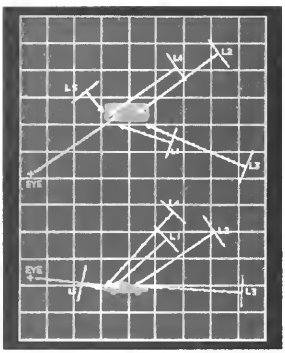
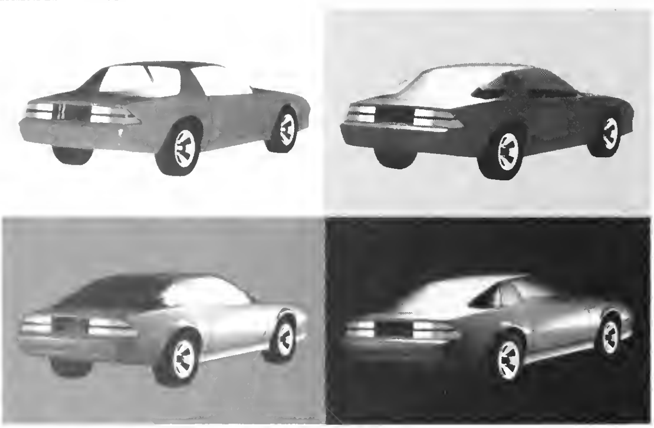


Figure 1 Computer display of plan view (upper) and side elevation (lower), indicating automobile location, lighting selections (L1-L5), and viewing position (EYE)

Figure 2 Four Autocolor images, showing the same view of an automobile as background and lighting change



WITH AUTOCOLOR, users can synthesize three-dimensional, shaded images of design concepts on a color display and then quickly explore how major or minor changes affect the overall aesthetic impression. The system is completely interactive. By choosing from a menu on the screen, the designer can redefine display parameters, select a viewing orientation, or mix a color. Each part of an object can be assigned a surface type with associated color and reflectance properties. Built-in lighting controls generate realistic "highlights" on simulated surfaces composed of differing materials.

Before developing the system, David Warn, a computer scientist at the General Motors Research Laboratories, observed the complex lighting effects achieved in the studio of a professional photographer. By simulating these effects, Autocolor can produce results unattainable by conventional synthetic image display systems. Previous systems used a point source model of light, which allows adjustments only in position and brightness.

The versatility of the lighting controls constitutes a major advance in Autocolor. An unlimited number of light sources can be independently aimed at an object and the light concentration adjusted to simulate spotlight and floodlight effects. The lighting model even includes the large flaps or "barndoors" found on studio lights. These comprehensive controls permit the user to view the simulation in studio lighting conditions, as well as to make revisions in color, paint type, and materials.

With real lights, direction and concentration are produced by reflectors, lenses, and housings. It would be possible to model these components directly, but that would introduce considerable overhead to the lighting computation. Instead of modeling individual causes, Autocolor models the overall effect, reducing complexity by simulating those aspects needed to produce realistic results.

Autocolor approximates the geometric shape of an object with a mesh of three or four-sided polygons. These polygons are grouped to form parts. For a car body, there might be separate parts for the door, hood, roof, fender, and so on. Each part is assigned a surface type, such as painted metal or glass, and each type of surface has associated color and reflectance properties. The entire data structure is stored in tables using an interactive relational data base developed at the GM Research Laboratories.

THE LIGHTING model determines the intensity of the reflected light that reaches the eye from a given point on the object. It takes into account the reflectance properties of the surface as well as the physics of light reflection. A hidden surface algorithm determines which point on the object is visible at each point on the display. For each of these visible points, the intensity is computed for each light source. The displayed intensity is the sum of the contributions from all the lights plus an ambient term which indicates the general level of illumination.

Using the point source lights of conventional image generation systems, highlighting a particular area of an object can be a difficult task and can result in unwanted highlights in other areas. By contrast, the light direction and concentration controls found in Autocolor make it possible to isolate the effect of a light to a particular area, and achieve a desired highlight easily and quickly (see Figure 2). This is not because Autocolor's lighting model computations are faster, but because its controlled "lights" behave in a more natural way.

Another unique feature of Autocolor is the ability to portray realistically a variety of different materials and lighting conditions. The color seen from a surface is really a combination of two colors: the color of the surface or material itself (diffuse reflection) and the color of the reflected highlights (specular reflection). The highlight color may be the color of the material, the color of the light, or a color derived from the material and the light.

A different highlight color can be used for each different surface type that is defined. This makes it possible to simulate materials such as plastic, painted metal, and chrome—each of which has different reflectance properties and requires a different highlight color.

The user can interactively adjust the blending of the surface and highlight colors, watching the image change dynamically on the screen until a desired effect is achieved.

"Autocolor will free designers to be more creative," says researcher Warn. "Our goal is to move from controls that show changes in lighting, color, and materials, to software that will let the user change the actual shape, manipulating the image on the screen like a flexible clay model."

THE MAN BEHIND THE WORK

David Warn is a Senior Staff Research Scientist in the Computer Science Department at the General Motors Research Laboratories.

He received his undergraduate degree in mathematics from Carnegie-Mellon University, and his M.S. in computer science from Purdue.

He has done extensive research in relational data management systems with special emphasis on user interfaces and human factors. He also designed the prototype for the network data manager used in the GM Corporate Graphic System. His previous work on other aspects of computer-aided design include system design, file management, and simulation models.

His foremost research interests are in color synthetic image generation and interactive surface design. He joined General Motors in 1968.

Tech Profiles

Peter W. Sauer, a native of Minnesota, received his undergraduate training in electrical engineering from the University of Missouri. After serving in the Air Force for four years, he attended Purdue University and obtained his master's and Ph.D. with a concentration in electrical power systems.

Sauer has served as a professor in the College since 1977 and currently teaches EE 333, Electronic Machines Lab, and EE 331, Introduction to Electrical Power Engineering.

Though Sauer enjoys teaching, he prefers to devote an equal amount of his time to research. Presently Sauer is studying the effects of electro-mechanical oscillations in generators due to outside disturbances. Also called "security assessment" or "contingency analysis," this branch of research "attempts to maintain the integrity of power systems."

With the help of computers and a great deal of mathematical calculation, Sauer is also researching theories of time-scale modeling, dealing with the interaction of electronic and mechanical devices. In yet another part of his research, Sauer is investigating the propagation of transients through power supplies and into computer systems.

Sauer takes the many facets of his position as professor, researcher, advisor, and teacher seriously. To Sauer, the combination of these demanding roles and the many responsibilities they entail aren't always properly appreciated.

Apart from his annual fishing trip, Sauer spends his spare time with his two children and is currently refinishing his home.

Carolyn A. Keen

Clark W. Bullard, director of the University's Office of Energy Research, has done research into the effects of acid rain legislation on public utilities.

One bill being considered by Congress would set a maximum statewide pollutant emission standard, while another would simply call for installation of pollution control devices on the nation's fifty largest pollutant emitters. The first would promote the use of low sulfur content coal in utilities as a least-cost strategy, while the second would require pollution control devices on targeted generating plants.

These bills raise the question of whether it would be most economically feasible for utilities to switch to low sulfur content western coal, to install scrubbers, or to simply retire "problem" plants early. Bullard has developed computer models which simulate these alternatives by accounting for changes in electricity demand and the costs of energy sources.

From test runs of the models, Bullard found that Illinois' high sulfur coal industry would be hurt if utilities followed the least-cost strategy of buying low sulfur content Western coal. However, that industry would not be hit as hard if scrubbers are installed or if the early retirement option is selected.

Bullard explained that this research project was data-constrained due to the variety of sources, unlike many University research projects where data is more easily collected through controlled experiments. His research is aimed at identifying, through error and sensitivity analyses, the types of multi-year, capital intensive data collection efforts needed to resolve uncertainties associated with acid emission reduction strategies.

Mike Schneider

Light Sculpture by Bill Parker
© Studio for Visual Technologies in Fine Art New Canaan, Ct.

Your mind has been stretched by education, your skills sharpened by training. Now your imagination is ready to fly.

Your kind of company. One that extends the boundaries of technology, creating opportunities on which minds like yours thrive.

It's the magic in your mind that turns dreams into reality.

It's time to dream, to reach out, to dare. And to do it you need the space for achievement. You will find it in companies that challenge you to fulfill the potential of your mind.

One of them is General Electric.

There you will find a sense of urgency that demands your very best, and stresses the individual's contribution to the success of the enterprise. At GE there is a climate for excellence where excellence means rewarding you when you win—*and rewarding you when you try*: the fuel for entrepreneurship in a large corporation.

Aerospace and aircraft engines. Medical diagnostic systems and robotics. Factory automation and microelectronics. CAD/CAM and consumer electronics. Information systems, plastics, and engineered materials. Plus future technologies still in your imagination.

A diversity you could not find anywhere else.

Today your future is in your imagination, and at General Electric. Reach for it.

If you can dream it, you can do it.

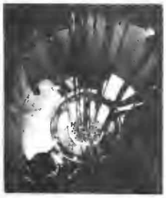
October 1985 Volume 101, Issue 1 Newsstand [illegible]

IllinoisTechnograph

Redeeming Reactors

October 1985 Volume 101, Issue 1

IllinoisTechnograph



4 *Lind*
mpus puts
gy.

6 *well*
and termed
cent

10 epth
ering Family

ovations 12,

On the cover: The core of the Advanced Triga nuclear reactor bombards various materials with neutrons for use in further research. The University has had a critical reactor since October 21, 1960 (photo by Mike Brooks).

***Illinois Technograph* Statement of Ownership**

Editor-in-Chief of the *Illinois Technograph* is Mary McDowell, 620 E John St , Champaign, IL 61820 General Manager of the Illini Media Company is E Mayer Maloney, Jr , 704 Harmon, Urbana, Il 61801

The Illini Media Company is a not-for-profit organization established in the State of Illinois in 1911

Average number of copies of each issue during the preceding 12 months 4200 Annual subscription rate $7 00 Paid circulation through dealers and carriers none Average mail subscriptions preceding 12 months 1066 Free distribution preceding 12 months 3034 No copies distributed to news agents Total distribution preceding 12 months, 4100 Office copies preceding 12 months 100 Total average distribution 4200 No paid circulation through dealers or carriers Actual April mail subscription 1065 Free distribution at the Engineering campus of the University of Illinois nearest to filing date 2935 Total distribution nearest to filing date 4000 Actual number of office copies nearest to filing date 100 I certify that the statements made above by me are correct and complete E Mayer Maloney, Jr , Publisher

matter October 1920 at the post office at Champaign Illinois under the act of March 3, 1879 *Illinois Technograph* is a member of Engineering College Magazines Associated

Mary McDowell
tion Editor *Michael Lind*
Editor *Mike Brooks*
es Editor *Bob Janssens*
Editor *Eric Guarin*
Copy Editor *Dee Bartholme*
Charlie Musto
Design *Robert Baittie*
Publisher *E Mayer Maloney, Jr*
Production Manager *Geoff Bant*
Editorial Staff *Scott Brun, Fred Brunner, Sally Cohen, Cheryl Danke, Jeffrey Dobos, Stephen Ferree, Chris Gerrib, Ashraf Hameedi, Jeff Hamera, Raymond Hightower, Steve Lotz, Andrew Koepke, Peter Lei, Jeff Mote, Pam Susemiehl, Steve Tongue, Bill Weiss, Jay Zeff*

Editorial

It seems that every generation of students must be classified by the media. Those of the 1920's will be forever immortalized by their goldfish swallowing antics. In the 1950's, everyone was supposedly a wholesome, cleancut, all-American type who dreamed of eventually living in a white picket fence enclosed suburban house. The youth of the 60's were typified as rebellious, wire rim bespectacled drug abusers, but they were at least given credit for believing in and fighting for an ideal.

Students of the 80's are given no such mercy. We are perceived as being materialistic, success and status oriented creatures who act only in ways that will benefit ourselves and our careers (no one has merely a job any more).

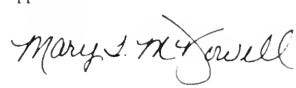
In some respects, this classification is warranted. Students don't seem to get involved on campus just for fun anymore; they do it only to have something that looks good on their resumes. People are not concerned with laws which aid the poor and elderly but are very worried about tax shelter regulations. The only time the local senator is written to is when a tuition increase is being considered.

Engineers are probably the ones worst afflicted with this attitude. With only 7.5% of last May's graduating seniors listing themselves as still available for employment, we know we will most likely get jobs. With an average starting salary in the college of $27,432 per year, we know they'll be good ones. This leaves us free to go for the bucks, get our B.M.W.'s, and plan our vacations in our time-sharing condos without too much concern with anything else, right?

Not exactly. Our technical degrees from a top-ranked engineering school put us in a position to be on the forefront of new scientific advances--advances which could have wide spread repercussions on modern society.

It is important that we break away from our stereotype of dollar chasing pre-yuppies and make a concious choice as to what our creativity leads to. If you believe in the necessity of stockpiling nuclear warheads and the Star Wars program, then you should have no qualms about applying your skills toward these ends. It doesn't make sense, however, to participate in a nuclear freeze rally on the weekend and then to show up Monday morning to continue working on a project that will eventually be used to improve the range of ICBM's. Similarly, you should consider if your ideas are being used to economically aid some country whose political ideology is in direct conflict with your own. If your creativity helping to expand a corporation which has racist or sexist policies or which builds unsafe facilities in third world countries so as to exploit the lack of labor and environmental regulations, you might want to think about what you are directly supporting through your work.

Realistically, probably none of us will invent a DeLorean time machine that allows us to go back in time and meddle in our parents' teenage romances. We do, however, have the potential to make incredible technical achievements. It would be a very sad fate if our press-conceived image was proven correct, and we allowed our brain power to be sold to the highest bidder without regard to its final application.

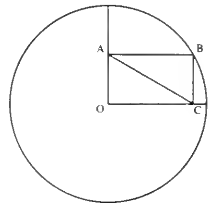


***Illinois Technograph* invites letters in response to its articles and editorials, or any other items of interest to its readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be witheld upon request.**

Tech Teasers

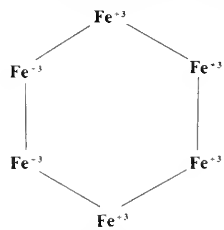
1. What is the greatest value in coins that somebody can have without being able to give change for a dollar bill?

2. If this circle has a radius of r, what is the length of hypotenuse AC?



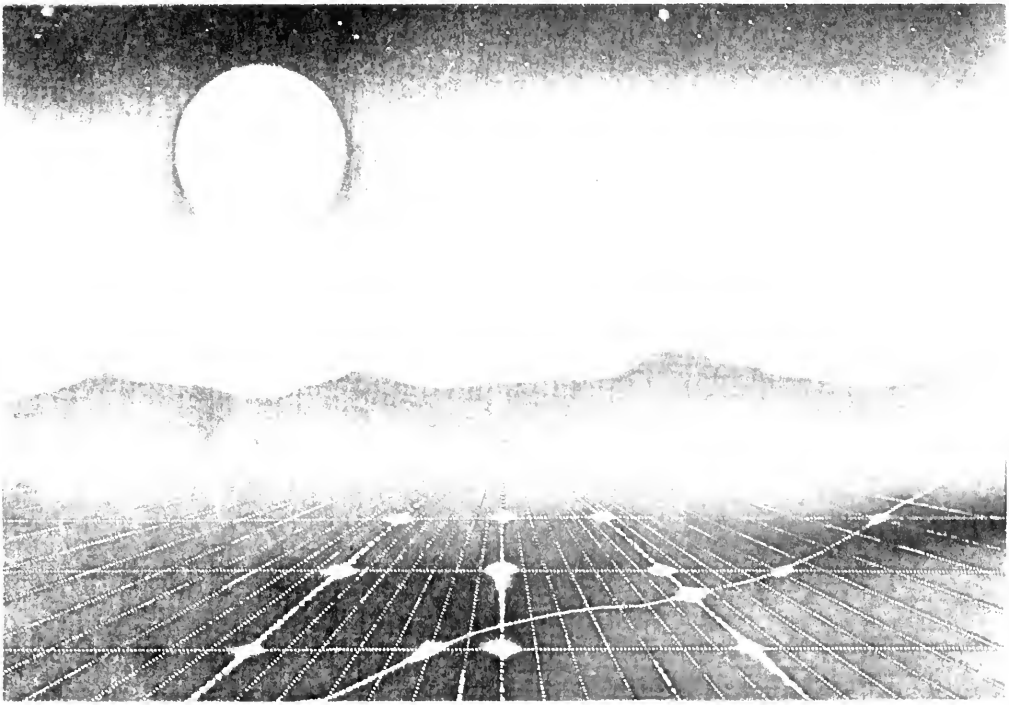
3. In order to prove he is worthy of his name, Mark S. Mann asks his brother to throw a baseball in the air, and then he shoots at it with his hunting rifle. If three pieces of buckshot embed themselves in the rapidly spinning ball, what is the probability that they all lie in the same hemisphere?

4. For those people who aced Chemistry 101, what does this formula represent?



5. An ocean liner is on its way from New York to Europe. Somebody flies over it in an airplane and drops a penny out of the cockpit. Which occurrence will raise the level of the Atlantic higher:
a) The penny falls on the deck of the ship.
b) The penny falls into the water.

Answers on page 11



University Flexes Computer Muscle

The University has long been renowned for the excellence of its computer facilities. This excellence has now achieved nationwide prominence as the school becomes home to the National Center for Supercomputing Applications.

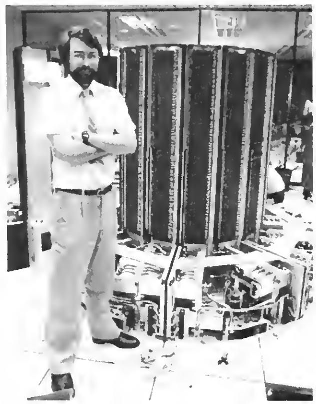
The University has many traditions, including football games, homecoming, and Chief Illiniwek, but also important is the tradition of conducting the highest quality research possible. With the installation of a Cray X-MP/24 supercomputer at the beginning of September, that tradition will continue far into the future.

Since the Cray is such a powerful machine, it will not be treated as just another computer to run a program on. Instead, it will become the hub of a sophisticated research center, dedicated to solving previously unsolvable problems. Obviously many such problems surface in the engineering world, but the center will actually cater to any researcher of any discipline who has a purpose for the machine.

Called the National Center for Supercomputing Applications, or NCSA, the center was made possible with funding from the National Science Foundation. Larry L. Smarr, professor of astronomy and director of the center, estimated that state and national funding should total about $75 million over five years. Of this, the initial configuration costs $11 million.

Cray Research, Inc. packed quite a lot of power into this machine. The X-MP/24 is really two processors operating simultaneously. Both have access to four million words of 64 bit, high speed memory. When a task needs more memory, 32 million words of solid state disk storage are available, along with substantial magnetic disk space.

Solid state disks add even more to the virtual memory size of the computer. Conventional hard disks are devices which magnetically store data on a disk. A solid state disk works similarly, but stores data electronically. Both are used to store more data than the computer can use at one time, but a solid state disk is several times faster. Utilizing



Larry Smarr, director of the National Center for Supercomputing Applications, stands next to the Cray X-MP/24 Supercomputer. With its extremely fast duel processors, the new supercomputer will enable researchers from all fields to solve more complicated problems than ever before.

both types of disks gives the Cray an additional speed advantage over computers with only hard disks.

Fast memory and disks are important, but the real power of the X-MP lies in its central processors. The X-MP/24 contains two processors, operating simultaneously. This design is a great improvement over ordinary computers, which contain only one processor. Instead of plowing through an entire program, each processor receives different tasks to complete simultaneously. In this manner, a program runs quicker and more efficently than is otherwise possible.

If two processors are efficient, why not add more? NCSA will add more, most likely in the third quarter of 1986. At that time the supercomputer will be upgraded to a Cray X-MP/48 with four processors, eight million words of memory and more solid state disk storage.

Just as unique as the features of the Cray is the cabinet it is housed in. Instead of a standard rectangular cabinet, the X-MP resides in a bright red 270 degree arced cabinet. Cray's engineers chose this configuration to pack components as densely as possible and minimize the distance any elctrical signal has to travel. To prevent overheating, the cabinet also houses a liquid cooling system.

Unbelievable as it may seem, the computer occupies only 112 square feet of space in the Astronomy Building. NCSA chose this second floor space appropriately, as the former occupier of this location was ILLIAC IV, the fastest computer in the world from 1972 until 1982.

Though a fascinating room historically, the magnificence of second floor Astronomy fades when compared to the soon to be completed "Intellectual Center" (IC). The IC will house technical support staff and workstations for various researchers. This building will be the center of activity, with training programs taking place often and researchers from many different disciplines coming together to use their common tool.

Workstations for the Cray will be organized in a practical network arrangement. Most will be IBM-XT's, IBM-AT's and Macintosh XL's, allowing users to prepare programs at home or in the IC. Similar workstations will eventually exist across the country, allowing use of the Cray from thousands of miles away.

In addition to these normal workstations, special stations will provide three dimensional and high resolution color graphic displays. After the program has run, facilities to print microfilm, microfiche, slides, movie frames and standard paper output will aid in the interpretation of data.

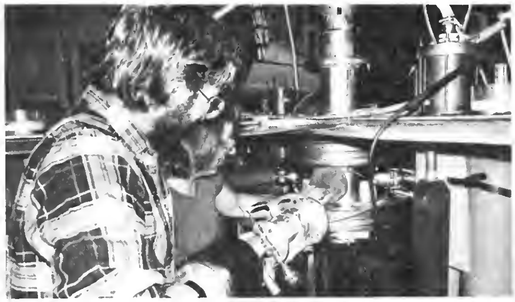
All of this power is enough to wet the appetite of any computer user, but just who will get to use this valuable machine? Computer time will be in high demand, therefore time will be allotted on the basis of the overall quality of a research proposal and on

continued on page 8

M i c h a e l L i n d

Responding to Reactor Rhetoric

Recently, media coverage of nuclear power has focused on the halting of nuclear construction projects. Despite the recent lack of plant construction and Three Mile Island, the nuclear engineering field still has room for growth.



Kevin Boulais, graduate student in electrical engineering, and Frank Venneri, graduate student in nuclear engineering install an x-ray counter onto the dense plasma focus at the Nuclear Radiation Laboratory. The dense plasma focus is being used for fusion and x-ray research.

Ever since the days of Jane Fonda's histrionics in the "China Syndrome," nuclear energy has been berated by the media. Any American newspaper reader has been bombarded with articles insisting that nuclear reactors are an uncontrollable threat to the environment, that using nuclear fuel renders the public prey to uranium thieving terrorists, and that a nuclear meltdown in ones own backyard is imminent.

Now, however, the tone has shifted. Instead of directly attacking any particular aspect of its feasibility, current mainstream literature suggests that the nuclear era is at an end and will eventually be eliminated as a viable, cost-efficient energy alternative. Is this more media hype, or is the atom to be abandoned as an energy source of the future.?

Admittedly, the industry has had some rough times in recent years. Every domestic reactor ordered since 1974 has been cancelled at some stage of construction. No new plants have been ordered since 1978, and U.S. utility companies have spent $15 billion on cancelled and abandoned plants. This has led directly to higher utility bills for consumers. Even the reactors that are eventually completed go over budget. A Department of Energy survey of 47 reactors found that thirty-four cost twice as much as was originally budgeted, and thirteen were quadruple their budgeted allocation.

One of the main reasons for the problems besetting the nuclear industry, according to Barclay G. Jones, associate chairman of the College's nuclear engineering program, was the change in the increase in demand for electricity. It fell from +7% per year to +2% per year. He cites two causes for this decline. The first was the 1972 Arab Oil Embargo. This awakened the public to the need for conservation, which had a major impact in reducing the amount of consumption increase. Secondly, the nuclear plants that were being built were more efficient, and there was a tendency to overbuild, meaning that eventually the supply would overtake the demand.

Another major contributing factor was a direct result of the Three Mile Island incident, which occurred in March, 1979. Following that event, the Nuclear Regulatory Commission introduced hundreds of new requirements and regulations. Many of these applied to plants under construction, which caused delays and increased costs. The greater number of new regulations also made it increasingly difficult to obtain a permit to build a plant. Whereas it used to take seven or eight years to obtain permission, it now takes between ten and fifteen years.

It's not time to toll the funeral bells for nuclear power, though. The problems such as overbuilding and coping with more regulations are those associated with a modern, growing industry, not one ready for an artificial respirator. Nuclear energy on the commercial market is still relatively young. In the initial stages, manufacturers were in a rush to produce functioning systems. There was no industry-wide standardization. Now, in the lull of the rush, manufacturers can redesign and reevaluate their product. The changes in the design of safety equipment must now be incorporated into new reactors. This situation is somewhat analogous to that of the early days of the automobile, in which there were no traffic laws, emission standards, or automatic air bags, yet it survived the onset of federal regulations to become a multibillion dollar industry. Clearly, the problems are related more to growing pains than to deathbed symptoms.

Nuclear energy is certainly a feasible option from an economic standpoint. It

continued on page 8

M a r y   M c D o w e l l

Reactor continued from page 6

costs less to generate electricity from uranium than from coal or oil. According to an article in *National Review*, including construction costs, the price of nuclear generated power is 3.1¢/kilowatt-hour, while coal costs 3.5¢ and oil costs 7.0¢.

Nuclear power is also safer from an environmental standpoint as well. Coal fired plants are responsible for pollution leading to acid rain and the green house effect. Effective coal scrubbers which would reduce the sulfur levels and lessen these hazards are still in the developmental stage. Once they become implemented in industry, they are sure to raise the price of coal generated electricity even higher.

There is also the matter of demand. While the rate of increase in consumption has fallen, the consumption is still on the rise. Nuclear energy currently provides 20% of the nation's electrical needs. This will have to increase to meet the growing demand, as other alternatives such as solar energy have not been shown to be economically feasible in terms of use for central electric power generation.

Stepping up the use of nuclear power has certainly been the trend among other industrialized nations. France obtains over 50% of its power needs quite cheaply from 43 nuclear plants. 24 more are either under construction or have been ordered. The only country to ever be the victim of a nuclear bomb, Japan, currently has 31 operating plants with 14 more either ordered or under construction. The ground has been broken for the use of nuclear power on a worldwide scale.

On a local level, the nuclear engineering program has not been unaffected by the slump, but is still a maturing, vital program. According to Jones, enrollment peaked in 1978 at which time there were over 140 undergraduates and over 105 graduate students. Following Three Mile Island, there was a general decline in enrollment. For the past two years, the entering freshman class had numbered 18, but this year it nearly doubled with 35 students entering the program this August.

The employment prospects in nuclear power for these students are quite promising. Jones said that while the market is soft among reactor vendors who design new reactors, there are still many opportunities for jobs with utility and support service companies. The large number of regulations that the NRC has mandated has created many jobs for engineers to implement them.

Statistically, only 5.6% (1 student) of May's B.S. graduates were still available for employment as of July 23, 1985. This was the fifth lowest percentage among all College disciplines. Nuclear engineers had the highest number of job offers (averaging 3.7 per student) and the highest average monthly starting salary ($2455). Obviously, there is a good market for nuclear engineers.

B.S. graduates have the third highest graduate school attendance rate in the College, just behind agricultural engineering and engineering physics. About one-half of the graduate work done in the program is devoted to fusion research. Some work is also done on developing other reactor concepts including breeder reactors and integral fast reactors.

Also indicative of a positive future is the ongoing upgrade of the reactor program and the addition of two new faculty members will be added to the staff, one of whom will serve as the director of reactor programs. Hot labs are currently being planned to expand the existing experimental facilities at the reactor.

The last decade has been a rough era for the nuclear power industry. Despite all of the problems encountered, it has survived and will continue to grow as an economical, safe, and efficient domestic source of energy for the years to come. ■

Computer continued from page 4

its suitability to the Cray. Approval must come from the NCSA officials and from a National Science Foundation panel.

Already many projects are waiting for the Intellectual Center to open its doors. Weather concerns everyone, including Robert B. Wilhelmson, a professor of meteorology at the University. Severe storms interest him most, and he plans to use computer models to study them and their accompanying hail, tornadoes and wind downbursts. His research will help meteorologists predict these hazards and prevent some of the damage they cause.

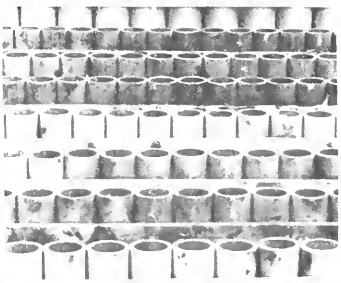
Other projects of an interdisciplinary nature include the analysis of pollutant flow through groundwater aquifers and the study of global atmospheric circulation. Life itself will be simulated, with several projects to model the behavior of living cells.

Some projects will be carried out in conjunction with the Center for Supercomputing Research and Development, directed by David Kuck. This newly created center investigates the use of parallel processors to speed up processing time. While the Cray X-MP/24 has two processors, Kuck envisions a computer with 128 processors. This center and NCSA will work hand in hand to develop supercomputer technology even further.

What of the future? Obviously only a handful of the many possibilities for the supercomputer have been realized. As more people become familiar with it, more and more useful applications will be realized. In the next few years, with the installation of more processing power on the Cray X-MP, this demand will be met. Researchers across the nation will be able to take advantage of the computer through a national networking system, making the University truly a national supercomputer center. ■

Shooting the Works

While FarmAid was going on inside Memorial Stadium, outside Garden State Fireworks prepared that evening's pyrotechnics. First the mortars (below) were set up, the larger ones filled with sand for stability. The shells were then loaded and fused (lower right). After twelve hours of hard work, the result (right) was fifteen minutes of delight *(photos and text by Mike Brooks).*



Engineering Family Album

Some people do not believe it, but being an engineer is more than learning formulas. Here are descriptions of engineering societies on campus designed to stimulate an active interest in various engineering fields.

American Academy of Mechanics (AAM)

This group represents the smallest of all engineering curricula, engineering mechanics. Besides holding regular meetings and sponsoring an Engineering Open House (EOH) project, AAM sets up a photo board in Talbot Lab of all the freshmen in engineering mechanics. Anyone interested in the society should call Scott Parks at 332-3325.

American Institute of Aeronautics and Astronautics (AIAA)

This Aero/Astro engineering society has plans for several student-faculty mixers and picnics. It will also hold monthly meetings with guest speakers. Go to 105 Transportation Building for more information.

American Institute of Industrial Engineers (AIIE)

Among the varied activities sponsored by AIIE are meetings with guest speakers from local industries, plant trips, semester picnics, a "take a professor to lunch" program, and tailgate parties. Students who want to participate can pick up an application in Professor Kaplan's office at 232 MEB. Alpha Phi Mu, the industrial engineering honor society, participates in AIIE programs and has its own tutoring and social programs.

American Nuclear Society (ANS)

The main purpose of the ANS is to supply information on nuclear engineering from a technical standpoint. It sponsors lectures, field trips to nuclear plants, and tours of campus reactors. As a student organization, it helps freshmen with class decisions, organizes resume writing sessions, and sponsors a speakers' bureau. Undergraduate and graduate students who are interested should contact George Hrbek at 332-2264 or Pat Hogan at 398-4524.

American Society of Agricultural Engineers (ASAE)

ASEA is open to any engineering student interested in agriculture. Activities include speakers, an EOH project, and several fundraisers. Contact Jennifer Kmetz at 359-9493 for more information.

American Society of Civil Engineers (ASCE)

ASCE was voted best professional society in the College last year. Members participate in a service project and are eligible for scholarships from the national society. Talk to Rob Twardock at 367-5530 or Eileen Cowhey at 398-1164 to find out more.

American Society of Mechanical Engineers (ASME)

Besides the usual activities of engineering societies, ASME is also committed to "having fun." For more information contact John Hinger at 328-2005.

Engineering Council

All engineering societies at the University belong to Engineering Council. As the student government for engineers, it takes the students' opinions to the administration. Some of the many programs it sponsors are: EOH, Engineers' Night, the Engineering Speakers' Bureau, Engineering Freshman Committee and the Knights of St. Pat's Ball. Every year the council gives out awards for excellence in teaching, the advancement of student-faculty relations, and outstanding professional and honor societies. If you are interested in becoming involved, drop off a note at 300 Engineering Hall or call 333-3559.

Illinois Society of General Engineers (ISGE)

In addition to monthly meetings with speakers, ISGE sponsors social activities like bowling and pizza nights. The society recruits members through their undergraduate faculty advisers. The General Engineering honor society is Gamma Epsilon.

Institute of Electrical and Electronic Engineers (IEEE)

IEEE tries to keep students in touch with electrical engineering industry and research. It invites companies to come to talk to students to keep them abreast of new developments and to help them determine what companies want in employees. The society meets in 151 EEB every two or three weeks. Interested students can also stop in at the office at 247 EEB.

Society of Automotive Engineers (SAE)

Despite the "Automotive" in its name, SAE is a society of engineers interested in many types of transportation. The group sponsors speakers, plants trips, and the annual collegiate driving championships. Interested students should leave a note in the SAE mailbox in 140 MEB.

Association for Computing Machinery (ACM)

ACM is designed "for those people whose careers and/or interests have involved them with any of the countless aspects of computer science." It sponsors speakers from such places as IBM, Motorola, and

B o b   J a n s s e n s

Texas Instruments. Every year it sponsors an Illinois high school programming contest. In November, it will be holding a job fair. To join, go to an ACM meeting and fill out an application.

Association of Minority Students in Engineering (AMSIE)

AMSIE intends to serve minority students academically, professionally, and socially. It is a member of both the National Society of Black Engineers and the Society of Hispanic Professional Engineers. Its services include tutoring, academic advising, and a resume book. To join call 333-3558 or stop by 302 Engineering Hall.

Bioengineering Society

Both LAS and Engineering students are invited to join the Bioengineering Society. Its program includes monthly speakers and participation in EOH and IM sports. Through preregistration counseling sessions it helps students with course and professor choices. For more information go to room 164 MEB.

Society of Women Engineers (SWE)

Although it exists to satisfy the special needs of women engineers, SWE is open to everybody. It sponsors a career night and a resume book. The society's outreach program gives high school students a taste of the College. For more information, stop by 302 Engineering Hall.

Student Branch of the American Ceramic Society (SBACS)

SBACS participates in Tailgreat and EOH, and it publishes the Illini Ceramics Yearbook. Meetings are every third Thursday of the month in 218 Ceramics. Keramos, the ceramics honor society was designated best honor society in the college last year.

SYNTON

SYNTON is the amateur radio club at the University. Some of the many club activities are contests, ham radio classes, and operation of the amateur radio station W9YH. If you have an interest in ham radio, contact Jeff Austen at 367-2647 or attend one of the meetings which are held the first Thursday of every month at 7 pm in 167 EEB.

Tau Beta Pi

The stated purpose of Tau Beta Pi is "to confer honor," and "to foster liberal culture." The College honor society invites juniors in the upper eighth and seniors in the upper fifth of their classes to join. The society also sponsors services for non-members, including tutoring, the outstanding freshman award, and a career development seminar. This year Tau Beta Pi will sponsor a Strategic Defense Initiative (SDI or Star Wars) conference on October 12th. For more information about all these programs call 333-3558 or go to 302 Engineering Hall.

University of Illinois Metallurgical Society (UIMS)

UIMS is the departmental society for metallurgical engineers. Call Ric Smith at 384—1043 for details.

Illinois Technograph

Celebrating its 101st anniversary, Technograph is still riding the waves of a great centennial year. Engineering students interested in writing, photographing, editing, producing or any other activity associated with creating the magazine for the students of the College should consider joining. The magazine, which supplies both technical and informational articles, is published five times a year. To join, apply at the Illini Media Co. office in the basement of Illini Hall or at the Technograph office in 302 Engineering hall or contact Mary McDowell at 344-4217 or Mike Lind at 332-3865 ■

From page 2

Tech Teasers Answers

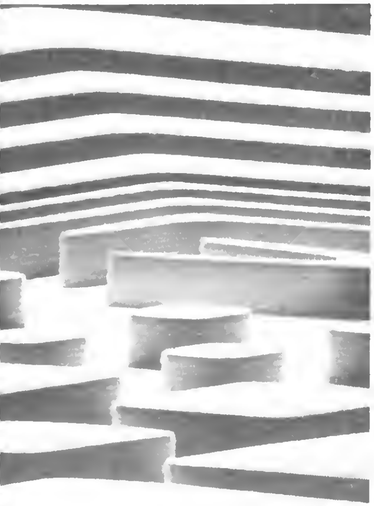
1. $1.19, three quarters, four dimes, and four pennies.

2. Draw radius BO to discover that AC = BO = r

3. The probability is 1. Three points in a sphere always lie in the same hemisphere.

4. A ferris wheel.

5. A submerged body displaces its volume, and a floating body displaces its weight. Since copper is denser than water, it will displace more water if it falls on the ship.



Magnified 9,800 times by an electron microscope, the features on this one megabit computer chip could just as well be a futuristic city. Actually, the "buildings" are one hundredth the width of a human hair.

Million-bit Chip Created

IBM recently produced a one megabit computer memory chip. The chip, which can store more than a million bits of information, was made possible by the development of a new photoresist material. A photoresist is a chemical sensitive to light that is used to cover computer chips during their manufacture. In order to fabricate a certain chip, an image of an integrated circuit is projected on the resist. In areas where light strikes the chip, the resist dissolves, copying the circuit onto the chip.

The new photoresist can be used with shorter wavelengths of light, allowing narrower etched lines and thus more memory on one chip. The new material allows the creation of features of one micrometer width, or one-hudredth the width of a human hair. With prior resists, features had to be at least two micrometers wide.

The material was developed at the IBM San Jose Research Laboratory in California.

European Supercomputer

Soon Japanese and American scientists will encounter competition from a German laboratory in the contest to build a fifth generation supercomputer. Researchers at the German Laboratory for Innovative Computer Systems and Technology in Berlin are working on a computer that can perform a billion operations per second. Other interests of the lab include parallel processing and artificial intelligence research. The research is supported with funds from the German government and from several international companies.

Artificial Ear

Researchers at the University of Wyoming have recently developed a fully programmable advanced artificial ear. It consists of a brass cavity, a microphone, an amplifier, and a desk top microcomputer. Since any human's ear canal dimensions and ear impedance can be entered at the keyboard, the instrument can accurately mimic a wide range of human hearing abilities. The artificial ear is used in tests on telephone receivers, headphones, earphones, and hearing aids, where using human subjects would be uncomfortable or harmful.

Splitting Water with Sunlight

Hydrogen, produced from water with the sun's energy, would be the perfect fuel. Burning it in air would not release any gases besides water vapor. Since the water can then be split again using sunlight, the supply of hydrogen would never run out as long as the sun exists. Only plants use photosynthesis as an efficient way of splitting water molecules into hydrogen and oxygen. Scientists at the Department of Energy's Solar Research Institute and the University of Nebraska have come one step eloser to understanding this biological process. By a technique that involves removing individual proteins from a small slice of spinach leaf, they have found the location of manganese, the metal required for the water-splitting reaction during photosynthesis.

Other SERI scientists, using semiconductor superlattices as photoelectrodes, have made advances in the collection of solar energy for use in chemical reactions. If illuminated, electrons will transfer from the superlattice electrode into a liquid electolyte where they can be used for such oxydation-reduction reactions as the production of hydrogen from water.

The actual production of hydrogen fuel from water on a large scale, however, is probably many years away.

Laser Allows Underwater Communications

Engineers at the University's Gaseous Electronics Laboratory have developed the technology for a new kind of laser that can penetrate ocean water. Since the mercury halide laser operates in the blue-green spectrum, it is not absorbed by the water like other light and radio waves. In the past, submarines had to be close to the surface to receive radio communications from a satellite. The new laser can send data down as far as 200 meters, where the submarine is safe from enemy surveillance. The new mercury halide laser also has a potential to be used for future laser surgery and other medical applications.

Bob Janssens

Technotes

Grants Start Rolling In

In a recent interview Samuel F. Herbert, president of Rose-Hulman Institute of Technology, said that engineering education is in a crisis. He pinpointed the shortage of faculty and modern equipment at engineering schools all over the United States as a major cause. At the University, however, a flood of recent grants has helped to remedy this.

Harris Corporation recently gave the department of electrical and computer engineering a second Harris 800 superminicomputer. The computer, which together with peripherals is valued at $342,000, will be used by faculty and graduate students for work in electromagnetics, aeronomy, electro-optic systems, and radio astronomy. Dedication ceremonies for the system were held September 4.

The same department received another grant from the Hewlett-Packard Corporation. This one, worth $140,000, consists of microwave measuring equipment. It is intended primarily for instructional rather than research purposes.

Meanwhile, Texas Instruments, Inc. announced the donation of more than $850,000 in computer hardware and software. The grant consists of thirteen "Explorer" workstations to be used in artificial intelligence (AI) and cognitive sciences research. AI looks into ways of making computers think and learn while cognitive sciences try to understand human thinking processes.

Finally, the Amoco Foundation, Inc. gave a total of $446,464 to the University. In the College, the departments of computer science, electrical engineering, mechanical engineering, and civil engineering received funds. Other grants went to chemical engineering and geology in LAS, and to the College of Business Administration.

New CS Department Head

In August, Charles W. Gear succeeded James N. Snyder as the head of the computer science department. Gear is a professor in electrical and computer engineering and applied mathematics, as well as computer science.

Faculty Win PYI Awards

This year the University again did very well in the Presidential Young Investigator (PYI) awards. It placed in the top six institutions nationwide in the number of awards won.

The PYI awards were established to keep at universities "outstanding young Ph.D.'s who might otherwise pursue non-teaching careers," according to the National Science Foundation. Of the 200 awards granted nationwide, seven went to the University. The College award winners were: C. William Ibbs, Jr., civil engineering; Hua Lee, electrical and computer engineering; George Mozurkewich, physics; David N. Ruzic, nuclear engineering; and Haeok Lee, mechanical and industrial engineering.

Go Out and See the World!

A lot of engineering students probably think that once they get through four years of an engineering college and find a decent job, they have got it made. According to the president of the American Society of Mechanical Engineers (ASME), young engineers should experience the world before starting their jobs. "All too often our B.S. graduates in engineering graduate in one day and accept a position with industry the next day," he said. He suggested traveling cross-country or experiencing a different culture as possible pre-job activities for engineering graduates.

Army Clarifies Stand

In a memo to the Champaign-Urbana news media, an official of the U.S. Army Construction Engineering Laboratory reassured readers that joint Army-UIUC research would continue. It seems that a memo has been circulating among the faculty in which Colonel Paul J. Theuer, head of the laboratory, expressed his view that those scientists boycotting Strategic Defense Inititiative (SDI or, popularly, Star Wars) research should not be given any further financial support from the army. Later, in a letter to Chancellor Thomas Everhart, the colonel expressed the Army's intent to continue funding all research.

Bob Janssens


THE SKY WAS THE LIMIT.

AT&T has shattered the information barrier—with a beam of light.

Recently, AT&T Bell Laboratories set the world record for transmission capacity of a lightwave communications system—20 billion pulses of light per second. The equivalent of 300,000 conversations, sent 42 miles, on a hair-thin fiber of super-transparent glass. But that's really getting ahead of the story.

Actually, the 20-gigabit record is only one of a series of AT&T achievements in the technology of lightwave communications.

But what does that record mean?

The Light Solution To A Heavy Problem

All of us face a major problem in this Information Age: too much data and too little information. The 20-gigabit lightwave record means AT&T is helping to solve the problem.

For data to become useful information, it must first be quickly, accurately and securely moved to a data transformer—a computer, for instance. Getting there, however, hasn't always been half the fun.

Metallic pathways have a limited transmission speed, sensitivity to electrical interference and potential for interception—factors that reduce the effectiveness of today's powerful computers. Factors that are eliminated by lightwave communications technology.

Ten Goes Into One 20 Billion Times

Three primary components make up any lightwave communications system. On the transmitting end, a laser or light-emitting diode; on the receiving end, a highly sensitive photodetector; and in the middle, super-transparent glass fibers we call lightguides.

Installing these fibers is a major cost of a lightwave communications system. So, once installed they should stay put—increased capacity should come from fibers carrying more, rather than from more fibers.

Which brings us to the 20-billion bit-per-second story—about experimental technology that has the potential to upgrade installed fiber to meet any foreseeable capacity needs.

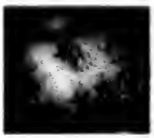
Using new, sophisticated lightwave system components, we multiplexed (combined) the outputs from 10 slightly different colored 2-billion bit-per-second laser beams into a single 20-billion bit-per-second data stream.

Playing Both Ends Against The Middle

But, let's start at the beginning—the 10 distributed feedback laser transmitters.

These powerful semiconductor lasers can be grown to produce light of different, but very precise, wavelengths. The lasers we used transmitted in the 1.55 micron (infrared) range, with only minuscule fractions of a micron between their wavelengths. The purity and stability of the beams let us pack their ten colors into the most efficient transmitting region of our single-mode, silica-core fiber.

To make the original 10 beams into one, a fiber from each laser was fed into a new lightwave multiplexer—a prism-like grating that exactly aimed each beam into the single transmission fiber. Over 42 miles later, a second grating fanned the beam back into its original 10 colors for delivery to 10 exceptionally sensitive avalanche photodetectors—receivers that convert the light pulses back into electrical signals and amplify them many times.



20-gigabit multiplexer

A similar avalanche photodetector was the receiver when AT&T Bell Laboratories set the world record for unboosted lightwave transmission—125 miles at 420 million bits per second.

From Sea To Shining Sea

System capacity is important. But system reliability is vital. Especially when the system is going under 10 thousand miles of water—and is expected to last for 25 years.

AT&T is going to build the first lightwave communications system under the Atlantic Ocean. A similar system is planned for the Pacific. In 1988, laser beams traveling through two pairs of glass fibers will carry the equivalent of 37,800 simultaneous conversations overseas, underwater, from the U.S. to Europe and the Far East.

AT&T has manufactured and installed lightwave systems—as large as the 780-mile Northeast Corridor and as small as single-office local area networks—containing enough fiber to stretch to the moon and back. And the capacity of each network is tailored to meet the unique needs of its users.

Systems being installed in 1985 will be able to grow from 6,000 up to 24,000 simultaneous conversations on a single pair of fibers.

AT&T is meeting today's needs with lightwave systems that are growable, flexible and ultra-reliable. And anticipating tomorrow's needs with a whole spectrum of leading-edge lightwave communications technologies.

AT&T
The right choice.

Tech Profiles

Duane H. Cooper, an associate professor in the department of electrical and computer engineering, received his Ph. D. degree in physics and mathematics *cum laude* at the California Institute of Technology in 1955. His areas of interest have been many, ranging from radio and radar repair in the U. S. Army, to his thesis work in particle physics, to research in the audio field.

His teaching experience at the University began in 1954 and has included courses dealing with stochastic processes, probability, communications, acoustics, and other topics. Cooper has been connected with research efforts in many diverse areas also, including computer processing of radar, surface waves, and particle-beam weapon feasibility.

Cooper enjoys an enviable reputation in the field of audio engineering; he is an internationally recognized authority in numerous areas of this field. He has been a member of the National Quadrophonic Radio Committee, is Vice President of the Audio Engineering Society's educational foundation, and has held important offices in the society such as president and vice president as well as having served several terms on the AES Board of Governors.

Additionally, Cooper has been selected as a Fellow and Honorary Memeber of the AES and as a Senior Member of the Institute of Electrical and Electronics Engineers; he holds membership in the American Physical Society and the Acoustical Society of America. Also to his credit are over thirty published articles and over forty patent applications. He has won many awards including the IEEE Consumer Electronics Group's Paper Award and the AES Gold Medal.

Currently, Cooper may be caught in action teaching EE 229 (electromagnetics) and EE 220 (circuits), or pursuing independent research on stereo sound.

Eric Guarin

Edwin E. Herricks of the department of civil engineering is one person who does not fit the engineering stereotype of being completely math and physics oriented. Rather than obtaining a B.S. in engineering, he earned a dual degree in zoology and English from the University of Kansas. However, his concern for the environment and his small engineering course backround motivated him to study environmental engineering at Johns Hopkins University. He later obtained his Ph.D., did post doctoral work, and was on the faculty in agricultural engineering at Virginia Polytechnic Institute.

In 1975, after several years of working for Union Carbide, Herricks came to the University. As an environmental biologist, he pursues research in environmental assessment and management. For over seven years he has been studying stream flow needs analysis, which determines the amount of water needed in a stream to sustain various life forms.

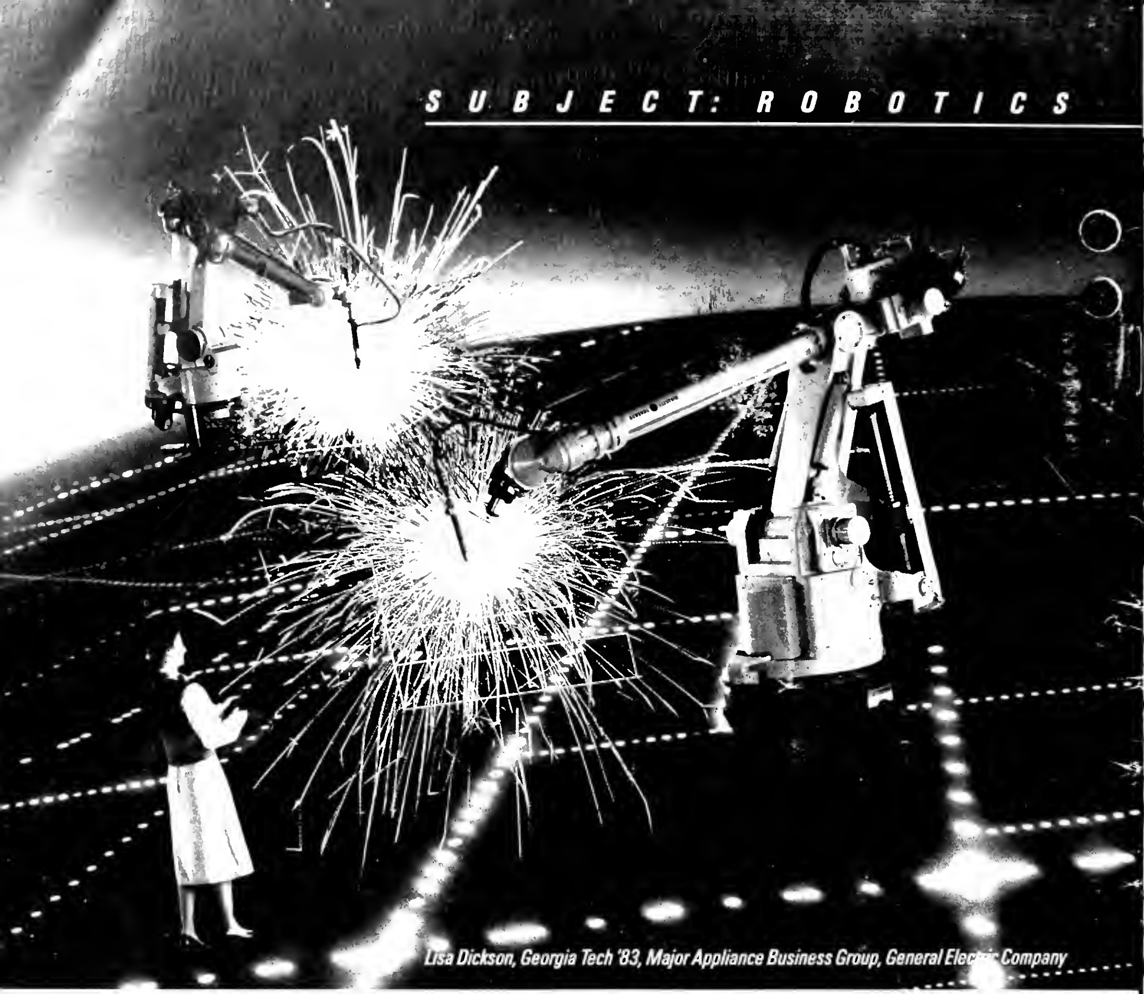
Highway construction projects create problems when streams must be diverted. Herricks studies such dilemmas and tries to obtain solutions for rerouting the stream which keep the stream in good condition and meet engineering requirements.

Herricks teaches several environmental engineering classes at the university. CE 241 examines the many aspects of air and water quality, while CE 347 explores aquatic ecology. He will also teach two new courses, CE 337, Managing Wastewaters and Aquatic Ecosystems and CE 338, Effluent Environmental Biomonitoring.

When not pursuing his research, Herricks likes to sail, golf and fish in the Rockies. He is an avid whitewater canoeist, but because the Boneyard Creek offers few rapids, he seldom has a chance to take out his five kayaks and canoes.

Michael Lind


THE NUCLEAR NAVY.
RIDE THE WAVE OF THE FUTURE.
You're deep under the sea. There are 4600 tons of nuclear-powered submarine around you. Your mission– to preserve the peace.
Your job– to coordinate a practice missile launch. Everything about the sub is state-of-the-art, including you.
The exercise– a success. You're part of that success and now you're riding high.
In the nuclear Navy, you learn quickly. Over half of America's nuclear reactors are in the Navy. And that means you get hands-on experience fast.
You get rewarded fast, too. With a great starting salary of $22,000 that can build to as much as $44,000 after five years. And with training and skills you'll use for a lifetime.
Then, whether you're in the Mediterranean, the Pacific or the Atlantic, wherever you move around the world, you'll be moving up in your career and in the Navy.
Find out more about an exciting future that you can start today.
See your Navy Recruiter or
CALL 800-327-NAVY.
NAVY OFFICERS GET RESPONSIBILITY FAST.



Lisa Dickson, Georgia Tech '83, Major Appliance Business Group, General Electric Company

See Your Future Through the Eyes of a Robot

[illegible]

Sound like sci fi? It's as close as your first career move. Because at GE we're already using robots like these, for jobs that require decision as much as precision.

When GE adds vision capability to lasers and off line programming robotics takes a giant leap forward. Just on the horizon are GE sight-equipped robots that guide themselves through intricate laser welding. What next? Tactile sensor pads to enhance GE robots with super-human dexterity. And computer brains for "trouble-shooting" robots whose thought [illegible] close to human intuition!

If you're fascinated by robotics, the new frontier is happening at GE. We not only design, build and sell robotic systems – we're using them in bold, new ways. Robots are an integral part of GE manufacturing processes, for everything from lightbulbs to locomotives.

So consider your future through the eyes of today's most exciting technologies. If you're that rare individual whose excellence is driven by the power of imagination you'll find room with a view at GE.

If you can dream it, you can do it.

ber 1985 Volume 101, Issue 2 Newsstand $1.40

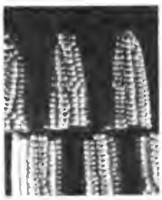
[redacted]

Illinois Technograph

High Tech Corn

November 1985 Volume 101, Issue 2

Illinois **Techno***graph*



On the cover: As American as apple pie and baseball, midwest corn represents dinner for some and a way of life for others. (photo by Mike Brooks).

4 **Averting Earthquake Disasters** *Jeff Hamera*
The recent devastation in Mexico has brought attention to the use of technology to build cities that are less susceptible to earthquake damage.

6 **Technoscope** *Jeffrey Dobos*
The second in the series of articles which will focus in on several features of the College is Finding Square One, an in-depth look at Placement Office procedures and policies.

10 **Improving Illinois Corn** *Ashraf Hameedi*
Believe it or not, all kernals were not created equal. A University researcher has found a way to separate the good from the best and improve the overall quality of the crop.

Departments
Editorial 3, Tech Teasers 7, Technovisions 8, Technotes 12, Technovations 13, Techprofiles 16

Illinois Technograph (USPS 258-760) Vol 101 No 2 November 1985 *Illinois Technograph* is published five times during the academic year at the University of Illinois at Urbana-Champaign Published by Illini Media Co., 620 East John St., Champaign, Illinois, 61820 Editorial and Business offices of the *Illinois Technograph* Room 302 Engineering Hall, Urbana, Illinois, 61801, phone 217 333 3558 Subscriptions are available for $7.00 per academic year Advertising by Littel-Murray-Barnhill, Inc 1328 Broadway, New York, N.Y., 10001, 221 N LaSalle Street, Chicago, Il., 60601 Entered as second class matter, October 30, 1920, at the post office at Champaign, Illinois under the act of March 3, 1879 *Illinois Technograph* is a member of Engineering College Magazines Associated

Editorial

Revenge of the Nerds

I'm not sure when the trend began, but it seems that engineering students have always been a target of abuse for their classmates who spend their time decorating their textbooks in various neon hues south of Green Street.

You know the kind of abuse I mean. It's the stereotype that labels us with such endearing terms as squid, goob, enginerd, snoid, and dweeve, and these are just the printable ones. It's the image that makes "engineering party" a paradoxical phrase and "engineering fashion" suggest an ensemble of cropped pants and white tube socks.

As members of this much maligned group, we know that this is not a well-fitting image and that these slurs are completely undeserved. Our rationale is not that pocket protectors are really valuable in protecting ones shirts from horrid ink stains, or that only GE 103 students publicly display T-squares, or even that perhaps if the rest of the campus knew the joys of spending Friday nights drawing force diagrams, debugging assembler code, or deriving the heat equation, the bars would close for lack of business. We are able to apply the scientific method and prove definitively that engineers are truly a fun bunch.

We start, as all good proofs do, with the base case; show that $n = 1$ is true. So I asked a friend of mine what she would do if her mission was to have an incredibly fun time in Champaign-Urbana, Illinois in November, 1985.

"Well," she said, "I suppose I'd sleep until noon and then spend the afternoon at a football game. After dinner I guess I'd go out on a date with a really great guy."

I asked her to elaborate on what a fun date would be.

"Well, you know, we'd go to a movie, maybe grab something to eat, and then, well, you know . . ." She smiled.

Well, it was quite obvious to me how indebted she was to engineers for her perfectly fun day.

In order to see the football game, she had to go to Memorial Stadium, which was designed by an engineering alumnus. Now, while she knows enough about football to distinguish a field goal from a touchdown, she certainly doesn't know all the referee signals, which means she relied on the audio system to let her know what was going on. She also didn't bring her own scratch pad to keep track of the score, signifying that she kept an eye on the electronic scoreboard in order to be informed. The application of various engineering products was necessary in order for the game to be fun for her.

It's incredibly obvious that in order to see a movie, she had to rely on the work of engineers. Sure it took talented actors, directors, and costumers to put the performance together, but there would be no way for their creativity to be displayed on a national level if engineers had not developed movie film, projectors, and Dolby sound. Even in an artsy activity, engineers play a key role in providing fun.

As for "grabbing something to eat," it's not the cooks who prepare the food or the copy writers who extol the freshness and purity of the product on the package who are responsible for making sure that you don't die of botulism or ptomaine poisoning when you open a bag of doritos. No, it's the engineers who monitor factory production and who design protective packaging who make sure that eating is fun for you.

Moving on to the inductive step of the proof, or showing that the theorem holds for all n, one of the most popular American pastimes is TV watching. The country spends millions of hours per day glued to an electronic screen. Who do you think is responsible for bringing that pleasure to his fellow citizens? I'll give you a big clue: an archeologist did not find a television among the ruins of the Acropolis and later sell it to RCA to be used as a prototype for mass production.

What was true of my friend's date at the movies applies to popular music too. Where would Bruce Springsteen be without the technology to create albums bearing his Levi's covered posterior on the cover that are played everywhere? Who would be able to hear him without sophisticated sound equipment, and what would he sound like with an acoustic guitar?

When you go to an amusement park, do you expect to be handed a great work of literature to wile away the day and thereby amuse yourself? Do you get to spend the day balancing accounting records? Not usually. Instead, you pay approximately $15 to experience forces, momentum, rotations, gravitational pull, and many other manifestations of mechanics guaranteed to permanently rearrange your internal organs. The country turns *en masse* to freshman-level physics to have a good time.

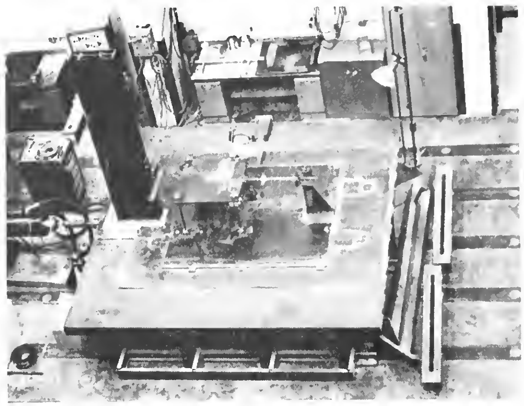
The proof seems very conclusive. It is not only a misnomer to depict engineers as slide rule toting study hounds, it is a great injustice. It is only through their engineering skills and knowledge that anyone else is able to have a great time. My friend would have had a rotten perfect day if not for modern technology, as all of her fun activities required an engineer—even, in her case, the smile.

Q.E.D.

***Illinois Technograph* invites letters in response to its articles and editorials, or any other items of interest to its readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be withheld upon request.**

Averting Earthquake Disasters

Earthquakes may be one of the least feared natural disasters in the midwest, but the centering of civilization on fault zones has brought new attention to the design of safe buildings. Using sound engineering techniques, structures can be built to ride out a quake, rather than crumble.



The "shaker," located in the crane bay of Newmark Lab, is used test building designs by subjecting models to the kind of motion encountered in an earthquake (*photo by Mike Brooks*).

Late in September a force of tremendous destructive potential was unleashed. from just below Mexico's Pacific coast. As this force ripped through Mexico City, the infrastructure of that city was reduced to an entanglement of rubble, chaos, and human tragedy. But this need not have been so. Since the early 1970's, enough has been learned about earthquakes and the destruction they can bring that structures can be designed to withstand their tremendous force.

Earthquakes cause damage by inducing motion in structures, by disrupting the stability of soil and rock and by setting earth and water into violent motion. Of these effects, the most apparent is the motion induced in structures. Acceleration of a structure designed primarily as a static body creates forces which can greatly stress components to the point of failure, cause structural elements to move into ineffective positions, and damage building contents and adjacent structures by impact. As a building is accelerated in a horizontal direction, its inertia resists motion and shearing stresses are induced in vertical supports. If the center of mass of each level does not coincide with the center of rigidity of the resisting system, a torque is caused and twisting of the structure results. Structural elements, such as bridge girders, may be shaken from their bearings or rotated to a position which is far less capable of resisting bending.

Disruption of the integrity of the ground occurs in two manners. The ground may develop discontinuities, causing underground structures to be sheared, heaving of pavements, and moving of the foundations of structures. Longitudinal movement of bridge foundations can result in the bridge buckling or the girders falling off their supports, either being quite unacceptable. Another form of ground failure is liquefaction of a soil. Liquefaction is a term applied to the transformation of soil into a fluid state. As the soil vibrates, pressure develops in the water in the soil. The individual soil particles lose contact with each other and the soil loses shear strength. Without shear strength the soil acts as a fluid in which dense items sink and buoyant items (underground tanks and pipes) rise toward the surface.

Landslides and large waves are often instigated by earthquakes. Mudslides and falling rock result in the overwhelming and undermining of roads, buildings and other structures. Also, impacts from falling rock can damage critical members of a structure thereby causing failure. When a quake originates under a body of water, a tsunami or seiche may result. A tsunami is a fast moving, low ocean wave that rises to a great height when it reaches the coast. Coastal geometry may cause localized amplification of such a wave. A seiche is a similar occurrence on an inland body of water. In addition to damage incurred from the impact of the wave, flooding of coastal areas and adjacent waterways causes damage.

With increased urbanization comes an inherent increase in the potential loss of life and property. Estimates of losses if a great quake were to strike southern California or the eastern United States are tens of thousands dead and tens of billions of dollars in damage. Technology has developed primarily since the San Fernando earthquake in 1971 and is sufficient to prevent much of the damage and death that would occur.

The prevention of damage begins with the mapping of potential hazards. Methods used include the simple accumulation of data from past earthquakes, as well as evaluation of the present state of an area. Sets of aerial black and white photographs producing a three dimensional image are used to identify regions of seismic activity such as fault zones and areas susceptible to ground failure such as alluvial fans, dried stream channels and areas with unstable slopes. Satellite infrared photos are also used to determine

J e f f H a m e r a

slope instability and liquefaction potential by evaluating the water content of the soil. Liquefaction potential can also be evaluated by soil testing. Monitoring fluctuations of magnetic fields can also reveal areas of seismic activity. Another remote sensing technique involves transmitting acoustic waves through the ground and monitoring the reflections for evidence of discontinuities beneath the surface. Carbon-14 dating methods determine the frequency of past fault activity and evaluate the present state of strain and the shear modulus of the rock along the fault, which helps to determine the likelihood of activity.

While identifying impending quakes is possible, the exact prediction of occurrences is not. By performing analysis on historical data and by monitoring ground motion, magnetic behavior, and animal behavior, analysts can give some warning of an earthquake. However, these warnings can be inaccurate and can damage the economic activity in an area.

Forewarning of quakes is important in saving lives, but a general model of potential seismic activity is usually sufficient for engineering purposes. Engineers are most concerned with the type of ground motion that can be expected and with what frequency it can be expected. Strong motion accelerometers are used to record movement that will induce forces in a structure. This data is combined with historic and geologic data to derive a probability model that is used to determine the magnitude of ground motion for a specified return period. Return periods vary from 50 or 100 years for typical structures to 500, 1000 or 'largest probable' for critical structures such as nuclear reactors and large dams.

A number of approaches to preventing damage in structures have been made. Basically, a structure may be designed to be ductile, to deform without failure, or to be rigid and overpower an earthquake. One effective way of resisting earthquakes is using a steel moment frame. This system is ductile and rigid and therefore allows the distribution of concentrated effects which would otherwise damage the structure.

Reinforced concrete shear walls provide effective resistance by providing large resistance to both the horizontal motion effects and the amplification of forces that occurs when the period of vibration of a structure coincides with that of the tremors.

A hybrid of these two systems produces a building with the ability to sustain its integrity under large forces and the ability to reduce the effects of these forces. Reinforced concrete columns that have only longitudinal reinforcement are particularly vulnerable because they lack ductility. However, if helical reinforcement is used, concrete within the steel is confined and greater strength and ductility are gained.

Flexible systems must be designed so that the natural frequency of the building is not that of expected tremors. The natural frequency is determined by modeling the building as a cantilevered beam with point masses at each floor. A dynamic analysis of the approximated structure is then performed. If the periods are allowed to synchronize, the contents of the structure may be thrown about, damaging property and endangering occupants. Also, permanent deformation of the building may occur. If this happens, columns will experience bending for which they are not designed and will be overstressed.

Designing against torsion involves the development of a seismic resisting system which has a center of rigidity, the point around which torsion will occur, that is coincident with the center of mass of the structure. The center of mass of a building is variable and for each level it may vary. Also, the resisting system may vary causing discontinuities which are undesirable. The best solution available is an experienced designer who will minimize and account for these effects according to the needs of a particular structure.

An innovative solution to earthquake design involves isolating the foundation by placing the structure on a shock absorbing system. While this system is effective, standard building practices can achieve satisfactory results. One such system employs large steel and rubber cylinders to absorb tremors before they affect the structure. Another uses large steel spheres as bearings, allowing the ground to roll beneath the building without inducing inertial forces. These systems have been used more abroad than in the U.S., but they are gaining acceptance in the western states.

Earthquake resistant design is possible today. The technology has been available for several years and building codes have reflected the need for such design. But without the threat of an imminent disaster, the added cost of earthquake design does not seem necessary. Many building codes in regions where earthquakes are rare have been slow to adopt earthquake design requirements and slower yet to enforce them. Many think of earthquakes happening in California or Japan or on television, but the largest earthquake to be recorded originated south of St. Louis and rocked the midwest for months. ■

Finding Square One

The Engineering Placement office provides graduating engineers and those seeking summer employment with a means to find the perfect career path.

Except the lucky few with inside job connections and those who are graduate school bound, everyone graduating from the College will use the Engineering Placement Office (EPO). In the quest for permanent or summer employment the EPO provides the initial contact between student and company recruiter and organizes the crucial interview.

Room 109 of Engineering Hall houses the EPO which is open from 8-5 Monday through Friday. The phone number is 333-1960. Inside, a large table and a reception desk dominate the room. Several staff members work at the reception desk answering questions and collecting resumes. Small interview rooms encircle the main room. At the large table students copy company addresses and complete interview request cards. On shelves throughout the room, binders hold literature on hundreds of companies.

Engineering students one or two semesters away from graduation may use the EPO in the pursuit of permanent employment. Even though companies generally look for juniors and seniors for summer positions, freshman and sophomores can also use the EPO. The role of the EPO in summer recruiting is smaller than for permanent recruiting, but it is still helpful.

The road to permanent employment begins when the job seeker goes to the EPO and picks up a standard placement data sheet along with a set of instructions for its completion. After returning twenty copies of the resume to the EPO, saving

Top, Dannis Fay, senior in mechanical engineering, checks his interview schedule with the list outside the placement office. Below, Susan Bowery, secretary for the placement office, assists Randy Smith, also a senior in mechanical engineering (*photos by Mike Brooks*).

J e f f r e y D o b o s

about thirty copies for future use, the student receives a copy of the current placement manual, computerized interview request cards, and a registration number.

The placement manual should answer all questions the job seeker might have. A summary of EPO services, pages and pages of interview do's and don'ts, a list of companies recruiting, the dates they will be on campus, and interview sign-up instructions make the manual very helpful. In addition to the placement manual several orientation sessions are provided in the begining of each semester. Also, during the semester the EPO conducts meetings which discuss interview preparations, plant trips, technical sales, and manufacturing engineering.

To keep information current, weekly bulletins available in the EPO update the placement manual. The bulletins also contain descriptions of the jobs recruiters need to fill. Day to day updates are posted on a bulletin board right outside the office in the hallway. If a student misses an interview, however, future use of the EPO will be denied unless an acceptable explanation is given. The office requires forty-eight hours advance notification of cancellation, otherwise it is considered a no-show.

So, you have the latest weekly bulletin and you see employment possibilities with ABC, Inc., now what? As the next step the student completes an interview request card and returns it to the office before Wednesday of that week. On Friday a list posts the results of the request outside of the office. If the request is granted, the interview's time and place shows. The student must then place a copy of their resume in the company's slot before the interview. Company slots are located in the hallway outside of the office. The prudent student will consult the bulletin board every day for changes before the interview.

To help prepare for the interview, many guides are available to the student. The placement manual contains many pages of advice including a section on the ethics of interviewing. In addition to the manual, stacks of handouts sitting on the reception desk in the office contain even more guidance. Each source stresses the need to know as much as possible about the company. The EPO helps out by providing a library of literature on over seven hundred companies. Also, numerous handbooks and directories in the office provide additional material. For student convienence, information on companies interviewing that week is set out in a special bin on the south wall of the office.

In addition to assistance in finding permanent employment, the EPO provides assistance for summer employment seekers. Starting in the fall, a bulletin printed on blue paper is released about every other Monday. The bulletin is located in a slot on the far right of the south wall in the EPO. The sheet lists companies looking for summer employees and describes requirements for candidates. Usually the contact between student and company is by mail. A resume sent along with a cover letter is fine. Occasionally a summer recruiter will be on campus collecting resumes and interviewing. Summer employment is very competitive, so be sure to pick up the blue bulletins on the appropriate Mondays.

The EPO also provides counseling for students. A conference can be arranged to answer questions on career choices, resume preparation, interview preparation, and other pertinent topics.

In return for their services, the EPO receives information from students and recruiters on job offers, salaries, and final career decisions. A release form must be completed by everyone using the office which asks for the above information.

The main goal of the EPO is to sign-up students for interviews, after which the EPO offers advice on how to conduct oneself during the interview. Remember, responsibility for landing a job comes right down to you. ■

From page 7

Tech Teasers Answers

1. Since the wheels of the car rotate while it is moving, at any instant the point at the bottom of the wheel is stationary, and at the next instant the same point actually moves backwards.

2a. All the Greeks on campus should be ashamed if they didn't get this one: Alpha, Beta, Gamma, Delta, Epsilon...Zeta.

b. 120-132-242 is the calculus sequence we all have to take.

c. If you replace all the letters in TECHNOGRAPH with the next one in the alphabet you get UFDIMPHSBQI. So the missing letter is I.

3. Snow White and the Seven Dwarfs (in alphabetical order): Bashful, Doc, Dopey, Grumpy, Happy, Sleepy, and Sneezy.

4. $999 \times 999 + 999 = 999000$
The problem can be represented by:

$$(100x + 10x + x)(100x + 10x + x) + 100x + 10x + x = 100{,}000x + 10{,}000x + 1000x + 100y + 10y + y$$

where x and y must be integers between 0 and 9. This reduces to $111x(x-9) = y$. Since $111x$ and y are non-negative, $x-9$ has to be non-negative. This can only happen if $x = 9$. $111 \times 9 \times (9-9) = 0$, so $y = 0$.


DEPARTMENT

Waiting

Judging from the mayhem that the University Fire Department creates when they go out on a call, it may appear that life at the fire house, at far left, located between Engineering Hall and Mining and Metallurgy, has hardly a dull moment. But most of the job amounts to waiting. Lower left, fire fighters Joe Franks and Mike Rumer prepare a meal; their work clothes stand nearby, at left. All this time, the various fire alarms are ready, prepared to let them know that their services, right, are required (*photos and text by Mike Brooks; fire photo courtesy The Daily Illini*).

Improving Illinois Corn

Illinois has always been a leader in corn production. Now, techniques developed by a University researcher could improve the quality of this commodity and increase its market value.

The University's College of Agriculture has long maintained a world-wide reputation as being one of the most innovative institutions in the sphere of research and development. Today, much work continues in areas that directly affect the ailing Illinois farm. These projects could eventually not only increase the productivity but also improve the quality of the goods. Currently, Professor M.R. Paulsen, an agricultural engineer with the University, is actively researching one method that he hopes will increase the marketability of Illinois corn.

Stress cracks within the corn kernel are an inherent characteristic of the type of corn grown in the United States. Rapid, high temperature drying leads to an even greater number of cracks in the kernel, thus increasing the grain's susceptibility to mold and fungi invasion. The storage life of the corn is decreased, and these cracks result in increased kernel breakage which contribute to dust explosions in areas where the corn is stored. The types of corn grown in countries such as Argentina also develop stress cracks, but Paulsen believes that in such corn, the cracks apparently present less of a problem. For many specialized food processors such as corn starch manufacturers, using corn with a minimal number of cracks helps to increase the recovery of starch. Thus, for the same amount of corn, the manufacturer gets a greater amount of starch. Detecting these cracks before the grains are sold to end-users would allow the corn to be classified on a "quality" basis. By purchasing American corn, a buyer would be reassured of the quality of the commodity he is getting. This may encourage the buying of American corn; thus increasing Illinois corn exports.

Originally, Paulsen and a graduate student set out to detect the presence of these cracks through the use of a laser-beam. In this apparatus, a laser-beam is focused through an objective lense onto a single kernel. The light first passes through a beam splitter, where fifty percent of it is lost. Upon hitting the kernel, different intensities of light are reflected. For example, the white, cracked starch area reflects a higher intensity light than does the yellow, uncracked area. The reflected light is directed into a photomultiplier tube, and information is then fed to a plotter where a graph of the varying intensities is made.

Paulsen, however, was not satisfied with the results of the laser beam apparatus. Because the narrow laser beam focuses onto a very small area of the kernel, only those cracks enclosed by this very small area are detected, while those outside of this area are not. Explained Paulsen, "[Using this apparatus,] it is very difficult to judge the extent to which an entire corn kernel suffers from stress cracks."

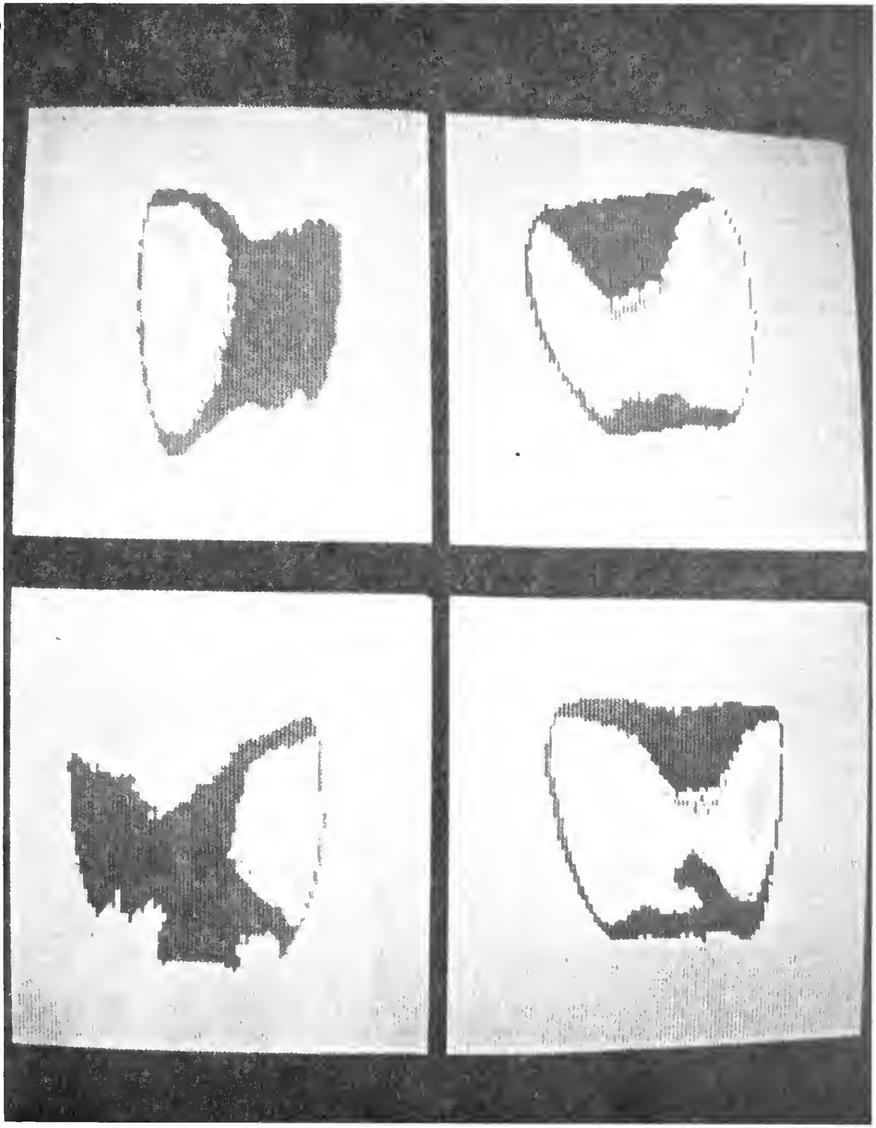
A new computer-vision system developed by North Carolina State University's Biological and Agricultural Department overcomes what Paulsen believes are the shortfalls of his laser beam apparatus. The system relies on a camera through which light shining on an entire corn kernel is reflected. The reflected light then travels to a photodiode array which senses its intensity. Information is then fed into a controller where the analog signal is converted into a digital signal. The digital signal then goes to a computer where the image of the kernel is produced on a color monitor with varying intensities of light.

Paulsen is currently in the process of constructing a similar system here at the University. The expected development cost of the system is approximately $20,000. Though the system is clearly superior to the original laser beam apparatus, Paulsen believes that much work still needs to be done on suiting the system for widespread use. For example, the system as it now exists only senses the intensity of reflected light and displays it on a monitor. Because differences in light intensity can result from discoloration and mold, as well as stress cracks, a person needs to stand by and decide exactly what the image on the monitor means. Paulsen eventually wants to develop a completely automated system that would allow the computer to interpret the data and make a decision by itself.

His plans call for a computer-vision system to be paired with a conveyor belt. The corn kernels would move on the conveyor belt under an overhanging camera lens which will take one-thirtieth of a second to form an image. The information would then pass to the computer, where a decision as to the extent of damage to the corn would be made.

A great deal of attention has been focused on Paulsen's research by both academia and industry alike, and he is optimistic about receiving funding for his project this year. Whether this project will prove to be cost effective remains to be seen. It is still questionable whether manufacturers will be willing to pay the higher price for their corn in return for the assurance of quality and a greater yield per kernel. In any case, Paulsen's research is evidence that work is continually under way at the University to further develop Illinois's most indigenous of industries, agriculture. ■

Ashraf Hameedi



At left is a computer enhanced image of visible light through several kernels of corn. Those furthest left have been fractured and have opaque zones, unlike those further right which have not been fractured (*photo courtesy M. R. Paulsen*).

Technotes

Spend a Year in Germany

Every year the College sponsors an exchange scholarship with the Technical University in Munich, West Germany. Every year one student from Illinois attends Munich and one student from Munich comes here. Both students receive a tuition scholarship and a stipend to cover living expenses. To apply you must be an honors student or have a grade-point average of 4.0 or above. You must also be a United States citizen and have completed your sophomore year by May.

Applications are made by submitting a letter to a member of the College Honors Council stating why you would like to be part of the program. The application deadline for next year is December 1st. The winner of the scholarship will be selected after interviews with every applicant are conducted. If you are interested, contact Dean Bokenkamp in 207 Engineering Hall.

Engineers Can Jam

Who says engineers don't know how to do anything else but punch their calculators? Tau Beta Pi, the engineering honorary society, is sponsoring a jam session this semester. The event will be "open to everyone to form a diverse group of musicians." Tentatively, the session is scheduled for December 7th from 7PM to 10PM, so mark your calendars. They might even be on the radio!

The Putnam Examinations

Every year the Mathematical Association of America organizes the William Lowell Putnam Mathematical competition. Started as a result of an article written by William Putnam in a 1921 issue of the *Harvard Graduate's Magazine* that described the virtues of academic competitions, the contest has grown to be an annual event.

The examination, which is open to all undergraduates at participating universities, is very difficult. Mathematics professor Bruce Reznick, who helped write the 1985 version of the test, said the problems are not only very hard but also "original" and "aesthetically pleasing." Many very good math students get very low scores, according to professor Harold G. Diamond, who is head of the Putnam organizing committee at this campus this year. He indicated that the two main requirements for success are the abilities to solve tricky problems and to cope with stress. Non-mathematics majors should not be discouraged from taking the examination, though. The test measures the student's cleverness in solving problems more than his knowledge of advanced concepts in mathematics.

The forty-sixth annual Putnam Competition will be held simultaneously at campuses all over the United States and Canada on Saturday, December 7th, 1985. It consists of two three hour sessions, from 9AM to noon, and from 2PM to 5PM. At each session, the students attempt to solve six problems. Prizes are awarded to both university teams and individuals. About 2000 students take the test. The mathematics department holds study sessions for the exam every Tuesday from 4PM to 5PM in 141 Altgeld Hall. Anybody who wants to take the test is strongly urged to attend these sessions. The department will give a mock (practice) Putnam in early November to select the three-person University team.

A good score on the Putnam guarantees recognition as a highly skilled mathematician. High ranking contestants regularly receive graduate fellowships at major universities. Interested students should go to one of the study sessions or talk to professor Diamond in his office at 374 Altgeld Hall.

Bob Janssens

Tech Teasers

1. Biff, a student at the University, just got a new sports car. He tells his friend Dexter, who is a physics major, that he made it go a hundred miles per hour the other day. Dexter sees a chance to embarrass Biff and make some money at the same time. He tells Biff, "I'll bet $50 that your whole car wasn't even moving forward when your speedometer said 100." Biff lost fifty bucks. Why?

2. Here are some sequences. Fill in the missing digits or letters.

a. ABGDE-
b. 12013--42
c. UFDIMPHSBQ-

3. Here is a similar problem. This one requires an answer to an arithmetic statement:

SW + BDDGHSS =

4. Finally, solve this equation. X and Y are digits making up the numbers.

$$XXX \times XXX + XXX = XXXYYY$$

If you get the answer, show why it is the only answer.

Answers on page 12

Scanning Tunneling Microscope

Scientists at the IBM research laboratory in Zurich, Switzerland have recently developed a new scanning tunneling microscope with a scanning assembly that is small enough to fit in a person's hand.

The scanning tunneling microscope was invented in 1981 by the scientists at the IBM laboratory. It is powerful enough to resolve individual atoms on the surface of solids. The new microscope will have many applications in future technologies as the size of components continues to shrink.

Once objects become smaller than a few hundred atoms in width, their surface composition becomes critical because the surface becomes relatively larger compared to the bulk inside. The chemistry of the surface is different from that of the bulk because surface atoms are not surrounded by other atoms on all sides; therefore, they arrange themselves in a different stable position. The new microscope will be able to look at individual atoms on the surface of materials, such as those used in computer chips, leading to even more miniaturized circuits.

The microscope makes use of a phenomenon of quantum mechanics called tunneling. When two materials are separated by a non-conducting area, there can still be a movement of electrons between the materials if they are close enough together for their electron clouds to overlap. The microscope relies on the principle that this electron current varies tremendously with the distance between the two materials. A very tiny probe scans the surface of a solid from a distance of about 10 angstroms (1 angstrom = 10^{10} meters). The tip is positioned very carefully so the tunnel current between it and the material being observed is constant. Since the distance is in direct proportion to the current, a topological map of the surface can be obtained by multiple scannings.

The new scanning tunneling microscope is basically a miniaturized copy of the 1981 invention. The whole assembly, including a vibration damping system, fits in a package small enough to use with other microscopes. The original version could not be aimed accurately at any specific points because the area it sees is too small to be located with the human eye. The new version can be put inside another microscope. Researchers can then target an area on a surface through the larger microscope and then zoom in with the tunnelling microscope.

The new microscope, IBM scientists believe, will be very useful in research into the nature of thin films and the surface structure of silicon and germanium compounds which make up semiconductor chips. The new device has also been used in such varying fields as surface science, molecular biology, metallurgy, electronics, and low temperature physics.

Light Wave Communications

In the past few years much attention has been paid to the potential for fiber optics in telecommunications, but only now is the first undersea light wave communication system being tested. A "real world" test system for a planned transatlantic cable was installed in the Canary Islands, a Spanish possesion off the North African coast. AT&T, in collaboration with the Spanish National Telephone Company (CTNE), spanned the seventy-two mile distance between the islands of Gran Canaria and Tenerife with a six-fiber optical cable.

At first the cable will only be used as a testbed for AT&T's planned TAT-8 transatlantic fiber optics cable. Besides determining whether the cable lives up to its design of being able to withstand the high pressures and low temperatures of the ocean floor, AT&T researchers will also cut and try to reconnect the cable. This simulated emergency will help prepare them for an eventual similar occurence with the TAT-8 After the testing has been completed, CTNE will use the cable to carry commercial voice, data, and video signals between the two islands.

Phoning a Computer

Soon it will be possible to have a phone conversation with a computer. AT&T is setting up a new venture to sell the Conversant® Voice System which, according to Thomas R. Thomsom, head of AT&T Technology Systems, will make it so that "The common telephone now becomes a computer terminal, and the human voice becomes a keyboard."

The system uses a combination of voice access, touch-tone dialing, and modems to access a computer. Right now there exist systems that use the touch-tone pad on a telephone as a keyboard, but only half of the nation's phones are equipped with touch-tone.

In its voice input mode, the system can recognize spoken numbers even if the user does not spell out every digit. It is designed to handle these numbers and the words "yes" and "no" in several accents and dialects. The system will be able to be expanded in the future with such options as speaker identity verification and a text-to-speech synthesis feature which enables the computer to read a text to the caller.

Bob Janssens

The Boundary Dynamic

The performance of a polymeric adhesive depends on the properties and composition of its surface. Now a scientist at the General Motors Research Laboratories has developed and validated a theory that describes the coupled effects of diffusion and chemical reaction on the changing surfaces not only of adhesives, but of chemically reacting surfactant systems in general.

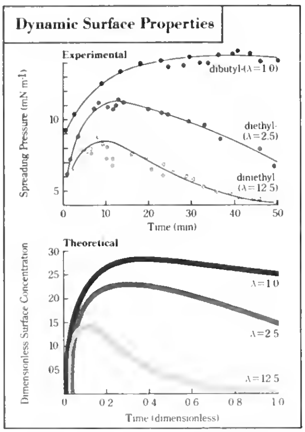


Figure 1: Experimental measurements of spreading pressure v. time for dialkylaminopropylamines with various Damkohler numbers (λ), and corresponding theoretical calculations of surface concentrations.

Figure 2: Evolution of an adhesive surface: Surface-active Solute 1 reacts with host resin to form surface active Solute 2.

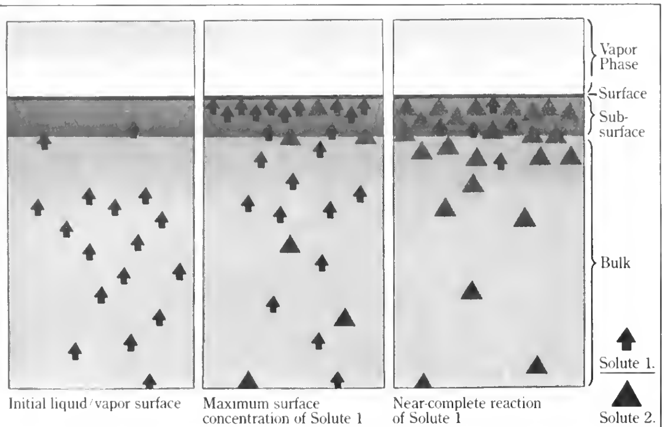
THE USE OF adhesives in the production of an automobile promises to make both the product and the process more efficient. Both weight and operations can be reduced. In practice, however, steel and other metallic surfaces are often contaminated by process lubricants. A durable bond depends on the ability of an adhesive to displace contaminants and to wet the substrate.

Assuring intimate contact between adhesive and substrate requires detailed knowledge of adhesive surface tension, since it is this property that controls displacement of contaminants and wetting. Up to now the surface tension of an adhesive has typically been assumed constant. In reality, though, surface-active components in the adhesive collect preferentially at the interface and also react, so that the surface composition varies with time, giving rise to dynamic surface tension. Variations can be large enough to significantly affect adhesive performance.

The understanding of time-dependent surface tension has been advanced by the work of Dr. Robert Foister, a scientist at the General Motors Research Laboratories. Investigation of dynamic surface properties of thermosetting adhesives led him to develop a general theory of adsorption kinetics in binary, chemically reacting surfactant systems. The significance of this theory is that it includes the coupled effects of surfactant diffusion and chemical reaction, making it possible for the first time to describe quantitatively the changing surfaces of such systems.

In a typical adhesive that polymerizes, or "cures," by chemical reaction (Figure 2), a surface-active curing agent (Solute 1) reacts with the host resin to form a second surface-active species (Solute 2) that is also reactive. Both solutes migrate to the surface, lowering the surface tension. Diffusion to the surface is driven by a potential energy gradient between the surface and the bulk, with the solute molecules experiencing a lower energy at the surface.

Dr. Foister derived appropriate transport equations to describe diffusion and chemical reaction in the bulk, in a subsurface region, and at the surface itself. The transport equations can be solved analytically if the chemical rate equations are assumed to be first order in the concentrations of reacting species, and if the subsurface and surface concentrations can be related to one another by a linear adsorption isotherm. For more complicated isotherms, a set of coupled, non-linear integral equations is generated.



These must be solved numerically.

Analytical solution for the special case of the linear isotherm indicated that the change with time in surface concentration (and consequently in surface tension) is composed of two terms: first the diffusive flux of Solute 1 into the subsurface from the bulk, and second the depletion of this solute due to chemical reaction. Hence, the surface concentration of Solute 1 exhibits a maximum with time (Figure 2). This maximum in surface concentration corresponds to a minimum in surface tension.

MODIFYING the transport equations to include binary adsorption isotherms allowed for consideration of competitive adsorption of the two reacting and diffusing solutes. By solving these equations numerically and conducting dimensional analysis, Dr. Foister identified various dimensionless parameters as predictors of system behavior. The most important of these parameters was a dimensionless number (λ), of the Damköhler type, involving terms representative of reaction, diffusion, and adsorption.

$$\lambda = \frac{k\,(\Gamma_m\,a)^2}{4D}$$

Here k is the reaction rate constant of Solute 1, D its diffusivity, Γ_m its "surface capacity" (the maximum number of molecules absorbed per unit surface area), and a its "surface affinity" (a measure of its energy of adsorption). For an adhesive, lowering λ by reducing k (the reactivity of the curing agent), for example, would prolong the time to maximum, and would increase the value of the surface concentration at the maximum (see Figure 1, Theoretical). As a practical consequence, this would improve wetting by minimizing the surface tension.

In experiments using a series of dialkylaminopropylamine curing agents (dimethyl-, diethyl-, and dibutyl-) in a host epoxy resin matrix, good agreement has been demonstrated between theoretical predictions for surface concentration and the measured dynamic spreading pressure, which is the change in adhesive system surface tension due to the curing agent (Figure 1, Experimental).

"I expect," says Dr. Foister, "that the physical insights gained from this analysis can be applied to other reactive surfactant systems by using specifically tailored isotherms and chemical reaction schemes. Predicting surface behavior can certainly help us design better adhesives for specific applications, but it is also pertinent to the performance of anti-oxidants and anti-ozonants in synthetic rubber, for example. And applied to interfaces in biological systems, a suitably modified theory may prove valuable in understanding the phenomenon of enzyme activity."

THE MAN BEHIND THE WORK

Dr. Foister is a Staff Research Scientist in the Polymers Department at the General Motors Research Laboratories.

Dr. Foister received his undergraduate degree from Guilford College, and holds a Ph.D. in Physical Chemistry from the University of North Carolina at Chapel Hill. His thesis dealt with the role of liquid inertia in the intrinsic viscosities of rod-like polymers.

He did post-doctoral work in Canada as a Fellow at McGill University in Montreal, and in the Applied Chemistry Division of the Pulp and Paper Research Institute of Canada, working on the microrheology of colloidal dispersions.

Dr. Foister joined General Motors in 1980. He is the leader of the Structural Adhesives Group in the GMR Polymers Department. His current research interests center on surface chemistry and adhesion.

Tech Profiles

Mark A. Stadtherr may be an associate professor in chemical engineering, but his laboratory lacks a bunsen burner. Instead, he specializes in modeling chemical systems using a computer.

Stadtherr first became interested in using computers in his field when he was an undergraduate at the University of Minnesota. He continued his computer work when he did his graduate work at the University of Wisconsin and has pursued his interest ever since he came to the University in 1976.

Rather than attempting to physically set up chemical manufacturing facilities in order to test them, Stadtherr has found that such processes are best tested on a computer. Often each process can be modeled using thousands of equations – work expecially suited to a computer.

Even computers can be too slow for effectively modeling chemical processes. With the arrival of the new Cray X-MP Supercomputer on campus, Stadtherr anticipates using it for even better computer models. The advantages of the supercomputer are several-fold. The increased power of the computer will allow the solving of more complex and therefore more realistic problems. Problems that used to take hours to solve will only take minutes, enabling quicker interaction between man and the machine. With quicker interactivity, better solutions to manufacturing problems will be found.

Students of chemical engineering know Stadtherr for the classes he teaches. Presently he teaches Chem. E. 389, Chemical Process Control; Chem. E. 466, Applied Mathematics in Chemical Engineering; and Chem. E. 469, Special Topics in Chemical Engineering.

When not working, Stadtherr enjoys gardening, bicycling and of course, playing with computers.

Michael Lind

W. Kent Fuchs received his Ph.D in electrical engineering from the University in January of this year. He earned a bachelor's in EE from Duke University in Durham, North Carolina, and a master's in EE from the University. He also holds a Master of Divinity from Trinity Divinity School in Deerfield, Illinois.

Fuchs is an assistant professor and a research assistant. His professorship is in the department of electrical and computer engineering, and his research position is in the Coordinated Science Lab. He also holds a zero-time appointment in the computer science department. This spring he taught a graduate course in EE. Presently he teaches Introduction to Computer Sciences, CS 121, and Introduction to Computer Engineering, EE 290.

Serving on several faculty commitees, Fuchs also enjoys the large amount of research he does. His specialization, reliant computer architecture, includes such things as fault-tolerant computer systems, VLSI chips, and computer-aided design.

Dr. Fuchs says that when he obtained his doctorate, he was faced with two choices, namely, industry or academia. Both offered opportunities for research, his main interest. But academia offered Fuchs an opportunity to teach and work with graduate students. For him, academia was an obvious choice.

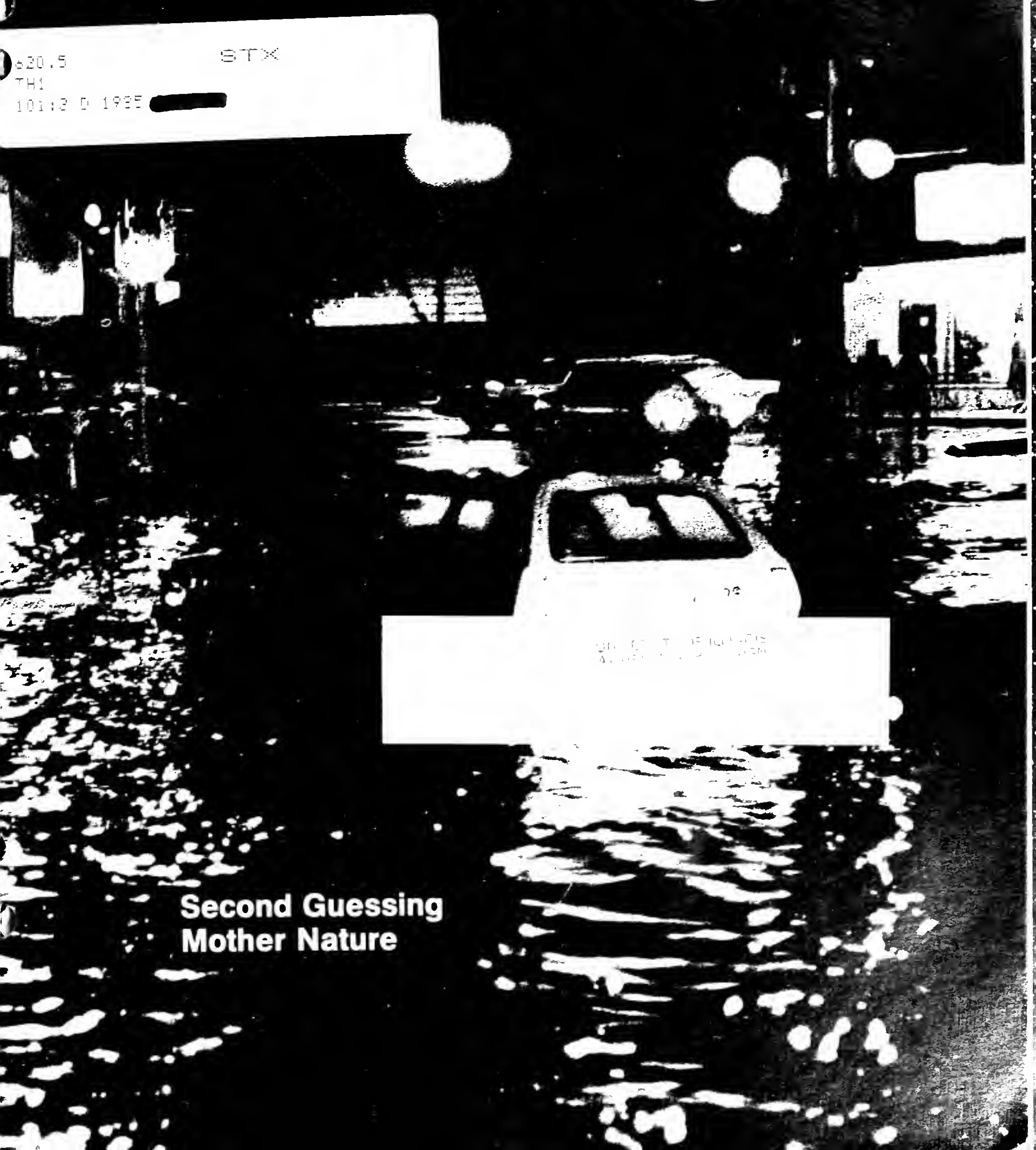
After four years of marriage, Dr. Fuchs and his wife, Linda, have a two year old son and a son born on September 20 of this year. His wife, besides raising the boys, is writing a master's thesis in art history for the University of Chicago.

Dr. Fuchs is very active in his church, the Stratford Park Bible Chapel in Champaign. He teaches some Sunday school classes, a college bible-study group, and delivers some of the sermons. He plays pickup basketball games at IMPE, and enjoys reading.

Chris Gerrib

December 1985 Volume 101, Issue 3 Newsstand $1.40

Illinois Technograph



Second Guessing Mother Nature

December 1985 Volume 101, Issue 3

Illinois **Techno***graph*

On the cover: Green Street becomes a sea of confusion during a recent downpour. (photo by Mike Brooks).

4 **Gravity and the Professor** *Raymond Hightower*
This science fiction short story tells of the interesting things one can learn in a math tutorial session.

6 **Remote Weather Sensing** *Fred Brunner*
New developments in technology are making weather predictions increasingly accurate. Aside from preventing your parade from getting rained upon, these predictions can help save lives and property from natural disasters.

10 **Integrating Technology and the Third World** *Stephen Tongue*
Advances in technology for some are setbacks for others. This account of the problems experienced in transfering technology to a Third World country illustrates the need for adaptability in engineering.

14 **Technoscope** *Cheryl Danke*
This month's Technoscope, Setting the Curve for Engineering Education, takes a step back and examines the quality of the engineering program.

Departments
Editorial 2, Tech Teasers 2, Letters 3, Forum 3, Technovisions 8, Technovations 12, Technotes 16, Techprofiles 17

Copyright Illini Media Co. 1985
Illinois Technograph (USPS 258-760) Vol. 101 No. 3 December 1985. *Illinois Technograph* is published five times during the academic year at the University of Illinois at Urbana-Champaign. Published by Illini Media Co., [illegible] East John St., Champaign, Illinois 61820. Editorial and Business offices of the *Illinois Technograph*: Room 302 Engineering Hall, Urbana, Illinois 61801, phone 217 333-3558. Subscriptions are available for $7.00 per academic year. Advertising by [illegible]ttel-Murray Barnhill Inc., [illegible]328 Broadway, New York, NY 10001; 221 N. LaSalle Street, Chicago, [illegible] 60601. Entered as second class matter, October 30, 1920, at the post office at Champaign, Illinois under the act of March 3, 1879. *Illinois Technograph* is a member of Engineering College Magazines Associated.

Editor *Mary McDowell*
Business Manager *Troy Brethauer*
Production Editor *Michael Lind*
Photo Editor *Mike Brooks*
Features Editor *Bob Janssens*
Copy Editor *Eric Guarin*
Asst. Copy Editor *Dee Bartholme*
Design *Charles Musto*
Asst. Design *Robert Baittie*

Publisher *E. Mayer Maloney, Jr*
Production Manager *Geoff Bant*

Editorial Staff *Scott Brun, Fred Brunner, [illegible] Cohen, Cheryl Danke, Jeffrey Dob[illegible], Stephen Ferree, Chris Gerrib, Gail Halley, Ashraf Hameedi, Jeff Hamera, Raymond Hightower, Steve Lotz, Andrew Koepke, Peter Lei, Jeff Mote, Steven Searey, Cheryl Smith, Pam Susemiehl, Steve Tongue, Bill Weiss, Mary Winters, Joseph Wyse, Jay Zeff*

Editorial

SUAEA Members Sought

There's been a lot of talk lately about engineers being unable to communicate well with the rest of the world. People are worried not only that our grammar may be less than perfect, but they also question our ability to verbalize our ideas. They fear that ideas that could cure cancer, provide efficient pollution-free energy, or feed all of Africa will be lost because the creator was unable to elaborate on his/her ideas.

This is a valid concern. Jokes like "when I came here I couldn't spell engineer, now I are one" are often too close to reality to be truly funny. It's obvious that a person has not received a well-rounded, complete education if s/he is allowed to graduate from a major university unable to express ideas in the native tongue.

Unfortunately, the means used to attempt to rectify this situation are not working. Requiring freshman to take Rhetoric 105 and insisting that all lab reports be composed using correct grammar don't even begin to address the heart of the problem, which is, of course, the engineer's love of acronyms.

Consider the following: "What a day! I was over at MEB working on an EOH project for ACM, when all of the sudden I realized I had to go to DCL to turn in an MP for CS. Then, on my way back, I realized I had missed my DSAC meeting in EH, and there was homework due in EE that I hadn't done, and I'd have to copy it from this IEEE friend of mine sometime before the next HE! I mean, the whole scene was OOC!"

See what I mean? Whereas non-technical types tend to refer to their buildings (FLB not withstanding) as Davenport, Harker, and Altgeld, north-of-greeners don't even bother to name them after anything other than the subject taught within it, and then they can't seem to describe the location using any more than three letters. We rarely have assignments or papers due; we have MP's and HW's. It's especially appropriate that the event that showcases the College, Engineering Open House, should also be reduced to a 3 letter nomer.

I really can't account for this phenomenon either. Perhaps the majority of engineers have completely right-hemisphere brain orientation, which makes it impossible for them to remember a string of letters that is not somehow associated with a mathematical formula. Maybe we've had too many math courses which have made us too eager to try to put everything in canonical form or else reduced to the lowest possible denominator, which in this case translates to the shortest possible number of initials.

The affliction seems to hit all engineers, not just the more studious types. Those who gather on Friday afternoons with beer consumption as the primary goal are known to refer to such an occasion as "H^2," rather than "happy hour," as a normal CBA or LAS type might.

Perhaps we could learn to overcome this at least while speaking to those who are not of this mindset in order that ideas may be more easily interchanged. This could take a big effort to overcome the urge to "initialize." Maybe we could form a self-help group and call it SUAEA-that is to say Students United Against Engineering Acronyms. . .then again, maybe it's a hopeless cause.

***Illinois Technograph* invites letters in response to its articles and editorials, or any other items of interest to its readership. Articles, photographs, and other contributions will also be considered. Letters must be signed, but names will be witheld upon request.**

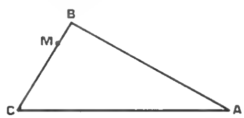
Tech Teasers

1. Here are some more equations similar to the ones in the last issue. A and B are digits making up the numbers. Solve these equations for A and B.

a. $A + B = AA - BB$

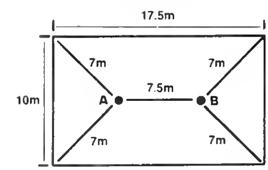
b. $2A + 3B = BB$

2. Construct a line through M that divides triangle ABC into a quadrilateral and a triangle of equal area.



3. What is the largest number that you can get by multiplying positive integers whose sum is 100?

4. Poles A and B are situated in the rectangular field below. Both poles have a ring attached to them. Farmer Brown has two bulls that will fight if they can reach each other. How can he fasten the bulls to the poles so that they can graze the whole field but will not fight each other?



Answers on page 13

Letters

Forum

An Icky Solution

The principal just passed his October copy on to me!

For shame, the Tech Teaser 4 on page 2 is a ferric wheel.

As I tell my students, "ic" makes the higher sound and stands for the iron ion with the higher oxidation state.

Redo your sketch with six Fe^{+2} ions in the strategic positions and you will have the right problem.

Natalie Fonte Tiernan
Warren Township High School
Gurnee, Illinois

CompE Avengence

I really enjoyed Mary McDowell's editorial concerning the "Revenge of the Nerds." However, I am concerned about her last paragraph.

I find two things wrong with her proof.

One, the reason that engineers should not be stereotyped is because we also know how to have fun. We "party," listen to music, see movies, and do other fun things. Her issue of not stereotyping engineers because we provide fun for others is irrelevant.

Two, I find it a little egotistical for engineers to assume that no one could have fun without us. Sure, we have made all of the progresses in the sciences, but what about enjoying a nice walk though the woods? Is that not fun? I don't see how engineers are responsible for that.

One unrelated comment: I heard another anti-engineering comment the other day. "You can't spell geek without EE." Oh well. . .

Rohit Gupta
Computer Engineering, '88

What's the Beef?

The Deans' Student Advisory Committee (DSAC) conducted Gripe Booths October 15 and 16. The net result was about eighty forms which were returned with one to ten gripes each. This result far surpassed that of previous years.

Our committee is very pleased. There is a lot of material to work with in these complaints. Topics ranged from the purely physical, "Where did the copy machines go?" to almost philosophical complaints about student-faculty relations. Most complaints lay in the course requirement/advising area.

At the same time, however, our committee was somewhat disappointed at the difficulty of getting students to complain. Every student on engineering campus has some problem or concern. They complain about it to their friends and classmates, so why won't they take the opportunity to complain to a fellow student who really does want to hear it?

Probably the largest factor in the willingness to complain is whether the person feels something will result from it. If a student feels his opinion matters, he will be more likely to offer it. One of the most common responses given by students when asked to complain is "What will it accomplish?" and then not waiting around for the answer.

Recently DSAC met with the deans to discuss the gripes received. The answer to the questions became perfectly clear. Complaining accomplishes a great deal. A good engineer knows that it is identifying the problem that is often the largest difficulty is finding a solution. The administration realizes that the students have problems, yet it is the fact that they are administrators that keeps them from identifying the problems themselves.

The administration created DSAC because of this difficulty. We were created by the deans, but to maintain the impartiality of a student organization, we are a committee of Engineering Council. Our organization's purpose it to act as a liason between the administration and the students. We are free to discuss or take action on any issue.

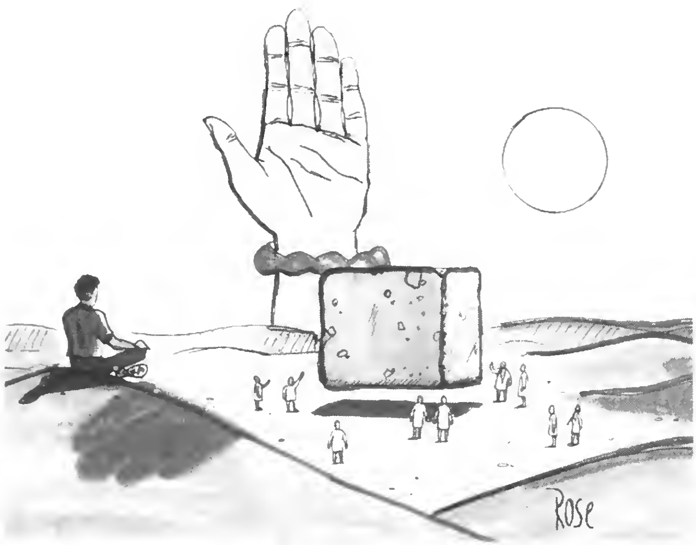
There is only one limitation to our organization. We need a representative voice. Our committee and the deans are willing to tackle any problems as long as we know it is significant. The only way we can be assured of this is through student feedback. Eighty gripes may have set the record this year, but when you consider a student body of over 5,000. . .

DSAC will continue to conduct Gripe Booths and at times will circulate surveys or in other ways ask for a response. Take the time to respond. Students who sit back and complain among themselves achieve nothing. The problem will still exist, and no one will know about it.

DSAC exists because students find it hard to complain to the faculty. They fear recrimination either in the form of bad student-professor relations or an influence on their grades. At the same time they are too intimidated to talk to the department head or dean. I encourage you to break through that invisible barrier. Go talk about a problem with a dean. Set up an appointment with your department head. You'll find they are much easier to talk to than you had expected. Remember that what goes on in their college or department reflects back on them, whether it be a poor professor or a useless lab, so they will do what they can to remedy the situation. However, if you can't take this step, remember that there are organizations such as DSAC to take your issue up for you. Participate in the next Gripe Booth or survey. You'll be doing something for yourself.

Annette Drilling
President, Deans' Student
Advisory Committee

Gravity and the Professor



I sat outside the professor's office with the hope that a short tutorial session would clear up the mysteries of my mathematics class. Other professors walked up and down the hallway. All of them had pensive expressions on their faces and a few smelled of exotic brands of pipe tobacco.

I sighed. Our appointment should have begun over twenty minutes ago. I guess some professors are so deep into their abstract math that they ignore trivial items of reality, like time. I hate to wait. "I'm sitting in the hall outside this office, people are looking at me as if I'm loitering, and the floor is very uncomfortable," I thought to myself. I decided to try the door; it was unlocked.

I entered the office boldly, as if I owned the place. And why not? People who make me wait shall suffer the consequences of said act, and in this case, invasion of privacy was the penalty. Besides, I needed a more comfortable place to sit.

An ergonomic chair! Professor Spooner really knew how to do things in style. I could see that the chair had levers for every type of adjustment imaginable. "One-hundred and one ways to comfort your butt," I said to myself. As soon as I sat down, a deep pain penetrated my skull. I immediately hopped to my feet, and the pain was gone.

Seconds later, the room began to vibrate. I had a sneaky suspiscion that something was wrong, so I left the office.

But everything in the hallway seemed normal! I didn't understand. Curiosity got the better of me, so I went back into the office to investigate.

"Most people knock before entering a private office," said the calm, yet commanding voice. Sitting in the chair was Professor Spooner, and she was staring at me. Where had she come from? I toyed with the idea that she had materialized on the spot, and to tell you the truth, the idea isn't that ridiculous.

Professor Spooner is one of those characters everyone likes to talk about. Her mathematics lectures were never boring, even though she often went off on tangents. Spooner loved to discuss the history of mathematics, and whenever she began a new topic, her brown eyes would twinkle, and off she would go describing the events that led to the discovery of the concept. Many of her stories focused on the exploits of ancient African civilizations, like the Nubians, the Egyptians, and the Carthaginians. Spooner was quite proud of her African ancestors.

She would go into such detail that some people assumed that she had fabricated the stories just to make the class more interesting. But unlike most of the others, I sensed that she really knew what she was talking about. I did not suspect that I would soon learn just how accurate her information really was.

I let my mouth hang open as she continued to speak. "Most people knock before entering a private office. May I help you?"

"Oh, excuse me, I thought this was your receptionist's office."

She knew I was lying, and she laughed. Hers was a contagious laugh, and I would have joined her if not for my embarassment. "Come in and sit down," she said.

Her recent materialization was still on my mind, but I didn't know how to approach the subject. I was worried that she might zap me with her chair or something. So, in an attempt to cover up my curiousity, I began to ask questions about the coursework.

"This problem," I said as I opened my textbook, "is giving me headaches." I pointed to a problem on the page. The exercise dealt with gravitational acceleration; I had no idea where to begin. It was plain to see that I was young and ignorant

Raymond Hightower

and had yet to grasp the subtleties of that universal law.

Professor Spooner began to answer my question, and I absorbed her words. Somewhere along the line, she went off on one of her famous (or infamous) tangents. My mind began to wander, and then, uncontrollably, and quite visibly, I yawned.

She stopped in the middle of her sentence and stared. She stared at me for two full seconds, and I just knew she would zap me with the chair. I waited for the fatal blow that would erase me from existence.

Professor Spooner smiled, and then she spoke. "You know, I've always been one to go off on tangents. Perhaps it would be better if I showed you what I mean instead."

She removed from her wrist a bracelet, and she placed it around my wrist. The bracelet appeared to be made of gold, but it had no weight. It was lighter than paper! Closing her eyes, she held the bracelet firmly for a few seconds, and then she let it go.

She looked at me and she spoke in a very solemn tone. "Gravity is something no one really understands. And to top it off, we all have great disrespect for this mysterious force of nature. We manipulate gravity in our equations, we drop things from high places, and we juggle objects for amusement. I am about to send you through time and space to a place where people truly understand gravitational theory."

After that last sentence I knew that she was hopelessly and incurably insane. I tried to get up and leave, but she touched the bracelet, and I. . . I don't know.

Well, in a way, I do know. My vision blurred, and I felt a deep pain within my skull. When my vision had cleared, I was no longer in the office.

Sitting on a sand dune, I looked around in every direction, and all I could see was sand. At that point I firmly resolved to drop Professor Spooner's class.

I climbed the highest dune in the area so that I could scout around and plan my trek homeward. In the distance, I could see what appeared to be some sort of cubical structure. I could also see people moving about the structure, climbing it, etc. It was the only sign of civilization around, so I decided to move toward it. Hopefully they could direct me to a telephone.

When I got closer, I saw that the structure was actually one huge block of stone. And it was apparent that this block did not rest on the ground; it was actually hovering about four feet above ground. I watched as they moved it horizontally, apparently in an effort to center it over a certain position. They then lowered the massive stone to the ground, ever so gently.

I was impressed not only with their accomplishment, but with their method. Their method of moving the stone was so simple, so blatantly simple, that I began to wonder why I had never heard of things like this being done before now. And then I remembered the professor's words: "I am about to send you through time and space to a place where people truly undersand gravitational theory."

Those words echoed within me; they echoed within me until I found myself again in Professor Spooner's office.

"Where did you send me? Or should I ask 'when' did you send me?"

"Oh, I sent you to a sort of 'ground breaking' ceremony for one of the Egyptian pyramids. Did you learn anything?"

"Yes, and no. It was pretty clear that they understood gravitational theory, and I watched them in action, but I still don't understand *how* they applied that knowledge. And, before you tell me about them, tell me how you managed to send me to see them."

She walked over to my side of the desk, and she removed the bracelet from my wrist. "The time/space travel thing is my secret, and that is something that is not open to discussion right now."

"As for how the Egyptians managed to move those massive stones, the method, as you now know, is quite simple. Think of it this way. If we hadn't invented the wheel, we might have stumbled upon this other, more amazing and more efficient method of transporting heavy objects. It's all a matter of advancement alternatives."

"What do you mean by 'advancement alternatives?'"

"Here's an example. If gasoline powered automobiles had never been invented, certain chemical engineers may have devoted their time to electric cells instead of petroleum distillation. Maybe we would have had electric cars faster and cleaner than the gas models we have today."

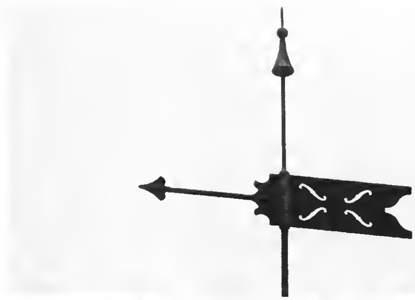
Many ideas came to mind. I only needed to travel to ancient Egypt one more time so I could learn their brand of gravitational theory. The applications here in the modern world are endless! I thought of all the things our society could gain from this knowledge, not to mention the money I could make. I needed to go back, so that I could set my plans in motion.

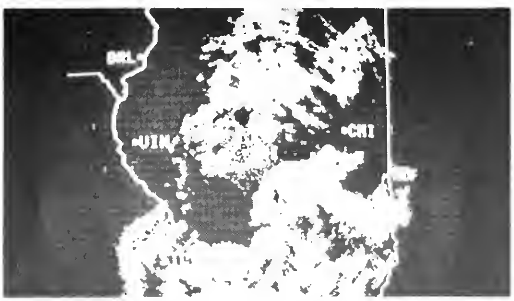
"I do not want you to discuss anything that you've learned today. . . not yet. There are still many things you will need to know before you can tell others. There is much to learn."

I listened, and I thought. ■

Remote Weather Sensing

Many people rely on the daily weather forecast to plan their lives, but have little idea about how the predictions are made. Today, this involves more than simply sticking a hand outside to check for rain.





Showing the contrast between traditional and modern methods of learning about the weather are (top) the weathervane on top of the Illini Union which is functional as well as decorative and (below) a radar weather map displayed on cable television *(photos by Mike Brooks and Peter Lei).*

To predict the weather. In this innocent phrase lies one of the most ambitious undertakings of mankind, one which most people take for granted in this day of the daily forecast. Yet the accurate and timely prediction of the weather is one of the most valuable and even vital developments of the modern technological age.

When the number of variables governing the interaction of the sun, atmosphere and earth are taken into account, the formidable size of the 5 o'clock forecast becomes apparent. It is through the development of new means for obtaining information on this system that this task becomes manageable. The most important of these new methods is an area which may be broadly referred to as remote sensing technology. This encompasses a broad range of principles and techniques whose common aspect is the gathering of data over a wide area from a point removed from it.

This is important because of the need to acquire a large amount of data simultaneously on a variety of variables. In order to understand the complex behavior of a system like the Earth's weather, a number of parameters must be measured. These variables include temperature, pressure, wind speed and direction, water vapor concentration, and percentage and location of cloud cover. The accuracy of these data directly influences the accuracy of the models which are used to derive future conditions. To allow the extension of forecasting to a longer time span, and to permit the detailed examination of violent small scale events, new observational methods have been developed. There are a number of operational and developmental systems for remote sensing which can be classified by wavelength.

The most familiar to most people are the millimeter waves used by conventional weather radar. Scientists at the National Center of Atmoshperic Research (NCAR) in Boulder, Colorado have gone beyond detecting simple precipitation to being able to detect hail. The general concept is similar to that of conventional weather radar. A transmitter emits a polarized, rather than unpolarized, radar beam and obtains a backscattered signal which corresponds to the amount of precipitation in an area. The difference in the system tested at NCAR lies in transmitting an initially polarized beam and measuring the ratio of polarized to depolarized return.

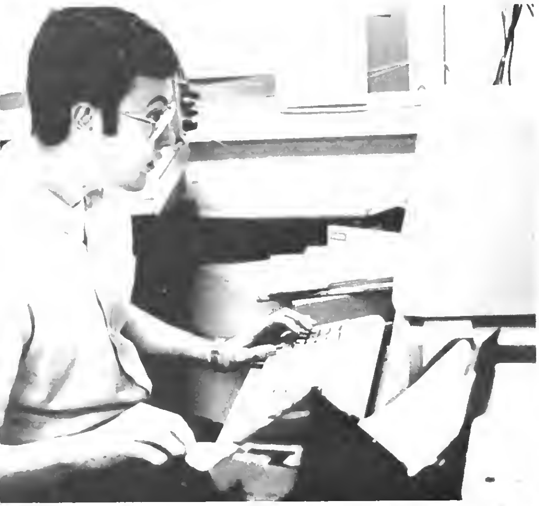
A computer is used to analyze this data, determining areas of hail production by a characteristic change in this ratio. Rain droplets are reasonably symmetrical and scatter the radar pulse uniformly, unlike the irregular hail particles. This identification allows three-dimensional plots of hail production which may someday be used to help prevent damage to aircraft, livestock, and crops.

Another form of radar which is familiar to many motorists on I-57 is doppler radar. Until recently, this technology has not been applied to weather analysis.

continued on page 13

At left are Morrill and Burrill Halls as viewed looking west from ISR during a thunderstorm *(photo by Mike Brooks).*

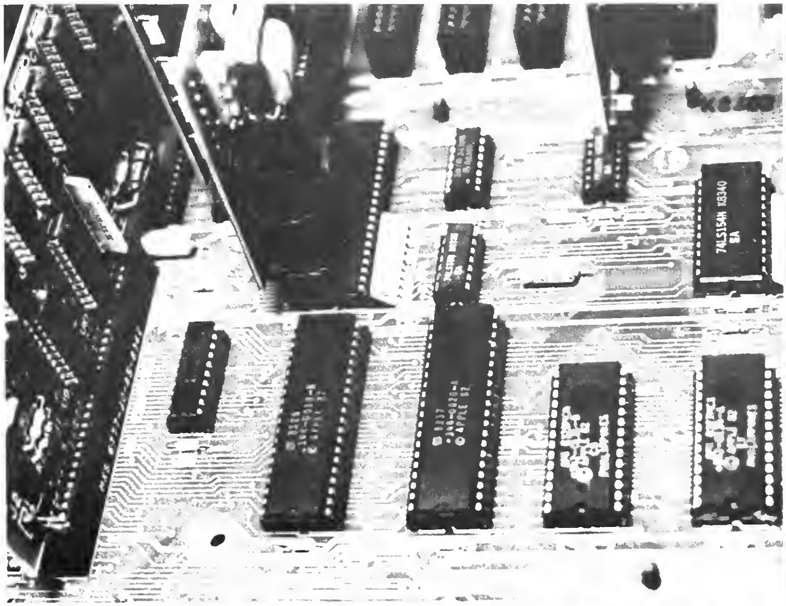
F r e d B r u n n e r




Nikon

Hitting the Bricks

Though the ceramic engineering department is one of the smallest in the College, its research is some of the broadest and most important. At left, George Carson, senior in ceramic engineering, tests material stength over time and high temperatures and then (far left) compiles the data with a computer. Counterclock wise from bottom left, data regarding the materials is used for optical components such as camera lenses, high temperature components such as the space shuttle's heat shield, building materials — concrete and masonry — like those being used by Janet Paluza, senior in civil engineering, and electronic components like this board from an Apple PC *(photos by Peter Lei and Mike Brooks, space shuttle photo by UPI, text by Mike Brooks).*



Integrating Technology and the Third World

When developing technical solutions to Third World problems, the engineer must go beyond rotely applying textbook equations and consider the sociological and cultural aspects of the situation.

At left, natives in Kenya use the river as a means of gathering water as well as medium for exchanging information *(photo by Stephen Tongue).*

Development specialist Elizabeth O'Kelly relates the story of a mission to a village in a developing country. The mission was so disturbed by the conditions that they decided to help the people there by providing them with a piped water supply. In due course the necessary piping was sent out, but when the technicians followed to install it, they discovered that it had been used to make benches for the men's meeting house. There was no need, the men said, for a piped water supply. What would the women do all day if they did not have to fetch and carry water?

Why the fuss about women? With television images of the east African famine affliction fresh in our minds, and the strains of "We Are The World" still ringing in our ears, we cannot ignore the 2/3 of the world living under the burden of poverty in the underdeveloped countries of Africa, Asia, and South America. Yet no one in these societies is affected to so great a degree as the woman. Her role is the most prominent in food production and processing and child care. In fact, a report of the World Conference of the United Nations Decade for Women noted that: "While women represent 50% of the world adult population and one third of the official labor force, they perform nearly two thirds of all working hours, receive only one tenth of the world income and own less than one percent of world property."

This reality is most acute for the woman in the typical rural Third World village. Consequently, any development for the poor which ignores the woman's role in acceptance and application of new technologies will be less effective.

What kind of technology are we talking about? Certainly not VCR's, microwave ovens, or curling irons. To meet basic human needs such as food, shelter, health, and water, one applies basic technologies. These are often referred to as "appropriate technologies." They contrast with the high tech, capital intensive answer to a technical problem we are accustomed to. Appropriate technologies reach those who daily struggle as subsistence farmers far from the reach of electrical grids, sewer systems, or microcomputers. The introduction of improved efficient wood burning stoves, small scale oil extractor/processors for local nut crops, and biogas generators are examples of appropriate technologies.

When faced with a problem, the engineer must consider the system: first defining it and then analyzing variables which may affect performance in light of basic physical laws. The engineer who attempts to tackle the problem of poverty with technical solutions must then contend with less concrete and often elusive variables such as culture, economics, politics, and aesthetics. The challenge, therefore, is multifaceted. Beyond insuring the technical integrity of a design, the engineer must

Stephen Tongue

determine whether or not the technology will be affordable by the rural woman with a typically small income, if it can withstand the rigours of humid, hot tropical environments, if the proper infrastructure of spare parts, knowledgable mechanics and properly educated users exists, and whether it will fit into the established daily patterns, traditions, and way of life.

In Siaya District of Nyanza, Kenya, a young engineer attempted to introduce a more efficient "kendo mar chwotho" (cooking stove) among the Luo people. He worked nearly six months developing the stove from a basic design of British origin. Later, while visiting one of the thatched hut kitchens, he discovered a traditional stove built by the elders of the tribe which offered nearly the same advantages as the foreign import. This traditional model was "lost" when primary schools began drawing girls away to learn math and history at ages traditionally devoted to basic home skills such as this stove. It is helpful to consider such "case studies" from those experienced on the field in order to glean a proper perspective.

Mary Keith, assistant professor of foods and nutrition, put her chemistry education background to the practical test in Paraguay, South America where she served five years as a Peace Corps volunteer. Her work in technical and agricultural development centered on the rural woman. From her experience she related an example in which well meaning volunteers built a sanitary water system where women could collect water and wash. What the engineers neglected was that washing was one of the few times of the day the women could meet socially to exchange news. The water system outlets were spread out and did not allow such congregation. Soon it was rejected by the women for the less sanitary but more "hospitable" river.

When solving problems in Third World countries, engineers should not overlook existing solutions such as this traditional Kenyan stove *(photo by Stephen Tongue).*

In another example, wells were provided for a village with keys and training given to the men, thereby limiting access by the women whose task it was to collect the water. Since the men had little at stake, maintenence of the wells was ignored and many became inoperable. Once training and access to the technology was given to the women, the wells were used and maintained to their fullest since the women had a vested interest in them.

The challenge to engineers involved in such projects is to develop sociological and anthropological sensitivities to culture. Moreover, the engineer must develop and implement the technology with the help of the local people who will in the end decide its acceptance or rejection. Most important, is recognizing the need for balanced technical development towards women, resisting the tendency to work only with the men because of the power and visiblity which they enjoy in traditional societies.

For example, if tractors are to be introduced for men to use for ploughing and planting (traditionally male roles in many societies), equal technical resources should go to the women who must cultivate and harvest the resulting larger crops with the same limited traditional hoe. Keith explains: "It is ironic that we are just now discovering that to improve the overall development of a country, we cannot ignore 50% of the population who are women and whose well-being directly affects the next generation.

On the shores of Lake Victoria, among the African Luo people who populate the rolling hills, a typical young woman, Akinyi, wakes to another day of tasks for survival. But unlike most others, Akinyi has begun to reap the benefits of small scale technologies conceived with the guidance of herself and other women in coordination with American volunteers. With a new protected well nearby, she no longer has to walk 3 or 4 miles to collect water. Much of the harvest normally lost to insects or spoilage is protected and preserved in improved crop storage systems. A low cost, locally made plow design allows the family to plant quickly when the rains start. With the extra time now, her husband has learned to make water tanks and earns an income with this skill. Akinyi has time to attend classes now and soon will be a certified village health worker, educating her peers in health and nutrition. With the vision that such benefits may reach others, the development engineer meets the challenge with appropriate technical solutions combined with sensitivity to the women whose survival and improvement depend on it. ■

Technovations

A Graphing Calculator

Finally, a calculator has appeared on the market that makes all those Math 120 problems a piece of cake.

The obvious difference between the Casio FX-7000G and other scientific calculators is its large 2.17" × 1.5" (94 by 64 dots) liquid crystal display which not only displays numbers but also graphs of functions. The calculator can graph one or more functions at the same time and can form a combined graph of several different equations. With the touch of a few buttons, the user can find absolute and relative maxima and minima, as well as the points of intersection of different functions.

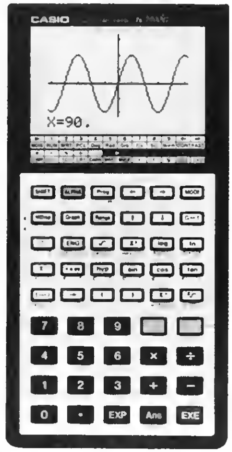
Casio also claims that the calculator is four times as fast as conventional calculators. All these features, according to Casio, make it "the ultimate problem solver."

A Computer That Understands

AT&T has developed an experimental computer system that understands plain English and remembers new words as it goes along.

The Transportable English Language Interface (TELI) answers questions that are entered in English at the keyboard. If it doesn't understand a word that is typed in, it will ask the user about the meaning and the grammatical use of the word. If the user defines the word in terms of other words already in the computer's vocabulary, the computer then "understands" the word. A new word has to be in the computer's area of knowledge, though. A computer that is programmed to know all about animals would have a hard time understanding "car" or "house".

Because it can be used by a computer illiterate or by a computer scientist, the system will undoubtedly find many applications.



A potential lifesaver for Math 120 students is the Casio FX-7000G Calculator, which is capable of graphing functions.

Supercomputers and Groundwater

The new University supercomputer is being put to varied uses. Albert J. Volocchi, professor of civil engineering, is using the machine to mathematically simulate the natural processes leading to groundwater pollution.

Research of this process in the field would take years to produce significant results. By feeding a computer certain assumptions about what happens when contaminants creep through the soil, one can determine what happens in real life. The mathematical processes involved are so complex though, that a supercomputer is needed to solve problems efficiently. Previous computers have only been able to use two dimensional models, but using a supercomputer will enable more accurate three-dimensional models to be made.

Looking Into Your Heart

Using depth-resolved magnetic resonance (MR) spectroscopy, Dr. Paul Bottomley, a physicist at the General Electric Research and Developement center in Schenectady, NY, can chemically analyze a living human heart.

Using powerful magnetic fields, radio waves and computers, MR spectroscopy detects the quantities of certain chemicals in the human body. A related technology, MR imaging, is currently being used to take pictures of internal organs and determine their chemical composition.

MR spectroscopy uses a five-ton superconducting magnet to produce a very high (1.5 Tesla) magnetic field. Scientists used to believe that at this huge a field could not yield good results. The performance of the GE system, though, disproved this misconception. The system functions by actually making the atomic nuclei of different chemicals in the body vibrate in different patterns.

Levels of certain chemicals in the heart fluctuate with the health of the organ. Until now, these levels went undetected. Dr. Bottomley has devised a technique to isolate resonance signals coming from the heart from those coming from other tissues. He can then check the levels of the chemicals present and make a diagnosis of the heart's condition.

The integration of advanced technology in physics, electronics, and computer science have put another tool at the disposal of diagnostic medicine.

Bob Janssens

Weather continued from page 7

The system has the ability to observe turbulence invisible by other means. By analyzing changes in backscattered radiation caused by differences in the radio refractive index, wind speeds and directions can be determined over a large area.

A more specialized extension of this idea is now in use at a number of major airports around the world. This involves the use of doppler radars to search for wind shear, which is the term for the sudden violent changes in wind direction and velocity caused by strong downdrafts from thunderstorms. Wind shear has been blamed for numerous air crashes, usually during take-off and landing when it may be impossible to make a correction. The ability of the doppler radar to identify quickly the size, strength, and direction of such downburst cells allows the guiding of aircraft away from such hazards, and should allow safer operation of air transport in poor weather.

Scientists do not just rely on radar waves to make measurements. Microwaves and infrared waves are also mainstays of current metereology. By studying the emissions of microwaves and infrared rays from clouds, meteorologists are able to determine the temperature of the clouds and make better storm predictions.

Instruments for detecting both kinds of radiation can be found on the Tiros series of satellites. Microwaves analyzed by the satellite can be used to determine cloud-top temperatures to within 1.5 degrees Celsius.

The resolution offered by current infrared radiometry instruments on satellites is fully capable of producing images of the Earth in various wavelengths of interest. This capability allows nighttime pictures of cloud formations to be obtained and to determine wind speeds by tracking these formations.

In addition to studying infrared light, the visible spectrum is not ignored. Lidar, or LIght Detection And Ranging, is hatching a broad new field of developing technologies in weather sensing. The uses of the laser in the field are vast and the applications numerous. Thus, we will restrict ourselves to some of the more important ones.

Lidar velocimetry is a proposed system to obtain profiles of wind speed by measuring the doppler shift of backscattered laser light from aerosols suspended in the atmosphere. Such a system should allow estimates of wind speeds from the surface to 25 km altitude. A proposed National Oceanic and Atmospheric Administration (NOAA) satellite called Windsat would do just that. One problem must be solved before this system can be fully implemented. Currently backscattered laser light is very difficult to detect with the normal bright backround of atmospheric scattering. The solution of this problem is one crucial to all methods of lidar sensing and one which makes this technology such an engineering challenge.

Lidar could also be used for other purposes. Cloud heights and composition would be obtainable, as would pressure and temperature data.

Finally, lidar techniques will be able to measure concentrations of trace constituents of the atmosphere. Using tunable lasers made of organic dyes such as rhodamine, concentrations of ozone, OH radicals, NO_2, water vapor and other compounds such as fluorocarbons can be made.

A related method stimulates various atoms or molecules with laser light, causing them to fluoresce. The sodium layer at 80-110 km is of interest to atmospheric scientists because of the information it can provide about extreme upper atmosphere temperatures and winds. Experiments to make such measurements have been performed here at the University by a group led by C.F. Sechrist, professor of electrical engineering. The group was able to get good information with the lidar system on the fluctuations in the density and altitude of sodium atoms over time. The ability of lidar systems to provide this type of data for such a large volume of atmosphere makes them extremely attractive for further development.

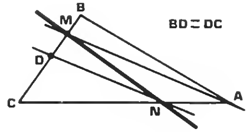
What of the future? Remote sensing technology continues to advance and to open up new possibilities for gathering different kinds of information about the atmosphere. The increasing accuracy and diversity of these data can only provide a better understanding of the weather and hopefully lead to even better forecasting of its continual course around the Earth. ■

From page 2

Tech Teaser Answers

1a. A=6, B=5
b. A=0, B=5

2. Draw line MA. Then draw a line through the midpoint of side CB parallel to MA. Label the point of this line's intersection with side AC of the triangle N. Then line MN divides the triangle into two shapes of equal area.



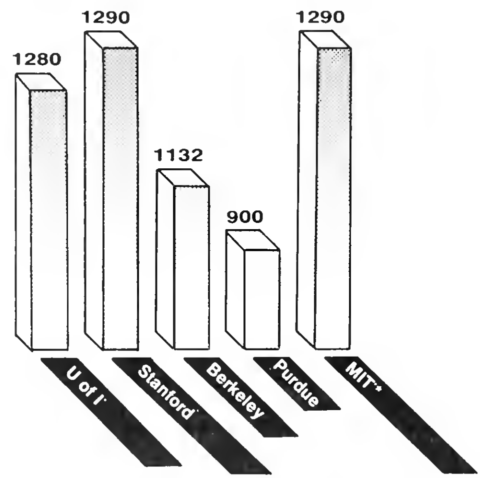
3. The number is $3^{12} \times 2^{2}$.

4. Tie a 14.5 meter rope to one bull, through the two rings and to the other bull. They will still be able to graze corners but will never be closer to each other than 1/2 meter.

Setting the Curve for Engineering Education

We complain about it to our classmates, yet we take pride in its increasing national prominence. Just how good is the undergraduate engineering program? To make a truly accurate assessment of its quality, we must look from the outside in.

Median SAT Scores of Entering Freshmen in Engineering



Score converted from median ACT of 30 which is equivalent to SAT scores ranging from 1260-1300
No median figure available. The majority of students accepted had scores ranging from 1200-1380
Sources: Universities' respective placement offices

Most University students know what Tom Cruise is talking about in "*Risky Business*" when he says, "Well, it looks like the University of Illinois." For many students, this is a "safety" school; either they were not accepted to their first choice school, or could not afford it. But for others, like Phoebe Slaughter, "I've always had my heart set on the U. of I. because of the engineering programs." First choice school or not, what exactly is the undergraduate engineering college at the University like?

"It's very competitive," says Lesley Lee, sophomore in mechanical engineering. "When my high school counselor told me it would be tough because everyone was in the top 10% of their high school class, I didn't believe him, but it's true."

It is true. In the past years the College has attracted an increasingly qualified freshman class. Since 1980, the median ACT composite score for incoming students has risen from 28 to 30. Likewise, the median high school percentile rank has jumped from the 95th to the 97th percentile. As a group, the incoming freshmen are as qualified as any other nationally. Even at such schools as Stanford and Berkeley, the median SAT scores are 620 verbal, 670 math and 532 verbal, 607 math, respectively.

While our students are comparable to those anywhere, the student to faculty ratio for the college is not. Especially at private schools, the student-faculty ratio is much lower than the 15 to 1 ratio found at the University. Students here may find themselves in classes with 50-70 people. Granted, many introductory courses are large lectures, but these numbers represent some 200 level classes as well. Frustration results. Students complain it is difficult to meet other students in their major. Education gained from student-faculty relations and peer interactions is often lost. As one professor stated, "Class sizes are ridiculous."

The department heads and the college deans recognize this and are taking action. One objective is to accept fewer students into the engineering college. Last year, 200 more students matriculated than were projected. Another plan is to add tenured faculty members. In the electrical engineering department alone, ten new professors and their supporting staff will be hired by 1990 for an increase of 11%.

In spite of the large demand for new faculty, only excellent candidates will be

Cheryl Danke

considered. The department heads who are in charge of hiring look for quality. Teaching and research abilities are most important. Other factors include publications, a good reputation in the field, and ties with industry.

Not only will these new professors ease the overload, but they will also bring fresh perspectives from industry to the College. Eventually, this means money too. When industries perceive a college to be at the forefront of a field, they will pour funds and equipment in to support research efforts. In terms of undergraduate education, this guarantees the equipment used in labs will be up to date and at industry standards. This is necessary to adequately prepare students for jobs in the "real world."

To update facilities, the state has given the College money under the Engineering Revitilization Program. While this helps, much more money is needed to run the school. To fill the gap, the College obtains funding from the private sector. As Professor Trick, head of the electrical and computer engineering department says, "We would have next to nothing without our industrial friends." In fact, with $42,849,000 budgeted for research at the college, that ranks us nationally behind only MIT ($60,440,874). Other schools with budgets between 25 and 40 million dollars include Stanford, Cornell, and Berkeley.

High rankings are impressive but what about the quality of undergraduate education? "I feel like I'm getting really well prepared." Lee states. Generally, classes are good, although a common student complaint is that some teaching assistants lack teaching and/or communication skills. All agree, however, that teaching assistants have good knowledge of their subjects. "My G.E. T.A. is great!" remarks one student.

Consistent quality is found in technical electives. To insure continuing excellence in these high level specialization courses, the administration and the faculty make a concerted effort to keep classes small. This seems to work well as these classes are the culmination of a students' undergraduate program.

First rate education extends beyond the engineering college at the University. An engineering student fulfilling humanities and social science requirements will find nationally ranked departments in nearly every field. This gives students a chance to broaden perspectives beyond technology. With the nationally growing problem of communication between science and society, these are truly valuable perspectives for an engineer to have.

Education, however, does not have to stop with required classes at the University. For those who choose to become involved, a myriad of other campus activities and student societies abound. Engineering Open House alone sets the stage for countless possibilities. For students with initiative, there are also research opportunities. Unfortunately, say professors, there is no organized program to get students involved. At schools such as MIT where programs have been implemented, as many as two-thirds of the undergraduates participate in research activities at some point in their education. As bio/electrical engineering assistant professor Bruce Wheeler comments, "Students who do not venture out of the classroom to see the research activities miss half of the University's activities and much of the novel and unique things that make us special.

Regardless of whether or not they do research, engineering graduates come out well prepared. This is best indicated by the number of companies that conduct on-campus interviews. Almost every major corporation that recruits engineering students has the University on their list, and graduates are hired quickly. As of July 23, 1985, only 7.5% of all B.S. engineering students who graduated in May '85 were still available, 56.7% were employed, 6.4% were undecided, 8.2% were involved in miscellaneous activities and 21.2% continued on to graduate school.

What is it that makes graduates special? As one professor speculates, "They're not all eggheads or have their heads in the clouds. They have good American values wih a strong midwest, farm work ethic." From the perspective of industry, Robert Brewer, University Relations Team Coordinator for General Motors says, "They're smarter (or else they wouldn't make it at the U. of I.) and well founded in engineering. They're bright, capable people." With this kind of positive response from industry, it is obvious that the College is doing a commendable job. ■

Army Lab Signs $8 Million Contract

On October 17th the U.S. Army Construction Engineering Research Laboratory (USA-CERL) awarded $8 million in task order contracts to the University.

In the past the laboratory usually would sign a separate contract every time it needed the University's cooperation. This new contract allows the Army lab to ask the University scientists and engineers to do research whenever it is needed. "Task order contracts make transferring funds to an organization for government research much easier than before," according to Colonel Paul J. Theuer, commander and director of USA-CERL. Since the USA-CERL program is growing rapidly, it is important to make contracting out work easier.

The laboratory , as one of the research and development facilities of the Corps of Engineers, conducts research in construction related areas. It gave out a total of $32 million in task order contracts to ten research institutions. The University's share of $8 million was larger than that of any other institution.

Students Named AT&T Scholars

AT&T foundation has awarded two of its 1985 AT&T Bell Laboratories Scholarships to Ph.D. candidates in the College. The awards went to Marc C. Foote, a student in physics, and David Overhauser, a student in electrical engineering.

The scholarships consist of a stipend, tuition, and funds for books and conference attendance. The students will also be given the opportunity to work at one of Bell Labs' locations during the summer. These scholarships will provide "the students with incentives and opportunities for continuing with advanced studies," said C. Kumar N. Patel, executive director of Research, Physics and Academic Affairs at Bell Labs.

The scholars were chosen from lists of students submitted by the department heads of participating universities. This year's twenty-six award winners included students in computer science, chemistry, electrical engineering, materials science, and physics at fourteen different universities.

More Equipment Donations

The University received two more substantial donations of equipment in October.

The National Center for Supercomputing Applications received almost $200,000 worth of computer equipment from Apple Computer Inc. and Sun Microsystems Inc. Apple donated twenty-five Macintosh computers along with external disk drives, printers, memory boards, manuals, and software. Sun Microsystems gave two advanced 32-bit workstations and a 72-megabyte hard disk drive. All of the equipment is intended to be linked to the center's new Cray X-MP supercomputer. According to NCSA scientist Steven Christensen, the equipment is not only destined for advanced research work. "Everybody will be using these machines, including administrators, staff, scientists, and graduate and undergraduate students," he claimed.

Meanwhile, the Coordinated Science Laboratory (CSL) received a $650,000 computer system from Gould, Inc. The Gould 9050 system is a high performance super-minicomputer. Timothy Trick, the head of CSL, said that the system, through a network of computer workstations, will be used by both faculty and graduate students for computer engineering related research. "This gift will substantially increase the computing power available to our faculty and graduate students in this important area of research," he indicated.

The last year has seen an increase in donations to the College, keeping it up in the ranks with the best in the nation.

Distinguished Alumni

The Electrical and Computer Engineering Association recently presented three distinguished alumni with awards. They selected the following people to receive the honor. Alfred Y. Cho, a graduate of the bachelor's (1960), master's ('61), and doctorate ('68) programs, is head of the Electronics and Phototronics Research Department of AT&T Bell Laboratories in Murray Hill, NJ. Donald J. Stuckel, who earned his master's degree here in 1962, is a brigadier general and commander of the Air Force Contract Management at Kirtland Air Force Base in New Mexico. Finally, Michael G. Tomasic, who has a Bachelor's degree ('66) from the University, is the chief operating officer of Kurzweil Applied Intelligence, Inc. in Waltham, Mass. The three were selected "on the basis of their accomplishments since they've received their degrees," indicated an Association spokesperson.

New Department Heads

Quite a few new department heads in the college were named recently. Norman C. Peterson from Argonne National Laboratory replaced the retiring Charles A. Wert as head of metallurgy and mining engineering. Shee-Mang Yen took over from Harry Hilton at aeronautical and astronautical engineering. Timothy Trick, already director of the Coordinated Science Laboratory, also took over the rudder of electrical and computer engineering. Finally, Roscoe L. Pershing came over from Deere & Co. to assume the position of head of agricultural engineering.

Bob Janssens

Tech *Profiles*

Kyekyoon (Kevin) Kim, professor of electrical and computer engineering, nuclear engineering, and mechanical engineering received his B.S. in Nuclear Engineering from the Seoul National University of Korea. He attended Cornell University, where he earned a M.S. in Nuclear Science and a Ph.D. in Applied Physics.

Kim came to the University in 1972 to do post-doctoral work and then joined the faculty in 1976. As the director of the Fusion Technology/Charged Particle Research Laboratory, he is involved in several research projects. These include the development of short-wavelength, high-power lasers using dense plasma focus, investigating charged particles and controlled thermonuclear fusion, and researching plasma engineering and physics. Kim is also pursuing research in cryogenic laser fusion targets, electrohydrodynamics, and a combustion-fuel injection system.

In addition to his many research projects, Kim also does consulting for the Lawrence Livermore National Laboratory, the Universities Space Research Association of NASA, and the Laboratory for Laser Energetics at the University of Rochester. He is also involved in many professional societies. Currently he is the chairman of the ICF Targets Group, a division of the NASA Electric Field Positioning Science Working Group. Kim is also the chairman of one of the committees of the American Vacuum Soceity in the Fusion Technology Division.

Although Kim is kept busy with all his research activity, he still finds time to teach at least one class a semester. Currently, he is lecturing EE 260. He has also taught classes in electromagnetics and solid state electronics. Kim says he enjoys teaching, even though most of his time is spent doing research.

Cheryl Smith

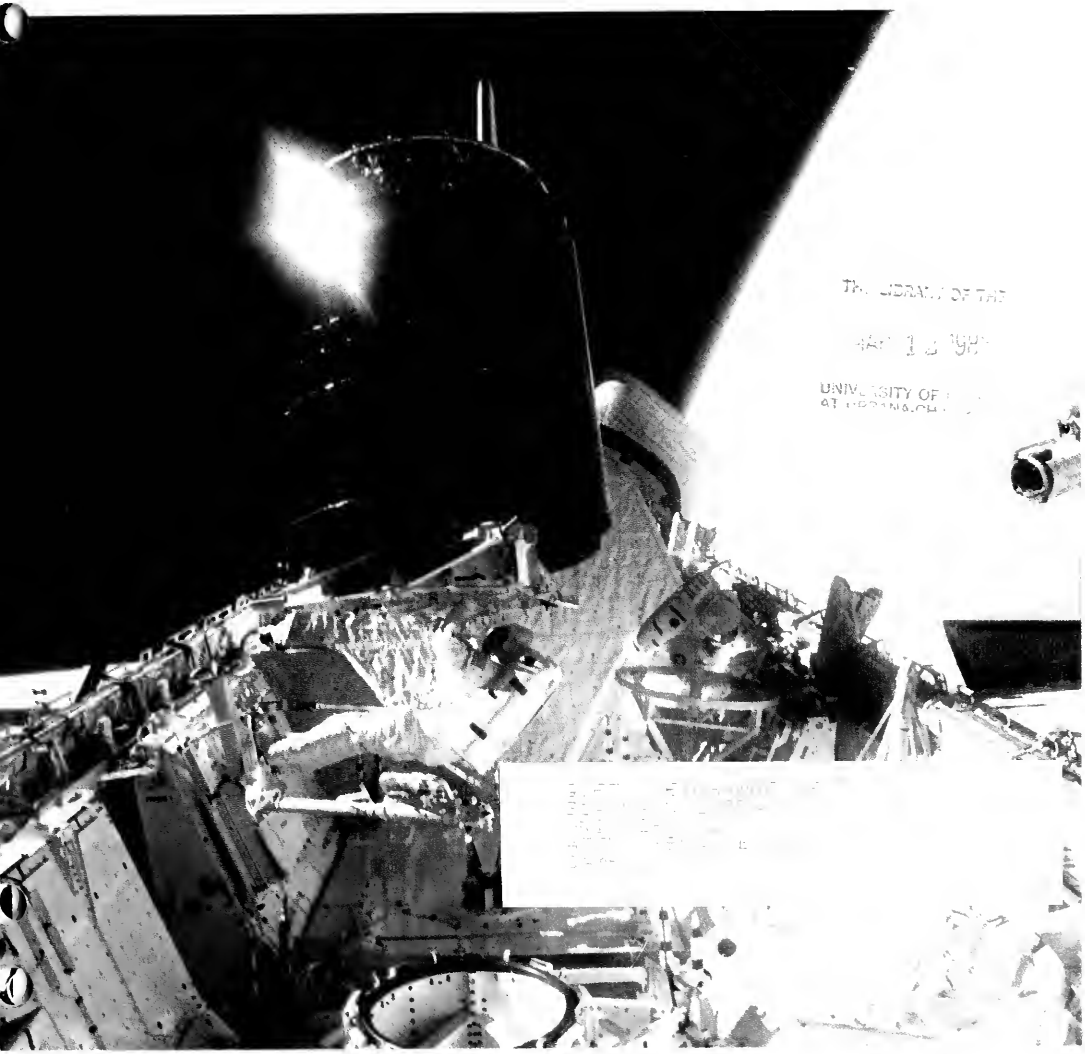
Relva C. Buchanan, professor of ceramic engineering at the University does not actually design pottery and porcelain, as many may be led to believe by his title. Rather, he works in the field of "high tech" ceramics. These exotic materials, synthesized from less elegant constituents such as impure ores and sands, are present in hidden component form in such popular devices as stereo speakers, television sets, digital watches, and personal computers.

Born in Jamaica, Buchanan began his higher education in the field of chemistry at the University of the West Indies. Soon thereafter, he journeyed to England where he learned the science of glass blowing at the University of Birmingham and Imperial College. He received his B.S. in glass technology from Alfred University and a D.Sc. from MIT in ceramic science with a minor in metallurgy.

After nine years of working in research and development for IBM, Buchanan joined the staff of the University in 1974. Presently, he is personally involved in research that delves into the preparation and development of vital electrical ceramics. Emphasis has been placed on the strength, purity, and properties of these materials. When he is not in his laboratory, the professor can be found teaching Ceramic Engineering 201 (Crystal chemistry) and Ceramic Engineering 340 (Electrical Ceramics)

In addition to being known among the relatively small ceramic engineering department of the University, Professor Buchanan enjoys recognition on a greater scale. A past Chairman of the Electronics Division and Fellow of the American Ceramics Society, Buchanan possesses several patents and has published extensively in the field. In fact, he is currently writing a book, *Ceramic Materials for Electronics*, which should be available by May, 1986. Moreover, he is a member of the American Association for the Advancement of Science and the International Society for Hybrid Microelectronics.

Scott Brun



SCIENCE/SCOPE®

The feasibility of turning sea water into electricity is being studied in fusion energy experiments at Kyoto University in Japan. The studies involve a Hughes Aircraft Company gyrotron, a microwave tube that uses a spiraling stream of electrons to produce extremely high power microwave frequencies. Fusion energy holds tremendous potential because its source of fuel (hydrogen) can be extracted from sea water. It could produce large amounts of power with little or no radioactive waste and no threat of meltdown or explosion. In fusion energy research, the gyrotron's high-power radio waves heat hydrogen particles (plasma) to temperatures of tens of millions of degrees. These particles fuse under pressure, causing a thermonuclear reaction that provides energy for driving steam turbines.

A new technique may expand the use of lasers in commercial and military applications. The approach, called optical phase conjugation, is considered a major advance in optics because it offers a solution to distortion problems that have limited the use of lasers. When a laser beam passes through a turbulent atmosphere or a severely strained optical component, the beam is distorted and the information it carries is degraded. The Hughes technique, however, forces the laser to retrace its path through the distorting medium so the beam emerges free of distortion. The method eliminates the need for complex electro-optical and mechanical components to correct the distortions.

A MIDAS touch will create the factory of the future by introducing computer technology throughout one Hughes manufacturing division. The new Manufacturing Information Distribution and Acquisition System (MIDAS) is a flexible, high-speed data communication network. It will transmit and gather millions of bits of data per day by linking computer terminals, laser printers, bar-code scanners, and other equipment. MIDAS will serve graphic workstations and facilitate paperless planning. Similarly, it will relay numerical-control programs from main computers to machines in the factory, eliminating the need for paper tape. MIDAS will let all users share important peripherals, such as a laser printer, which now is impossible due to the incompatibility of equipment from different manufacturers.

NASA's Project Galileo, which will explore the planet Jupiter later this decade, must arrive at a precise angle if it is to carry out its measurements of the chemical composition and physical state of the Jovian atmosphere. The Hughes-built probe will arrive at 107,000 miles per hour, fast enough to travel between Los Angeles and Las Vegas in nine seconds. If the probe hits at too shallow an angle, it will skip off into space; too steep, it will be reduced to ashes. Even at the proper angle, the probe will encounter extremes never before faced by spacecraft. In less than two minutes, much of the forward heat shield will be eroded by temperatures of thousands of degrees. With atmospheric entry forces reaching 360 times the gravitational pull of Earth, the 742-pound probe will take on a weight equal to an empty DC-10 jetliner. Project Galileo is scheduled to be launched from the space shuttle in May 1986 and to arrive at Jupiter in August 1988.

Hughes needs graduates with degrees in EE, ME, physics, computer science, and electronics technology. To find out how to become involved in any one of the 1,500 high-technology projects, ranging from submicron microelectronics to advanced large-scale electronics systems, contact Corporate College Relations Office, Hughes Aircraft Company, Dept. C2/B178-SS, P.O. Box 1042, El Segundo, CA 90245. Equal opportunity employer. U.S. citizenship required.

For more information write to: P.O. Box 45068, Dept. 9186, Los Angeles, CA 90045-0068

HUGHES
AIRCRAFT COMPANY

February 1986 Volume 101, Issue 4

Illinois **Techno***graph*

On the cover: Alumnus astronaut Dale Gardner maneuvers a satellite outside the space shuttle (NASA photo courtesy the University of Illinois Alumni Association).

4 **Halley's Return Engagement** *Mary J. Winters*
Historically a portent of evil, Halley's comet is once again in good graces as many await its arrival.

8 **Probing Ancient Mysteries** *Fred Brunner*
Forming a receiving line for the comet will be space probes from European nations as well as Japan and the USSR. The knowledge they garner will go a long way toward unraveling the mysteries of space.

12 **Propelling Toward the Future** *Chris Gerrib*
Today's rockets may appear to be at the peak of technological development, but work is continually being done to increase our odds of reaching the stars.

16 **Technoscope** *Ashraf Hameedi*
This month's Technoscope, Alumni Soar to the Heavens, spotlights two engineering graduates who have conquered the final frontier.

Departments
Editorial 3, Tech Teasers 3, Technotes 7, Technovisions 10, Technovations 15, Techprofiles 19

[illegible] 1986 [illegible] January, 1986 [illegible] published five times during the academic year at the University of Illinois at Urbana-Champaign [illegible] Media Co. [illegible] Champaign [illegible] Editorial and [illegible] Technograph, Room 302 [illegible] Engineering Hall [illegible] 61801, phone [illegible]. Subscriptions are available for $7.00 per [illegible] year. [illegible] Murray-Barnhill, Inc. [illegible] Broadway, New York [illegible] 10001 [illegible] Entered as second class matter [illegible] at the post office at Champaign [illegible] under the act of March 3, 1879. Illinois Technograph is a member of Engineering College Magazines Associated.

Editor *Mary McDowell*
Business Manager *Troy Brethauer*
Production Editor *Michael Lind*
Photo Editor *Mike Brooks*
Features Editor *Bob Janssens*
Copy Editor *Eric Guarin*
Asst. Copy Editor *Dee Bartholme*
Design *Charles Musto*
Asst. Design *Robert Baittie*

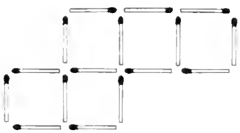
Publisher *E. Mayer Maloney, Jr.*
Production Manager *Geoff Bant*

Editorial Staff *Scott Brun, Fred Brunner, Sally Cohen, Cheryl Danke, Jeffrey Dobos, Stephen Ferree, Chris Gerrib, Gail Halley, Ashraf Hameedi, Jeff Hamera, Raymond Hightower, Steve Lotz, Andrew Koepke, Peter Lei, Jeff Mote, Steven Seaney, Cheryl Smith, Pam Susemiehl, Steve Tongue, Bill Weiss, Mary Winters, Joseph Wyse, Jay Z[illegible]*

Tech Teasers

1. Make the following correct by moving only one match.

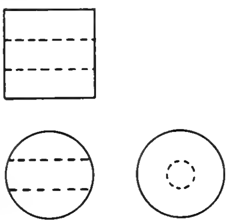
2. Move two of the matches below to make exactly four squares, one of which is bigger than the other three.



3. Complete the following sequence of numbers:

10,11,12,?,21,111,1111111

4. For all those who enjoyed GE 103 so much, here are 3 views of an object. Describe the object.



Answers on page 15

Editorial

Comic Perceptions

The scene: a professor droning on to a classroom full of students who are furiously taking notes. Suddenly, a student interupts the lecture to pose a question.

"I. . .I don't believe it," gasps the professor. "A response! I finally got a thinking response from one of you! And I thought you were all stenographers! I have a student! A student lives!"

This drama, satirized in the January 19, 1986 edition of Gary Trudeau's *Doonesbury* could have been held in nearly any classroom in the College, especially the increasingly typical auditorium sized ones. The only real distinction is that we're proof readers, not stenographers. With copies of many lecture notes available prior to class, the most a student ever has to do is make any necessary corrections and to jot down any supplementary information that the class was warned about on the first day so as to discourage excessive absenteeism. Of course with professors changing their overhead projector foils at Indy 500 rates, a student would never be able to keep up with mere pencil and paper alone.

Aside from the mechanics of notetaking and the monstrous debts incurred at Kinko's to merely keep up with a class is the very serious issue of the lack of participation by students in the lecture setting. This clearly cuts off an avenue of great learning potential. The greatest contributing factor is that many classes are just too big.

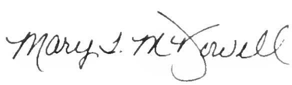
I can understand why some core requirement courses such as physics and chemistry must be taught in huge settings. This is at least offset by having quiz sections. I don't, however, think it's appropriate to have upper level courses being taught to the multitudes, especially when it's the only contact the student has with the class. Perhaps it's just that I'm in an overcrowded, understaffed major (computer science), but is it too much to ask to have a few courses in my major where the professor didn't have to use a microphone to reach the back row before I graduate?

Clearly, this type of environnment is not conducive to student-professor or student-student interaction. Some professors even discourage questions by being condescending with their replies or by not even recognizing people to call on. It's as though their rate of foil changes will be too slow if they pause to clarify anything. Even when professors do solicit questions, it's too intimidating for most students to ask a potentially stupid or irrelevant question in front of 100+ grade grubbing peers.

This problem directly affects the quality of learning in a negative way. Not only is the subject matter of the large classes not being learned as well as it could be, but there is also a carry over effect. For even in small classes where there is opportunity for participation, it seems that students are so ingrained in the pattern of being an invisible face in a sea of students that they don't even make the effort. After all, it's easier to be a proof reading automaton than to actually think about what's being taught.

It's clearly a problem that has its origins in the shortage of the high caliber engineering faculty needed and an increase in the number of students majoring in C.S., E.E., and CompE. Perhaps with the scheduled addition of new faculty members the problem will be alleviated. Perhaps limits on enrollments would help as well.

Clearly, a problem exists. The issue must be dealt with soon, for in 20 years it will be today's proof readers and stenographers who will be running the overhead projectors.



Halley's Return Engagement

A phenomenon first sighted by the ancient Chinese, Halley's comet makes its rendevous with the Earth and reawakens the American public's interest in the cosmos.

Halley's comet is back! Since it was first sighted approaching the Earth on October 16, 1982, both professional and amateur astronomers have been preparing for its historical pass across our skies. It has been 76 years since this famous comet was last seen shining in the heavens, and it is generating as much interest now as it did in 1910. Because Halley's comet has a periodical orbit ranging from 76 to 79 years, this will be the only chance many of us have to see the historic comet.

A comet is an object that resembles a fuzzy star and travels along a definite path through the solar system. Seventy to eighty percent of the comet is composed of frozen gases and water mixed with dust particles and is concentrated in its nucleus. As the comet nears the sun, some of the frozen matter sublimes and forms a cloud of gas and grit, called the coma, around the nucleus. Closer to the sun, the solar wind repels some of these particles, which stream out away from the sun to form the tail. The closer the comet is to the sun, the larger and brighter the tail becomes.

Halley's comet was named after the English astronomer Edmund Halley. It was Halley who proved that comets move according to definite laws. He collected all the recorded data on the observations of 24 bright comets which had appeared between 1337 and 1698. He then devised an arithmetical calculation for computing orbits and worked out the orbits of the 24 comets. He based his calculations on Newton's law of gravitation.

After computing the orbits of the comets, he found that the orbits of three of them, those of 1531, 1607, and 1682, were very similar. He deduced that these three comets were actually the same and

Above is the title page of *Cometa Orientalis*, which was published in 1618.

were probably also identical to one that had appeared in 1456, which had only been roughly observed. Although the intervals between the returns differed by more than fifteen months, Halley explained that this was the result of perturbations, caused by Jupiter and Saturn, of the motion of the comet. He estimated that the comet's next return would be delayed by the action of Jupiter and would appear again at the end of 1758. The comet was sighted on Christmas day in 1758. Halley had died sixteen years before, but because of the great value of his work, it was given his name.

Halley's comet is probably the best known comet because of its extreme brightness and long tail. Halley's comet, like other comets, has an elongated elliptical orbit which approximates to a parabola near perihelion. This comet is somewhat exceptional in that it has an orbit with retrograde motion, that is, an orbit with a motion opposite to the direction of motion of the planets.

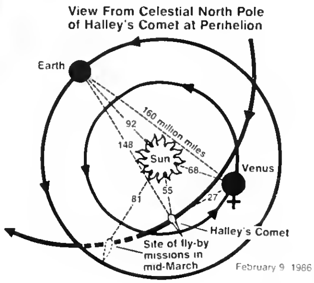
In order to increase their knowledge of comets, some astronomers have computed the times of Halley's comet's previous visits, and history shows that the comet did indeed turn up at the calculated dates. The earliest recorded sighting was in 239 B.C. Records of Chinese observers mention the event, and one such account states, "During the seventh year of Chih Shih-Huang a comet appeared to the north and during the fifth month it was seen again in the west." This corresponds to the calculations for Halley's comet. Its next passing occured in November of 163 B.C., but historical accounts of this time are rather confused. During its next appearance, in 86 B.C., the Chinese observed that "in the autumn during the second year of the Hou-Yuan reign-period, a comet appeared in the east."

Throughout history, a comet's sudden appearance was usually regarded as a precurser of evil. The passing of Halley's comet in 11 B.C. was no exception. The popular belief of the time was that the comet foretold the death of the great Roman general and statesman, Marcus Vipsanius Agrippa. Agrippa did in fact die that year.

The comet was seen as an even more terrible omen in the minds of the fearful during its next orbital revolution. The Jewish historian Flavious Josephus wrote of several prodigies which announced the destruction of Jerusalem in 70 A.D., following the rebellion of Judea against Rome. He notes, "Amongst the warnings, a comet, of the kind called Xiphias, because their tails appear to represent the blade of a sword, was seen above the city." This sword-like comet was, of course, Halley's.

Regular occurences of Halley's comet continued until 374 A.D. In that year the comet came exceedingly close to actually hitting the Earth. It passed just nine million miles outside Earth's orbit. It

Mary J. Winters



must have been a beautiful and awesome sight and visible all night long, but the observations of the time make no mention of its probable extraordinary brightness and overly long tail.

In 451, the comet was again taken as an omen. During this time, Attila the Hun was making his historical conquests all across Europe, seemingly unstoppable to all who challenged him. Then, during the summer, a great long-tailed star (actually Halley's comet) appeared in the heavens and was seen night after night. That year at the Battle of Chalons, one of the most terrible battles in history, Attila and his armies were defeated by the Roman general Aetius.

Routine appearances followed the 451 sighting with a few noteworthy exceptions. The 837 sighting was universally noted because it included the comet's closest known approach to Earth, a mere three to four million miles. When it was nearest, it crossed the heavens in just 24 hours and its tail spanned most of the night sky. The most famous apparition of Halley's comet occurred in 1066, just a few months before the Norman Conquest. It was this appearance which was included in the famed Bayeux Tapestry.

The next interesting return of the comet came in 1607. Its appearance came soon after the development of modern astronomy. European records provide actual magnitudes for the comet during this year.

Halley's comet was seen again in 1682. It was during this sighting that Edmund Halley made his valuable calculations on comets.

The 1835 and 1910 appearances of Halley's comet were used by astronomers to make physical studies of comets. The 1910 passing was unusual because it was the first time it was located using photography, and another comet unexpectedly appeared at the same time, causing confusion. Before the comet's return, it was calculated that the Earth might actually pass through the comet's tail. Because astronomers had observed the presence of a poisonous gas within the tail, rumors started which said that all life on Earth could perish when the comet passed. Publicity expanded this rumor, causing panic to occur among the general public. People actually locked themselves into their homes and stopped all the exits with rags in the hope that they could stop the lethal gas from getting in. However, the Earth passed through or near the comet's tail with no apparent harm.

Halley's comet is due to return again. Although it was seen through a 200-inch telescope in 1982, by March it should be visible to the naked eye. It could be seen with a home telescope as early as December of 1985, and will still be visible until June. The comet reaches its greatest brightness in April, coming closest to the Earth on April 10th and then fades as it moves away from us. After Halley's comet finally leaves our view, astronomers everywhere will start researching the mounds of data that will have been collected, which will probably be enough material to keep them busy until the comet's next return. For most of us, however, those few months of stargazing will be our only contact with this famous apparition. So everyone dust off their binoculars or telescopes and enjoy the sight of this brightly-glowing tailed star as it wings by on its journey through the vaults of the heavens. ■

Below is Comet Arend-Roland, photographed May 1, 1957. During the exposure of 51 minutes the telescope was tracking the comet so that the star images are drawn out into lines rather than appearing as points (photo courtesy McGraw-Hill Book Company).

Major Confusion

Engineering Council is sponsoring an "Academic Decision Seminar" for all those freshman and sophomore engineers who are undecided about the direction they wish to go in.

A lot of students do not even know what engineers in their field really do, according to Dick Welch, Academic Vice President of Engineering Council. Since engineering students can change their field of concentration with few difficulties until the beginning of their junior year, Welch believes that it is important to expose them to different educational options. The purpose of the conference will be twofold: to expose students to "real" engineers in the various fields of concentration and to help students with the selection of courses.

At press time the seminar was tentatively scheduled for late March or early April, to coincide with Advance Enrollment for the fall semester. It will consist of two nights with two hour-long sessions each night. Every department of the College will be represented in at least two sessions in order to allow students flexibility in which presentations to attend. Students can attend one session or all four. Every department's session will consist of a presentation by a speaker from industry about his job, and a question and answer session with an upperclassman in the department. Refreshments will be available after the sessions.

For more information stop by the Engineering Council office at 300 Engineering Hall, or call the office at 333-3558 or Dick Welch at 332-4040.

Faculty Members Recognized

Several members of the faculty received awards for excellence in research and teaching. Charles P. Schlichter, professor of physics, won the U.S. Department of Energy's Materials Sciences Research Competition for Sustained Outstanding Research in solid state physics. His prize is a $40,000 grant to continue his research on the properties of solids.

Professor Louis Wozniak

Gamma Epsilon, the general engineering honor society, gave its 1984-85 outstanding professor award to Louis Wozniak, associate professor in the department. The Society of Automotive Engineers gave the Ralph H. Teetor National Education Award to University professor Mansour H. Moeinzadeh. It recognizes the contribution of Moeinzadeh, assistant professor of general engineering and bioengineering, to preparing engineers for the challenges of the eighties.

LEADS Conference

The second annual LEADS conference, co-sponsored by Tau Beta Pi and the College, will take place February 14 and 15. The LEADS conference brings together legislators, educators, administrators, and students to discuss educational topics. This year's theme will be "The Effectiveness of Engineering Education." The conference is open to any student or member of the faculty in the College. Contact Kris Lang, the 1986 LEADS conference chairperson, or stop by the Tau Beta Pi office in 302 Engineering Hall for more information.

Problems in the Computer Age

Computers are having greater and greater effect on our lives every day. But many people, including scientists and professionals, have pointed out problems with the increased use of computers.

There has been much controversy lately about the health risk posed by computer video display terminals (VDT's). Data Processing Management Association (DPMA), an information management professional society, recently adopted the position that there is no evidence supporting claims of major health problems related to VDT use. The association, which consists mainly of managers that supervise VDT users, states that most health problems in their field result from "ambient lighting, poor seating, bad posture, improper furniture, etc." It claims that VDT's do not expose users to excessive amounts of radiation or "cause or contribute to stress related problems."

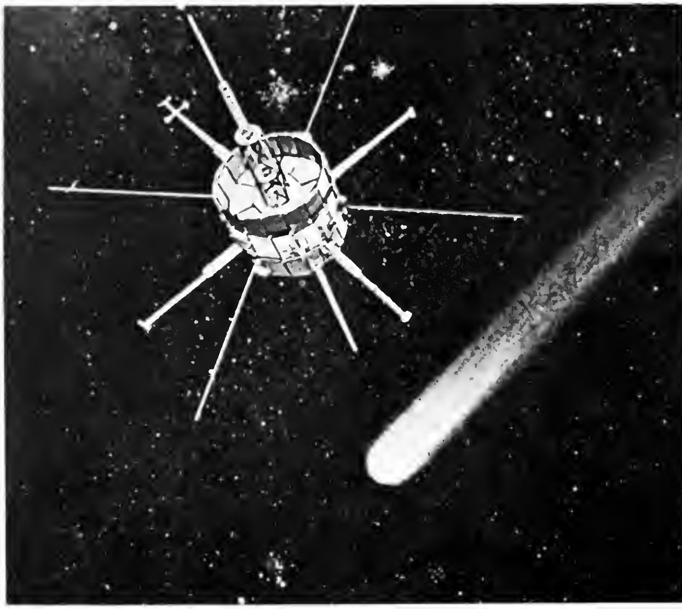
In a different area related to computers, Dr. George E. Smith, professor of philosophy and engineering consultant at Tufts University claims that computers are robbing engineers of their "gut instincts" concerning engineering design solutions. He says young engineers misuse computers by just entering data and accepting the results, without reflecting whether the computer arrived at the right result.

In an award winning paper for the American Society of Mechanical Engineers (ASME) Henry Milton Quinlan III, graduate student at the University of Georgia, expresses his opinion that the linking of computer data banks containing personal information should be prohibited by law. He points out the dangers of combining and analyzing great amounts of data about a certain person with today's powerful computers. He even goes as far as warning that the increase in use of computers could result in a society where the upper class, with access to computer-stored information, could control a lower, subservient class without access.

Bob Janssens

Probing Ancient Mysteries

The return of Halley's Comet presents scientists with a unique opportunity to learn more about the solar system. To capitalize on this event, several space probes from different countries are being sent to study this periodic wonder.



No one knows how long Halley's comet has been making its 76 year long round trips through our region of the solar system, but it surely has been for centuries. Records exist from Chinese astronomers before the birth of Christ which describe a comet whose regular reappearances mark it as the comet we know today as Halley's comet. Comets have long been considered portents of doom or disaster, and their appearance in the heavens has always been watched with great care by those who wished to be "in the know." Time has changed many things, but the desire to gain knowledge about the world we inhabit has not diminished.

Thus it is that this year, for the first time in its lonely journeys through the depths of space, that the visiting comet will have visitors of its own sent by us. An impressive fleet of five spacecraft has been sailing across the solar system for months now for a rendezvous with the comet next month. Two probes from Japan, two from the Soviet Union, and a European spacecraft will together make the first detailed contact with the comet in scientific history. This combined mission promises to yield a wealth of data on Halley's comet which will expand our understanding of the behavior of these beautiful apparitions, as well as serving as an admirable model of international cooperation.

It is reasonable to ask why it is necessary to expend such effort on examining what is essentially a giant snowball in space. Snowballs are quite easily produced here on Earth, and usually don't receive such a grand reception when they arrive in the vicinity. Comets are thought to have been formed at around the same time that the solar system as a whole was formed from the primordial planetary nebula. Being at great distances from the newborn Sun, these iceballs never experienced significant heating and it is believed they may retain the composition of the nebula which they and our own planet condensed from.

Millions of comets exist in the far outer fringes of the Sun's gravitational reach, preserved in the cold and vacuum of deep space in a giant region called the Oort cloud, after the Dutch astrophysicist Jan Oort. Occasional perturbations by other passing stars divert some of these into long hyperbolic descents toward the Sun. Most are then flung into interstellar space, but a few are captured by the gravity of the giant planets Jupiter and Saturn and become trapped in the inner solar system, becoming periodic comets.

About 700 periodic comets are known, of which one of the most reliable and spectacular is p-Halley (p- meaning periodic). The relative sparseness of this population is easily explained. The Sun is very hot, and ice evaporates readily. The uneveness of the outflow from the nucleus is also believed to produce an unpredictable jet action pushing the comet about and varying its orbit. One unlucky victim has even been observed to strike the Sun. It is believed that all periodic comets have relatively limited lives, ending finally as meteor clusters traversing the comet's old orbit.

Beyond this, there is some directly relevant information that may be obtained from a study of comets. Some comets

Fred Brunner

approach the Earth quite closely, and many cross its orbit. While the 3-6 km diameter nucleus of an average comet is small by planetary standards, a hit by a comet would unquestionably produce major havoc. It is in fact one of the more probable explanations of the Tunguska event of 1908, in which some force caused a vast explosion deep in Siberia which leveled trees over an area of hundreds of square miles. The lack of any real impact crater suggests that a small comet or cometary fragment may have broken up during atmospheric heating and caused the devastation. A similar occurrence today would probably kill many people.

Some scientists believe that cometary bombardment during the early years of the solar system may have provided much of the atmospheres of the Earth, Mars and Venus, and possibly even organic materials for the beginnings of life here – and elsewhere. There is little debate that comets deserve serious examination.

The spacecraft carrying out the task of making the detailed exploration of the composition of a comet are a varied lot. In fact, the U.S. probe with the honor of making the first flyby of a comet was never intended to leave the Earth's orbit at all. The odyssey of the satellite ISEE-3, renamed "ICE," somewhat tongue in cheek, for International Cometary Explorer, is one of the strangest in space history. Budget cuts and difficulties with obtaining sufficiently powerful boosters to meet the Halley rendezvous date forced NASA to scrap plans for its own Halley flyby mission.

As a substitute, Robert Farquhar, a member of the scientific team for the International Sun-Earth Explorer (ISEE-3) suggested that the satellite, originally launched to study the solar wind, geomagnetic tail, and plasmas in the Earth's neighborhood would be usable for studying the plasmas and fields around a comet. ISEE-3 was then maneuvered through a complicated series of flybys of the Earth and Moon which provided enough velocity to kick the eight-year old satellite successfully on a trajectory which took it through the tail of the comet Giacobini-Zinner, about 8000 km behind the nucleus.

ICE confirmed several predictions made about the unusual field structure around a comet, including the draping of interplanetary field lines around a comet. The spacecraft also detected carbon monoxide, water, and a small amount of dust. The flyby also raised new questions, because the spacecraft's instruments found a very complex plasma environment in the tail, as well as the lack of a well-defined bow shock as expected at the interface between the comet's field and the solar wind. These findings should allow the current armada approaching Halley to look for specific explanations for these observations, as well as to provide comparison data from a different comet.

A more detailed description of the purpose-built probes currently approaching Halley's comet is in order. The two Japanese probes, Sakigake and Suisei, carry no imaging equipment and are intended to make plasma and magnetometer measurements of the undisturbed solar wind at the time of the encounter, and to examine the tail and surrounding cometary environment much as ICE did. Suisei carries in addition a Lyman-alpha spectrophotometer to examine the immense envelope of neutral hydrogen which seems to surround all active comets. All spacecraft at Halley will provide complementary data, and, as they are timed to arrive within a few days of each other, they will permit time and spatial resolved measurements.

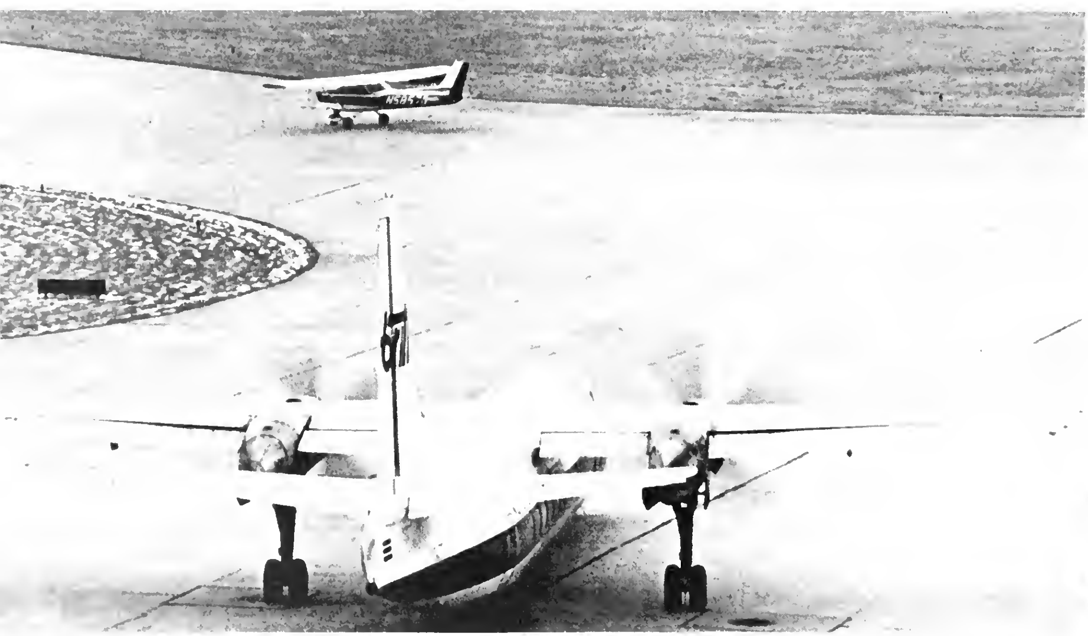
The Russian Vega 1 and 2 probes are identical and carry a host of instruments to examine Halley. They have high resolution spectrometers to observe the gaseous coma, as well as reflectance infrared instruments to observe the emission properties of the dust and hopefully determine its composition. They also carry mass spectrometers for examining the composition of the gases of the comet. Additionally, the Vegas have sensitive charge-coupled device cameras for imaging the nucleus itself, which has never been seen before. Vega 1 will flyby Halley at about 10000 km distance, while Vega 2 may proceed as close as 500 km in front of the nucleus, to provide targeting data for the European Space Agency probe.

The European Space Agency has perhaps the most sophisticated probe of the five with its Giotto spacecraft, as well as the most ambitious aim. Giotto will be aimed at the sun side of the nucleus for a flyby distance of just 300 km. Although both Giotto and the Russian Vegas have dust shields, they are making their approach to Halley at almost 70 km/sec due to Halley's retrograde or backward orbit. A strike by even the small centimeter-sized particles known to exist around the nucleus would probably destroy the spacecraft. Assuming Giotto survives its approach (as it is expected to do), it will bring to bear its own mass spectrometer, plasma instrumentation, and a CCD camera. This camera has the challenging task of locating and tracking the nucleus from the spin-stabilized Giotto, turning at 15rpm. At closest approach, Giotto should be able to see details 30 m across in four colors, assuming that no excessive levels of gas and dust obscure the surface. Giotto will also perform dust analysis, by penetration, acoustic, and plasma sensors on its forward surface.

This has been just a brief view of the quarry and the hunters which will meet for a few hours in March. The combined insight garnered by these spacecraft will add immeasurably to our understanding of these bright celestial wanderers, the comets, as well as providing a fitting tribute to the best known of the "hairy stars", Halley's Comet. ■

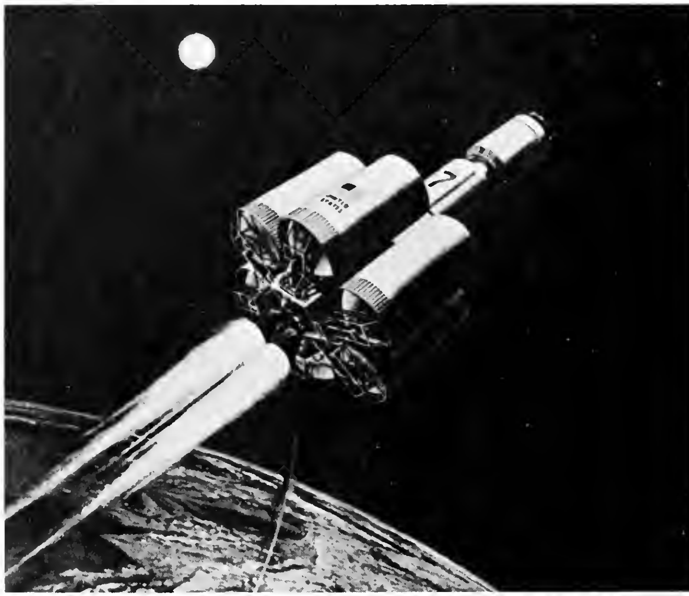
Safer Skies

On a busy day, most major airports, like the University of Illinois-Willard Airport, seem to be utter chaos. In reality, a high degree of order is maintained by a small group of air traffic controllers. Working from the tower (at left), they separate aircraft both large and small (below), either by sight or with radar (at right) *(Photos and text by Mike Brooks)*.



Propelling toward the Future

Although the space shuttle has been on 24 successful missions, the recent tragedy highlights the need for yet improved space travel. Future ships will explore the issues of economical means of entering orbit and interplanetary travel.



Above is a concept of an advanced Orbital Transfer Vehicle which is used to transfer payloads to higher Earth orbits (photo courtesy *Aerospace Magazine*).

At left is one concept of an advanced heavy lift booster system based on the space shuttle's two solid rocket boosters. The center booster, not firing at Earth liftoff is an upper stage; it also contains the payload (photo courtesy of *Aerospace Magazine*).

We are fascinated with space. *Star Wars*, *2010*, *Dune* and other movies all have cashed in on this fact. Science fiction is on the hardcover best-seller list. The first tenative steps into space are being made.

But how do we get from here to there? In science fiction when the characters want to go somewhere, they just say,"Warp factor 1, Sulu," or "Take her up, Chewie." In real life, it's not so easy.

Of course, scientists and engineers have been searching for better methods since 1903, when Russian Konstantin Tsiolovsky theorized that a hydrogen/ oxygen fuel mix would be optimum for space travel. The search involves work from quantum physics to applied aerodynamics, and everything in between. Research has been directed at two main topics: how to get from the ground to orbit cheaply and how to get from Earth to another planet and back before senility sets in.

Entering orbit requires a vast amount of energy in order to escape the Earth's gravitational pull. The challenge here is to find a highly efficient, economical fuel. Fuel efficiency is measured in I_{sp}, which is dependent upon the chemical and physical properties of the fuel.

Rocket fuel cannot be explosive, but it must be highly flammable. An explosive, such as TNT, undergoes a violent chemical change producing an extremely fast gas cloud. With gas speeds of 3000 meters/second, a jarring or shattering effect is produced. What is needed is a slower gas cloud to lift the rocket. Gunpowder, which burns (not explodes) is an example, having a gas cloud velocity of 300 meters/second.

Rocket fuel must also be stable and non-reactive enough to handle. Flourine is an efficient oxidizer, however, it is almost too reactive to store or use. Hydrogen and oxygen became and remain the best combination to date.

Early researchers (1920-1950) attempted to find the "sweet combination" or most efficient fuels for a rocket. This was risky business, as fires and explosions maimed researchers.

Researchers tried literally thousands of different chemicals as fuel or oxidizer. One tried nitroglycerin "tranquilized" with methanol. Another used pure carbon with oxygen. Robert Esnault-Pelterie lost four fingers working with tetranitromethane. Some engineers tried lemon oil and furniture polish as an oxidizer. These attempts failed as the chemicals

Chris Gerrib

used proved to be explosive, not flammable, or just too unstable.

Many aspects of the fuel problem have been dealt with through NASA's efforts on the space shuttles. While the liquid hydrogen and liquid oxygen fuel is incredibly dangerous, it has a high I_{sp} of 450. No other practical craft in use today has a higher I_{sp}.

British Aerospace and the U.S. Air Force among others are looking into a hypersonic ramjet. If a hydrogen-fuelled ramjet is accelerated by another plane or auxiliary jets to start its engine, it could reach low earth orbit. According to an Air Force spokesman, freight costs would drop to "a tenth or a hundredth" of present costs for using conventional runways for takeoff and landing. We may see these flying by the year 2000.

An interim idea, popular in the 1950's, is the Big Dumb Booster, or BDB. It is a huge, light, and unmanned rocket used for freight hauling. A more modern concept is laser boosting. Here one uses a ground-based laser to vaporize water or similar liquid inside the rocket lifting off. Laser boosting offers a one-to-one fuel/payload ratio, but requires a gigawatt laser to lift one ton. Obviously, initial costs are high.

After the establishment of a cheap way to get into orbit, the planets still beckon. The relatively great distance from the Earth makes conventional engine use impractical. Improved engines are necessary to make travel time shorter.

Scientists have been busily working on new engines. In the 1950's, the nuclear rocket was proposed. NASA, during the 1960's, started a program to build one. NASA's Nuclear Engine for Rocket

continued on page 14

Future continued from page 13

Vechicle Application (NERVA) program actually built and tested a nuclear engine. NERVA was a hydrogen-cooled nuclear reactor running as hot as possible without melting down. It had an I_{sp} of 850. Its coolant was vaporized and shot out the back.

Like all nuclear reactions, this one produced radioactivity. Shielding nessesary to prevent the crew from glowing cut the I_{sp} to 650. Due to a number of factors, it was hard to steer, slow to start and stop, and generally difficult to handle.

Another tested drive system developed in the 1950's is the ionic drive. It is another system that has been around since the 1950's. The general principle is to take a gas like argon or a metal like mercury and electrically ionize them. Resulting ions are electrically or magnetically expelled out the back. Ionic thrust is small but continuous, thus allowing constant acceleration. Final velocities can be quite high, so mission times are relatively short. As ionic drives have been tested, they could find extensive use.

Another idea, although based on an old principle, was realized only in the 1960's. One of the first communications satellites launched was a "passive" satellite. It was a large silvered balloon off which signals were bounced. Its only problem was that it slowly drifted out of orbit. Engineers realized that it was light pressure moving the balloon. Thus, the solar sail was born. These devices have cheap "fuel" (light) and continuous thrust. However, speeds are slow and sail areas are large. As a general rule, it takes a square kilometer to move one ton. These large sail areas are not ideal for experimentation. With work, money, and time, they may become great unmanned bulk-cargo haulers.

Another famous idea is the fusion rocket. One simply builds a fusion reactor with a hole in the rear for the heated plasma to escape. Theoretical I_{sp} for such an engine is one million.

An artist's conception of the Centaur G upper stage system is shown with Galileo spacecraft following its deployment from the space shuttle cargo bay.

Two problems come to mind. One, no one has achieved controlled fusion. Two, no one knows how to convert a reactor into an engine. These minor technicalities have not stopped the ship planners. Maximum speeds of 10 percent of the speed of light are projected. With 50,000 tons of fuel and 50 years, one could be orbiting Alpha Centari. When could we have these engines? As many scientists doubt fusion will be practical anytime in the next half-century, its anyones guess.

As mentioned earlier, fusion consumes large amounts of hydrogen. As a way of making interstellar voyages more economic, scientists developed the interstellar ramjet concept. Generally speaking, the ship would use a magnetic scoop to gather up interstellar hydrogen and use it for fusion. This idea has become as important to science-fiction writers as hyperspace and warp drives.

Unfortunately, interstellar hydrogen is very diffuse, averaging about one molecule per cubic centimeter. Thus, magnetic scoop sizes of one million kilometers to *one-half lightyear* in diameter have been proposed. Drag and energy loss incurred in making and moving these flying billboards would be vastly higher than they could generate.

Even more exotic drives have been proposed. One of the best is the Matter Anti-Matter (MAM) drive, which utilizes the concepts of particle physics. Matter, at the subatomic level, is held together by a "glue" of smaller particles. Anti-matter is held together by an "anti-glue". The glues are mutual solvents. If one combines the two, all matter is converted into energy. Theoretical I_{sp} exceeds 5 billion.

Presently, no one knows how to make enough anti-matter to do any good. We can only make a few thousand anti-protons at a time, and store them for only a few days. Also, the accelerators to make anti-matter are too big and slow to be of any use in space.

Once the grandchildren of today's engineering students solve these problems, some other interesting difficulties will arise. All of the matter reacted becomes energy. Half of this is in the form of gamma rays and light, causing problems when the engine is pointed at civilization. The other half is composed of neutrinos, which go through planets unscathed.

One last interesting thought is that many present and proposed devices rely on light metals such as aluminum and titanium, substances found in relative abundance on the moon. Perhaps in the future the moon will be the true hub of space activity. In the meantime, possibilities abound. Perhaps some day some of them will be realized. ■

New High Resolution Monitor

Wyse Technologies recently introduced a monitor for the IBM PC and compatible computers that for the first time combines high resolution graphics display with full IBM PC compatibility.

The WY-700 graphics subsystem consists of a 15 inch monitor and graphics board that can display 1280 by 820 pixels. The new monitor is expected to find applications in the computer-aided design and computer-aided publishing fields. It uses a bit-mapped graphics board that inserts into one slot in the PC. Although it is a monochrome monitor, it will map color output into four shades of grey.

Guy Wires Allow Taller Oil Rigs

At the mouth of the Mississipi River, Exxon Corporation operates the first commercially successful guyed tower drilling platform. Its design, which radically differs from that of a regular oil rig, allows it to operate in 1,000 feet of water.

Conventional drilling towers are designed to withstand swaying caused by the forces of waves and wind. They are wide at the bottom and narrow on top and secured by long steel rods driven deep into the continental shelf. Their structure is very rigid and can withstand great forces. But these towers, because they are big and heavy, become impractical at a height greater than 1,300 feet.

The construction of the Mississipi Canyon 280-A platform is completely different. It is connected to the sea floor by twenty wire cables that fan out on all sides. Each is attached to the bottom by 130 foot long spikes, 3000 feet away from the 1000 foot tall tower. At about the middle of every wire a 200 ton weight keeps it down on the sea floor. Its great advantage over conventional drilling towers is that it, instead of being rigid, actually moves with the wind and wave forces. As pressure is applied to one side, the weights on the lines on that side are partially lifted. The other wires slacken and the tower reaches a new equilibrium.

The new technology will allow oil rigs in the future to operate in up to 2,500 feet of water.

"Non-Penetrating" Highlighter

Sanford Corporation, a maker of pens, markers, and stationary supplies, recently introduced a new "quick reference pencil" (highlighter) that highlights without bleeding through the page.

The instrument looks like a mechanical pencil, except for the lead, which is about an eighth of an inch thick and has a consistency somewhere between that of a crayon and a pencil eraser. Two disadvantages of the pencil are that it does not mark as wide a line as regular highlighters and that it causes more friction between the lead and the page. It should be very useful, though, for highlighting thin papers such as carbonless copy paper, fax paper, and the paper used in phone books, Bibles, and engineering texts. The leads have to be replaced regularly.

Intel Introduces New Microchips

Intel Corporation recently announced two new products that have distinct advantages over earlier versions.

It introduced the 80186-12 microprocessor, a version of the 80186 microprocessor that is up to twice as fast as its predecessors. The chip performs faster during all of its operations, including memory access and input/output. Like all of the earlier versions, it combines a central processing unit and the equivalent of twenty other components on one chip.

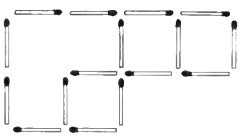
Intel also announced a new type of packaging for its high density EPROM's (Erasable Programmable Read Only Memories). Most microchips are housed in the familiar ceramic dual-in-line packages (DIP's). The new packages are of the plastic leaded chip carrier (PLCC) type. They are flatter and smaller than DIP's and can be mounted on the surface of printed-circuit boards. The surface mount technique allows the positioning of devices on both sides of a circuit board and requires no holes in the board. They are also superior because they can, unlike ceramic DIP's, "withstand the harsh handling of automatic test and assembly equipment." Their durability makes them perfectly suited for telecommunications and automotive applications. Intel will keep on repackaging its components, and hopes to have a whole kit of PLCC components available.

Bob Janssens

Tech Teaser Answers

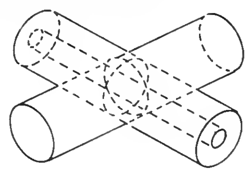
1. The square root of 1 is 1.

2.



3.This is the sequence 7_7, 7_6, 7_5, ?, 7_3, 7_2, 7_1 where 7_n represents 7 expressed in base n. Therefore, the missing number is $7_4 = 13$

4. The intersection of two cylinders of equal radius, one of which has a hole drilled through the center.



Alumni Soar to the Heavens

Dale Gardner (left) holds a For Sale sign on a satellite which had been stranded since its initial deployment. Aiding in the recovery is Joseph P. Allen IV (NASA photo courtesy the University of Illinois Alumni Association).

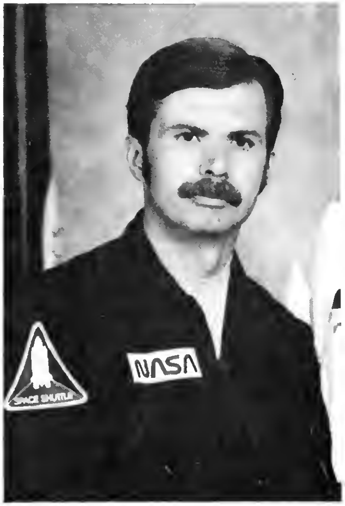
Among the most prominent of Illinois alumni are astronauts Dale Gardner and Stephen Nagel who helped propel the knowledge of space on their respective space shuttle missions.

When Dale Gardner blasted off into space on August 30, 1983, as a mission specialist aboard the Space Shuttle Challenger, it was indeed an historic step forward. Historic, not in the sense that he was part of the first shuttle crew, for a number of astronauts had by that time preceeded him, but historic in the sense that Gardner became the first University alumnus to trek into what has been called "The Final Frontier." By doing so he gained membership to the exclusive club of pioneers who have ventured out into that uncharted wasteland called space.

If Gardner was the first Illini, he was by no means the last. On June 16, 1985, Stephen Nagel, also a University graduate, was lifted into space aboard the Space Shuttle Discovery. Both have since had the opportunity to revisit the "Frontier", Gardner aboard the Discovery on November 8, 1984, and Nagel aboard the Challenger on October 30th of last year. In fact, accompanying Nagel on this subsequent flight was Bonnie Dunbar, a biomedical engineer and mission specialist for NASA, who studied ceramic engineering as a graduate student at the University from 1971-72 and later completed her work at the University of Washington.

In their days of fame, the two astronauts have not forgotten their roots at the University. When NASA asked each to collect small memorabilia to take with them into space, both solicited the University for contributions. Gardner carried with him on his first flight a tiny piece of beta-aluminum film bearing the words "Illinois" and "USA". The film is note-

Ashraf Hameedi



The alumni astronauts are, from left to right: Dale Gardner ('70), Steve Nagel ('69), and Bonnie Dunbar (NASA photos courtesy the University of Illinois Alumni Association).

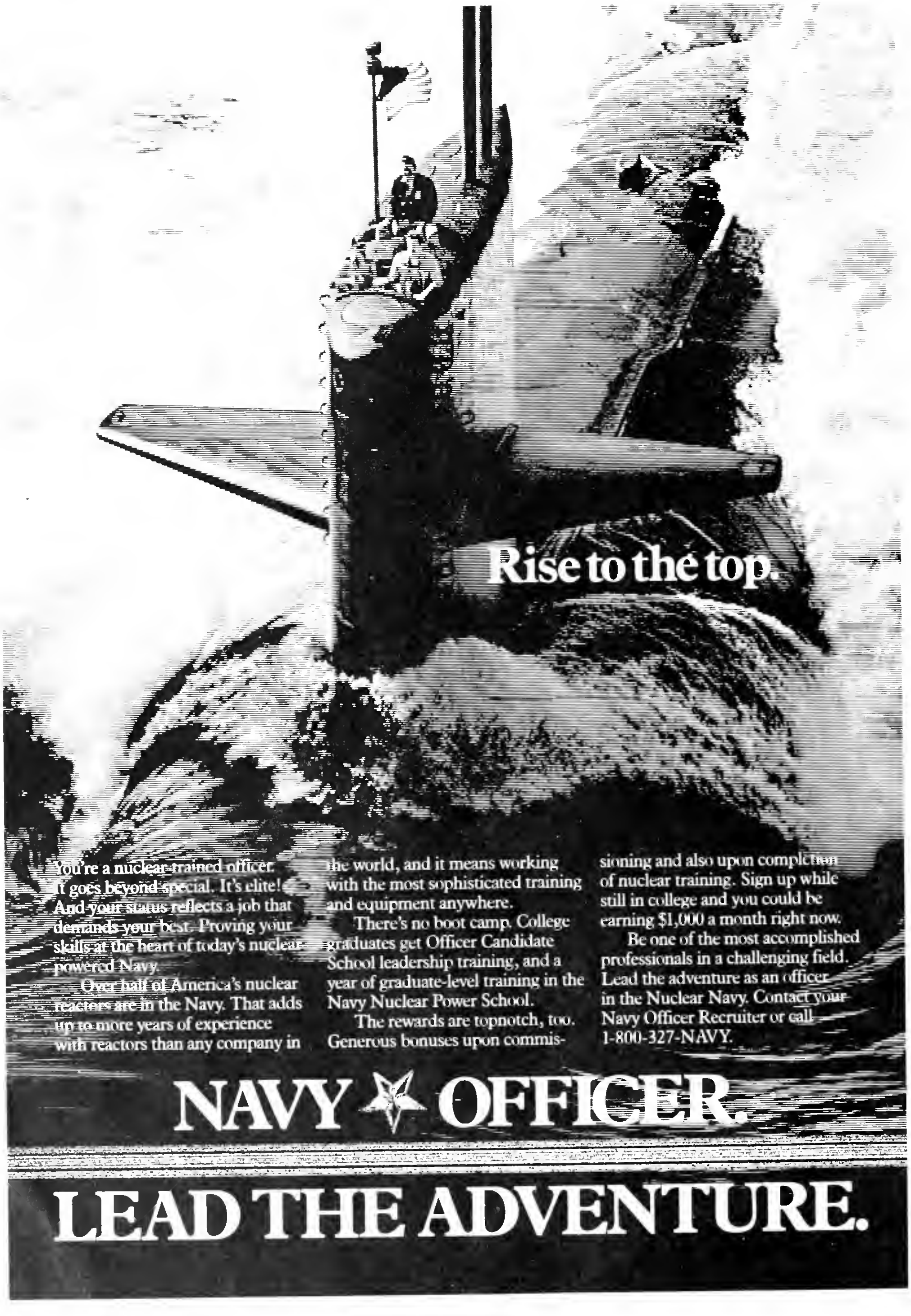
worthy because the holes and lines used to spell these two words are considered to be the world's smallest—only twenty angstroms in diameter. They were made here at the University by research metallurgist Margaret Mochel as part of a course in basic research. Gardner, a 1970 graduate in engineering physics, also carried with him a small niobium rod used as a probe in the University's superconducting linear accelerator. The niobium rod was chosen in particular to honor faculty physicist John Bardeen who shared one of his two Nobel Prizes for developing the theory of superconductivity.

While Gardner's momentos recognized the contributions of a few, Nagel aggrandized the contributions of us all. With him on his last flight was a roll of microfilm bearing the names of all students, alumni, faculty and staff of the College. Nagel, himself a 1969 graduate of aeronautical and astronautical engineering, is listed on the microfilm as are 40,781 others who have received bachelor of science degrees in engineering since 1872 and the 5,219 undergraduates who are currently enrolled in the College.

Certainly NASA did not invest seven billion dollars in the space shuttle program just so that momentos of cherished institutions could be carried into space. Each mission entailed countless experiments and activities that NASA hopes will justify the herculean investment that this country has made in the shuttle program. The most breathtaking of events was Gardner's six hour space walk to retrieve two malfunctioning communications satellites on the November 8th mission. Transported by nitrogen-powered backpacks, he and astronaut Joe Allen maneuvered the twelve-hundred pound satellites into the cargo bay of the shuttle, after the brackets designed to fish the satellites failed. The satellites, each worth $35 million, will be repaired and resold. In addition, the recovery allowed NASA to collect on a $5.5 million insurance payment.

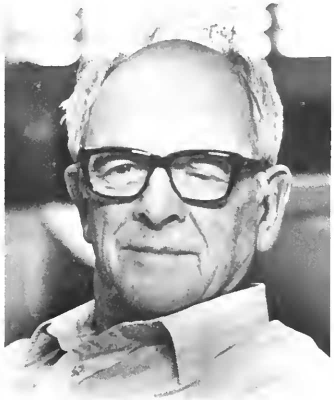
While Nagel's missions have lacked the man-in-space bravado of Gardner's space walk, his last mission did carry a payload of experiments designed, controlled, and executed by scientists in Germany. The mission gained an added international flavor when a Saudi Arabian satellite was flawlessly spun into orbit as a Saudi prince watched from inside the shuttle.

Two Illini have thus made the journey and countless others are sure to follow. Dale Gardner claims that because the only real qualification necessary for space shuttle astronauts is that they be in good health, NASA is very interested in recruiting for future missions writers, artists, photographers, and other "persons who can bring back something to convey the sense of how it is." ■



Rise to the top.
You're a nuclear-trained officer. It goes beyond special. It's elite! And your status reflects a job that demands your best. Proving your skills at the heart of today's nuclear-powered Navy.
Over half of America's nuclear reactors are in the Navy. That adds up to more years of experience with reactors than any company in the world, and it means working with the most sophisticated training and equipment anywhere.
There's no boot camp. College graduates get Officer Candidate School leadership training, and a year of graduate-level training in the Navy Nuclear Power School.
The rewards are topnotch, too. Generous bonuses upon commissioning and also upon completion of nuclear training. Sign up while still in college and you could be earning $1,000 a month right now.
Be one of the most accomplished professionals in a challenging field. Lead the adventure as an officer in the Nuclear Navy. Contact your Navy Officer Recruiter or call 1-800-327-NAVY.
NAVY OFFICER.
LEAD THE ADVENTURE.

Tech Profiles



Bruce A. Conway is an assistant professor in the department of aeronautical and astronautical engineering. He is currently teaching the undergraduate courses of Aerospace Dynamic Systems I and II, AAE 254 & AAE 255, and Orbital Mechanics, AAE 306. Professor Conway is also teaching a graduate course in Optimal Control Theory, AAE 404. He is planning a graduate level course in orbital mechanics for the near future.

Conway received his undergraduate degree in physics and math from Macalester College in St. Paul, Minnesota. He went on to receive his master's in physics and math from the University of Minnesota. From the University of Minnesota he went to Stanford and received his graduate degree in aeronautical and astronautical engineering. Finally, Conway received his doctorate from Stanford in 1980.

Conway's research involves the orbital evolution of natural satellites. By applying the laws of celestial mechanics and orbital motion, Conway predicts the orbital decay of objects such as moons and satellites. On a larger scale he is able to theorize how orbits could have changed over the evolution of the solar system. The arrival of the Cray X-MP Supercomputer will greatly aid his research by supplying helpful speed to his calculations.

In his spare time Conway enjoys an active family life, spending as much time as possible with his two and a half year old son, Charles, and his wife Linda. He also holds a commercial pilot's license with an instrument rating and frequently travels to give lectures at meetings around the country.

Steven P. Seaney

Allen I. Ormsbee, professor of aeronautical and astronautical engineering, pursued a boyhood interest in model airplanes to become Acting Associate Director of the Institute of Aviation. Ormsbee's ties to the University go back to the 1940's when aeronautical engineering was a new curriculum. Prior to World War II, only a few universities offered this study, but the war effort served as an impetus for aeronautics programs on a wider scale.

Ormsbee finished his B.S. degree in aeronautical engineering in 1946. His graduate degrees include a master's in mathematics from the University and a doctorate in aeronautics from California Institute of Technology. He then returned to the University and began teaching and conducting research.

With the post-war attention toward high speed aerodynamics, Ormsbee's research dealt primarily with supersonic flows. During this time, he was an active consultant to missle programs. In the mid-1960's, his interest shifted towards low speed aerodynamics with special attention to airfoil design.

Ormsbee is also active as an instructor and teaches graduate courses in wing theory and compressible flows as well as undergraduate courses AAE 199 (Freshman Seminar) and AAE 212/213 (Aerodynamics). Currently he lectures AAE 199 and 311

As he looks toward the future, Ormsbee is pursuing research possibilities in hypersonic flow. While this field has been studied for its relevance to the re-enty problems of manned space flights and ballistic missiles, exciting new applications are on the horizon for sustained flight at hypersonic speeds. Currently, his department is pursuing research proposals by NASA which point towards hypersonic aircraft.

At a more leisurely pace, Ormsbee enjoys soaring with the Illini Glider Club in nearby Monticello. Along with his wife, Ormsbee likes to travel, particularly on the trail with backpack and hiking boots.

Stephen Tongue

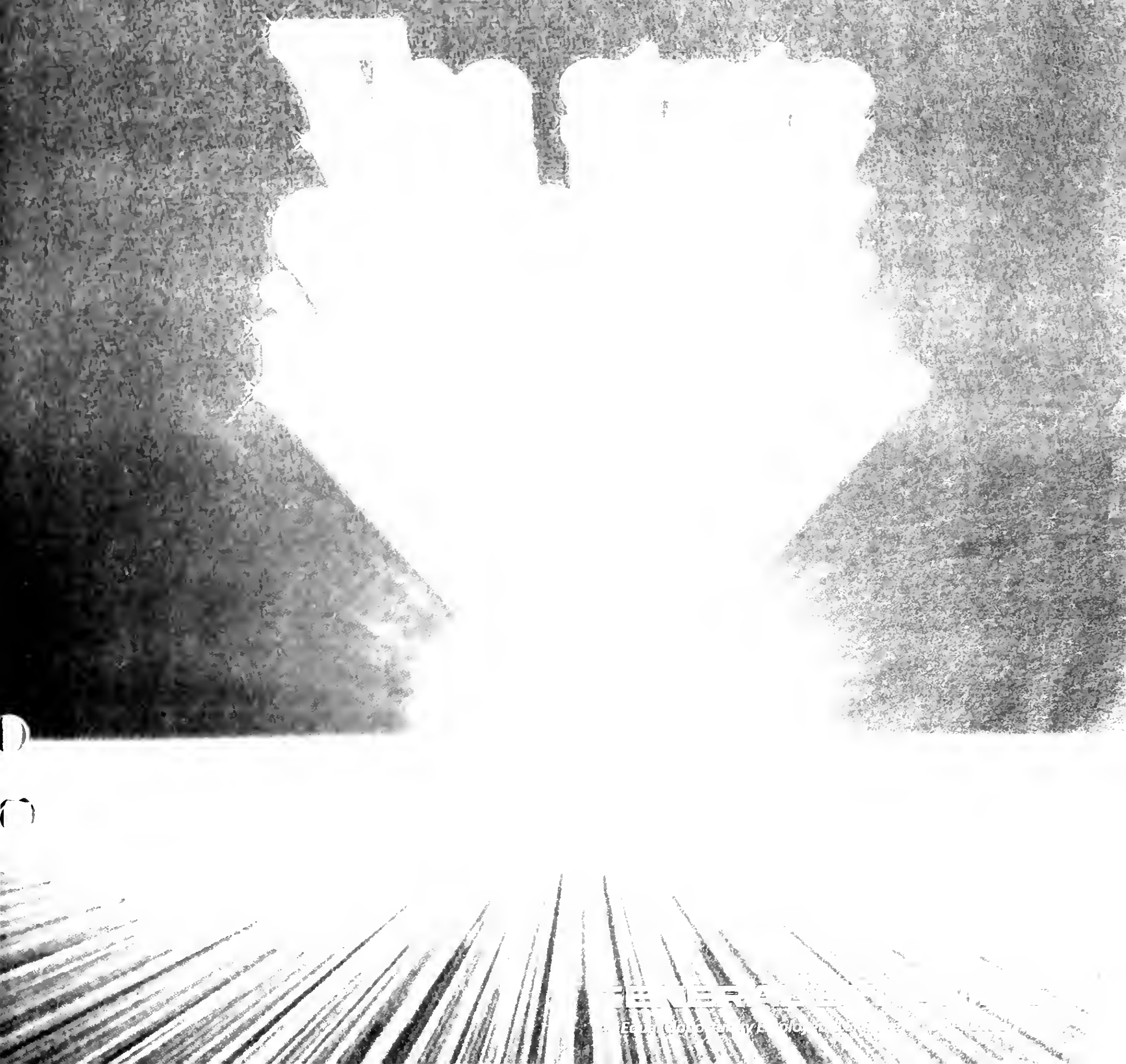
To design and develop today's most technologically advanced defense products, General Dynamics requires the talents of many highly-motivated Engineering and Scientific graduates.

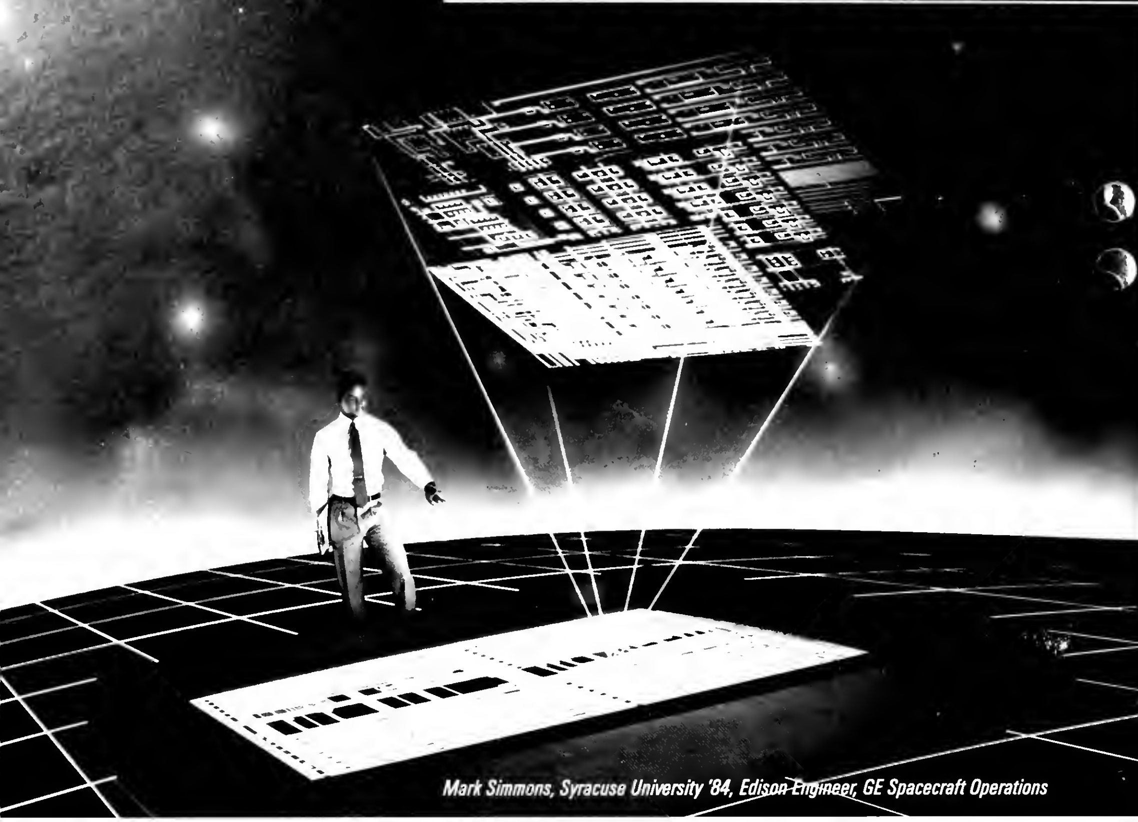
This year, nearly half of our 1,500 technical hires will be in Electrical/Electronic Engineering and Computer Science — goal-oriented, high-performance students who will graduate in the top half of their classes.

If you are one of these top performers, explore the wide range of opportunities available in the following technologies: Aeronautics, Advanced Signal Processing, Radar Systems, Embedded Software, Lasers and Electro-optics, Composite Structures, VLSI, Non-linear Structural Analysis, Robotics and CAD/CAM.

At General Dynamics, you will work with our innovative professionals in applying these technologies toward a wide variety of aerospace, computer systems, electronics, shipbuilding and military land vehicle programs. Plus, you can stay current in your field and make the most of your career through our corporate-wide training and lifelong education programs.

Don't settle for less than state of the art in your career. See your Placement Office for a campus interview with General Dynamics.





Mark Simmons, Syracuse University '84, Edison Engineer, GE Spacecraft Operations

Design an Expanding Universe on the Ultimate Chip

At today's GE, young engineers like Mark Simmons are pushing microelectronics to the limit, and beyond In design applications that take them from the ocean floor to the automated factory to the ultimate frontier - outer space

And with each design breakthrough, an amazing revolution takes place Because as each new GE chip design multiplies microprocessor capacity, so grows our capacity to design more powerful, more accommodating chips. The possibilities are endless

Consider some recent GE developments Our custom-designed Graphics Array Processor converts massive amounts of information into simulated 3-D images With far less time and expense than conventional computers require Ideal for CAD/CAM systems. For flight simulation. For electronic training manuals that let trainees see over, around, and even through solid parts!

Or consider GE's Advanced Very Large Scale Integrated Circuits With feature sizes a hundred times smaller than a human hair

What's our "electronic blueprint" for the future? Solar energy chips that power their own intelligence and pave the way for deep space exploration. Fifth generation computers that build on the astonishing speed and capacity of chips taking shape today Plus startling ideas still in the minds of our engineers.

If you're drawn to the challenges of microelectronic design, you should have designs on us At GE locations throughout the USA, we design, manufacture, use and explore breakthrough applications in microelectronics

Come contemplate the infinite universe. Flex your gray matter with the great minds at GE.

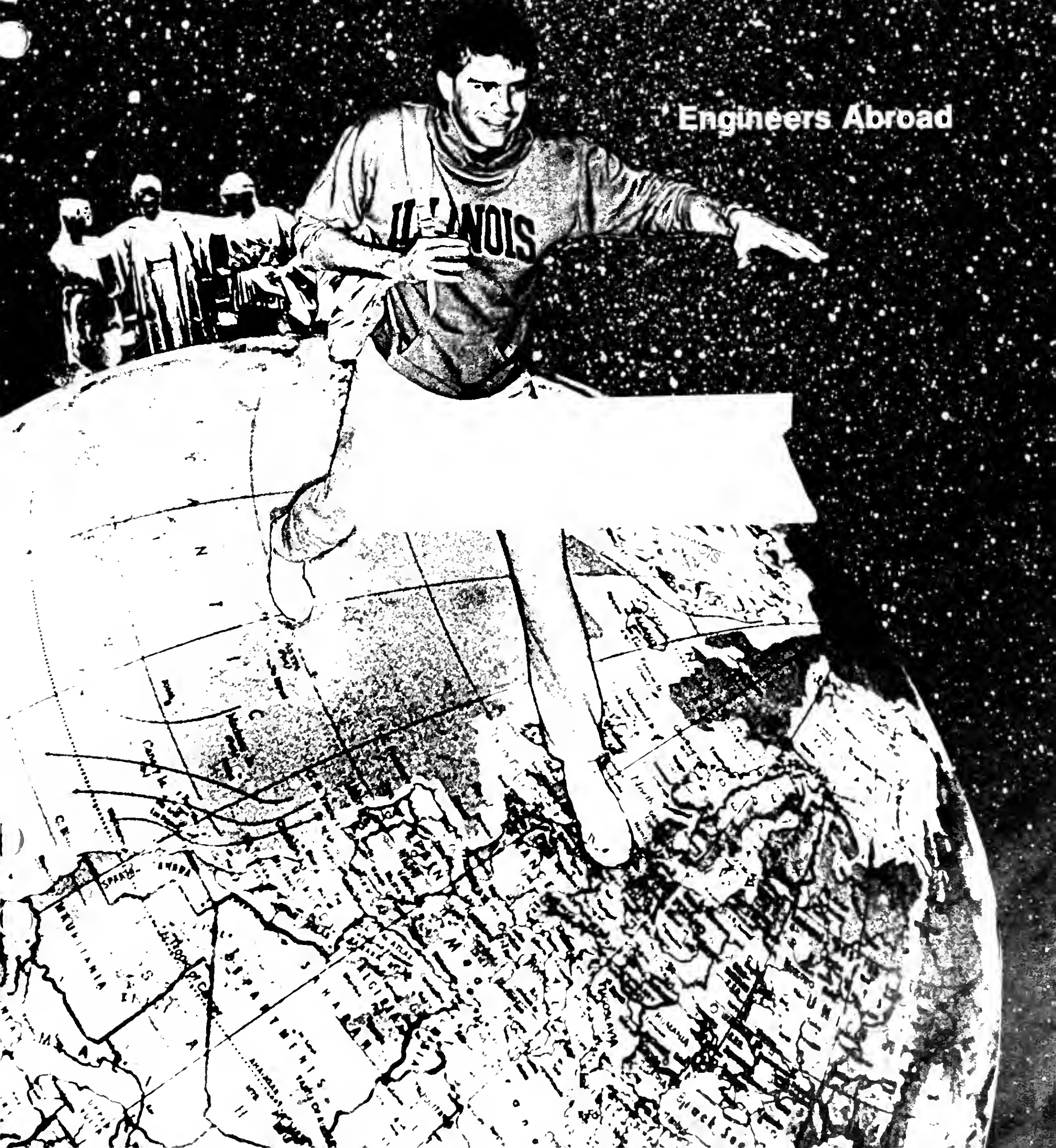
If you can dream it, you can do it.

General Electric is an equal opportunity employer

A registered trademark of General Electric Company

April 1986 Volume 101, Issue 5 Newsstand $1.40

Illinois Technograph



Engineers Abroad

April 1986 Volume 101, Issue 5

Illinois **Techno**graph

On the cover: Engineering students can escape the cornfields to pursue academic interests abroad (Photographic by Mike Brooks and Charles Musto).

4 **Awakening the Giant** *Stephen Tongue*
The ongoing technological revolution in China could have vast repercussions upon the rest of the world.

8 **Engineering Human Tissues** *Scott Brun*
The field of biomaterials engineering combines the disciplines of engineering and biology to research ways of increasing both longevity and the quality of life.

10 **Technoscope** *Cheryl Danke*
This month's Technoscope, *Students Crossing the Oceans*, describes the many opportunities available to those who wish to extend their classroom overseas.

Departments
Editorial 2, Tech Teasers 2, Technovations 3, Technovisions 6, Technotes 12, Techprofiles 13

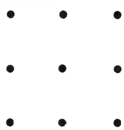
Illinois Technograph (USPS 258-760) Vol 101 No 5 April 1986 *Illinois Technograph* is published five times during the academic year at the University of Illinois at Urbana-Champaign Published by Illini Media Co., 620 East John St., Champaign, Illinois, 61820 Editorial and Business offices of the *Illinois Technograph* Room 302 Engineering Hall, Urbana, Illinois, 61801, phone 217-333-3558 Subscriptions are available for $7.00 per academic year Advertising by Littel-Murray-Barnhill, Inc., 1328 Broadway, New York, N.Y., 10001, 221 N LaSalle Street, Chicago, Il, 60601 Entered as second class matter, October 30, 1920, at the post office at Champaign, Illinois under the act of March 3, 1879 *Illinois Technograph* is a member of Engineering College Magazines Associated

Tech Teasers

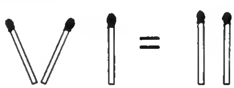
1. If every letter below stands for a different digit, only one set of digits will make the equation correct. What are the digits?

$$\begin{array}{r} ABCDE \\ \times \quad 4 \\ \hline EDCBA \end{array}$$

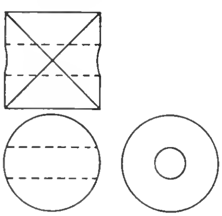
2. Without taking your pen off the paper, draw four straight lines that pass through all nine points.



3. There is a second solution to Problem 1 in the February Tech Teasers. Recall that the problem was: make the following equation correct by moving only one match.



4. Finally, in the same issue, Problem 4 was misstated. Thanks to Professor D.C. O'Bryant, head of GE 103, for taking the time to submit the corrected version below. Now find the object represented by the three views.



Editorial

Talking for Success

You can see them everywhere. They've traded in their Nikes for wingtips and pumps. They're wearing unfamiliar clothing. They look slightly nervous. They study corporate annual reports with the zeal they once applied to differential equations. They are the graduating seniors, seeking employment.

Perhaps a few words of advice and comfort are in order to help this weary group get through this trying time of sunbelt plant visits and corporate lunches. As anyone who's ever had any type of interview is well aware, there are certain stock questions that always arise. Here are some appropriate responses to such questions.

* * *

"So, what made you decide to major in engineering?"

Well, gosh, I don't like to go out much, and the idea of spending hours solving problems, doing labs, and debugging code while the rest of the campus was at the bars really appealed to me [push up glasses as you speak].

"What would you say are your strengths and weaknesses?"

Well, let's see... my back hand is just incredible, but I really don't get a chance to use it much because my thoughts are always on my job and how I can improve my performance. Uh, as for weaknesses, well, I never let myself take a break when I'm working so that I can maximize the productivity of my eight hour work day. That's probably my biggest flaw.

"Where do you see yourself in the next five years?"

Actually, with the incredible opportunities for career growth and professional development offered by your remarkable corporation, I could really be in a number of enviable career positions if I were fortunate enough to be offered a job.

"Please describe your ideal job."

To tell you the truth [slight chuckle], I'm in a bit of a bind here, for I find so many aspects of [fill in major] to be truly fascinating. I think a position that would combine technical expertise, communications skills, attention to detail, commitment to task completion, leadership abilities, and scientific creativity would be well suited to my natural talents.

"What was your favorite course and why?"

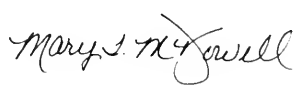
Well, there was one graduate level course I particularly enjoyed. It was a bit of a challenge because it was taught in Chinese to accomodate all of the grad students and the textbook had not yet been translated from its original Japanese. After a week or so I was able to surmount the language barrier and was then able to help some Ph.D. candidates complete work on their theses with the knowledge I had gained from the class.

"Do you plan to continue your education?"

Obviously, an engineer is always learning so as to never become technically obsolete and thus of no value to the corporation. In terms of formal education, I would like to go to school at night and on the weekends to pursue a career related degree, as long as it does not interfere with my job performance. Of course, I would like to pay all tuition and fees myself as a matter of personal pride.

"Do you have any further questions?"

Obviously, with such a momentous decision at hand, there is a good deal I would like to learn about your company. I have a list of things that I would like more information on, perhaps we could start with the highlights...



Technovations

Supercomputing Via Sattelite

On Monday, February 3, the University finally celebrated the official opening of the National Center for Supercomputer Applications. Novelist Arthur C. Clarke, whose fictional computer named HAL is born in Urbana in 1997, communicated with the supercomputer by phone from his home in Sri Lanka. Although phone lines are a very convenient way of communicating with the supercomputer, they are not fast enough for many applications.

Direct satellite links are more efficient. They cost less than phone hookups because they can transmit data at more than 200 times the speed of phone lines. A typical computer graphic of 8 million bits that takes two hours to transmit by phone will only take about 32 seconds via satellite. Larry Smarr, director of the supercomputer center, compared the relative speeds of data transmission as follows: "Imagine that we tried to understand the world not only by images but by the numerical readouts from each of the rods and cones in the retina. That's what scientists have been trying to do before this graphics revolution."

The supercomputer will be linked to the National Center for Athmospheric Research in Boulder, Colorado, to Indiana University, and to the Universities of Chicago and Delaware. A special high-speed phone line will link U. of C., on the south side of Chicago, to Northwestern University, just north of Chicago.

University Team Creates Superchip

Researchers in the College, under the leadership of Hadis Morkoc, professor of electrical engineering, have achieved a breakthrough that could transform the nature of the computer chip. They have discovered an effective way to deposit gallium arsenide on a silicon base.

Unlike silicon, gallium arsenide can generate light pulses. It also has a higher electrical conductivity than silicon. It lacks, however, silicon's structural flawlessness and strength. The new technology takes advantage of the favorable properties of both materials. Gallium arsenide with superior electrical properties can now be deposited on a strong silicon structure.

The reason no one had put these two materials together before is that their lattice constants, the distance between individual atoms in a crystal, are not the same. When attempting to deposit gallium arsenide on silicon, researchers always found the crystal to be strained and dislocated. Morkoc and his colleagues solved this problem by tilting the silicon surface four degrees, creating a series of two-edged steps. Then they applied a buffer zone of indium gallium arsenide/gallium arsenide by molecular beam epitaxy. On top of this zone they finally deposited the pure gallium arsenide. The result is a smooth transition from silicon to gallium arsenide and minimal dislocations.

The work of the Morkoc team has virtually eliminated the debate over whether silicon or gallium arsenide technologies will prevail in high-speed devices. Full advantage can now be taken of both technologies in the same device.

Cerebral Simulation

In two related areas, AT&T has edged closer to actually emulating the functions of the human brain. Researchers at AT&T Bell Laboratories have modeled neural networks on a computer and have used "fuzzy logic" to build an expert system on a chip.

Bell Lab scientists are actually trying to emulate the brain's neural networks on a computer. The brain, as an analog device, is much better at pattern recognition and in complex "no right answer" situations. Neural networks process information continuously, not bit by bit like digital computers. Information is stored in a matrix of neurons, not in one specific memory location. Decisions are made by "taking a vote" of neurons as in a democracy, instead of by the state of a single digital computer bit. In the future, researchers are looking to interface devices based on neural network with a computer to perform "human" functions.

IBM's latest development is a 6.6 mm square, 32K bit static RAM chip with a read access time of 3 ns. At that speed, the entire contents of a 75 volume encyclopedia could be read in one second.

Other scientists at Bell Labs have developed an expert system on a microchip that actually uses the "fuzzy logic" of brains. Fuzzy logic allows a digital chip to make decisions even when its inputs are vague or imprecise. When confronted with vague data, the chip compares it to many different rules in memory. It then assigns weights to these rules depending upon how well they match the data. The final action of the chip is determined by the combined recommendation (weighted average) of the rules.

Research in these areas and others are edging mankind closer and closer to understanding and constructing human brains. The ethical and philosphical implications of this possibility are enormous and will soon have to be resolved.

Bob Janssens

Awakening the Giant

China's quiet technological revolution allows U.S. engineers a chance to share their scientific skills as well as to learn more about this hidden culture.

A quiet revolution is taking place half way around the world. It is unaccompanied by the violence and unrest we recognize from images of South Africa or Haiti. Yet, its "radical" leader has made *Time* magazine's Man of the Year for 1986. The scene of this tacit coup d'eta is China and the leader is 4' 11" tall Deng Xiaoping. After emerging in 1975 from a decade of isolation under Mao's Cultural Revolution, the Chinese have swept through a decade of vigorous change in economy, technology, and lifestyle. The result is a radical blend of communism and free enterprise. It is a marriage of seemingly mutually exclusive partners in a land of tremendous manpower and enterprise.

But what does this have to do with the American engineering community with ample technological challenges of its own? Professors Herman Krier (ME) and Harold Corten (TAM) chose to answer that question for themselves during recent trips to China. Krier, hosted by former University Chinese exchange scholar S.Y. Wang, returned in January from two weeks of technical and cultural exchange. Most of his time was spent lecturing on fluids and combustion, but this did not prevent him from touring Chinese universities, research centers, and landmarks like the Great Wall and Forbidden City.

Corten visited 20 days in October under the auspices of the People to People Ambassadors Group. His professional group, the American Society of Mechanical Engineers, was there to exchange technical information for Chinese standardization of pressure vessels and piping to the ASME code. Though only in China for a short time, both men returned with vivid impressions of a land long hidden from Western eyes. There was the abundant warmth and hospitality of the Chinese people and the rugged beauty of their land. But more impressive was the potential technological benefits this nation poses as it emerges, like a sleeping giant, to shake the world.

Deng Xiaoping, Chairman of the Republic of China (photo by David Hume Kennerly, courtesy *Time* magazine).

The revolution began in the rural lands where 80 percent of the Chinese live. First, communes were replaced with a contract system which allowed the farms to keep, as a profit, the excess food grown above the minimum land lease cost. This created incentives for higher production and opened opportunities for small private businesses and marketplaces. Only during the last couple of years has the revolution invaded the cities, where China's traditionally state owned and controlled industry resides. What are the effects of all this? On a limited scale affluence began to emerge. On the farms it has taken the form of tractors and private residences. In the cities, consumer luxury products like refrigerators and TV's have become available.

However, as Krier noted, the countryside still resembles America at the turn of the century with ox carts and hand cultivation prominent. In the urban areas, "the Chinese are doing well with the technology of the 30's and 40's." There are isolated areas of growth. *Aviation Week and Space Technology* reported recently that: "using rudimentary techniques, with almost no outside help, the Chinese have demonstrated all the capabilities necessary to conduct a space effort important to defense, prestige, and economy." With "vintage 1955" technology, they are able to send two missions each year and will soon emerge as competition for payload and satellite transport.

In another example, Corten saw efforts to develop and market a 300 MW nuclear power plant of Chinese design. Engineers there hope it will be attractive to the Third World due to its low cost. And both Krier and Corten glimpsed a most prized and guarded tool: U.S. and Japanese personal computers finding their way into Chinese labs and universities.

But the circumstances facing most of China should not be forgotten in view of this limited development. Even today clean drinking water, electricity, and adequate communications systems are lacking. Until these basic needs are met, the world of high tech development will remain elusive.

Where will China go from here? According to a recent article in *Business Week*, emerging today is "the same kind of spirit that appeared in Japan in the

Stephen Tongue

1950's and Taiwan in the 1960's which preceeded tremendous growth. Imagine the energy and enterprise of Hong Kong multiplied by a population 200 times as large." China has great sources of raw materials. However, noted Krier, like many Third World countries, China lacks adequate energy supplies for rapid development. Capital is limited. So too are the management skills basic to professional business. But China's greatest resources are her multitudes – a full 1/5 of the world's population. The labor intensive economy seeks to fully use this asset and create employment for every able bodied person.

Furthermore, of the 1.1 billion Chinese, the average age is under 21. Consequently, education holds the brightest key to China's future. Already, literacy is close to 75 percent. Competition for postions at the top is stiff. As Corten noticed, "Idealism and an element of fear breeds success." The American engineering student would find many contrasts with his or her Chinese counterpart. The few who do make it to the university have managed to pass an excruciating barrage of examinations.

Students have little choice in their future. Field of study is usually decided by the government based on quotas to meet perceived needs. While this seems oppressive by our standards, Krier commented that our own economy has the same effect on educational choices which students often base on career potential and salary. The Chinese engineer can expect his or her hard work to pay off, though. Monthly salaries reach a whopping $150, almost six times the average factory worker's.

Along with the development of its own internal education, China has initiated exchange with American universities. According to an article in *New Leader* by Norman Gelb, "China tends to see the U.S. as the nation having the most to offer. . ." and in 1985 proved it with 12,000 Chinese studying at U.S. institutions.

The American engineer will soon have many opportunities for travel and work in China. According to *Time* magazine, over 2000 foreign companies have invested in China, 687 have worked out jointly owned businesses and 94 (including 30 U.S.) companies now operate independently within China. As Corten and Krier found, the American engineer in China faces many challenges. Obviously, there are barriers of language and culture to overcome first, and many comforts and entertainment will have to be left at home. Furthermore, China's vast bureaucracy may be a source of frustration for those who come in contact with it.

Even with all of the new opportunities under "controlled capitalism" or "individual initiative," China is still basically a communist system. The highest priority is maintaining 100 percent employment. For the American engineer, this goes against senses honed toward maximizing efficiency. A good example is an isobutane fuel system for a television picture tube plant in Shanghai. In 1983, Corning Glass sent a consultant for start-up. The engineer was startled to find 20 Chinese technicians assigned to run this system which, in the U.S. would be operated by a single part-time employee. As Krier came to realize, there are "different boundary conditions for the Chinese system." These must be respected. Corten said, "There is no use taking technology to China that will put people out of work." Robotics and automation are not options.

As China's quiet revolution continues, there are tremendous opportunities and challenges. For the U.S., it is an opportunity for building political and economic friendship. This is especially possible on the micro level: people to people. Trust may be cultivated as we trade and exchange technical and cultural information. Corten's hope is attractive, "Governments will always distrust each other. That is their job. But the people can overcome it as they learn about each other." Krier could not help but see a "great admiration of American enterprises, engineering and technology. Clearly, China could be a tremendous ally and friend."

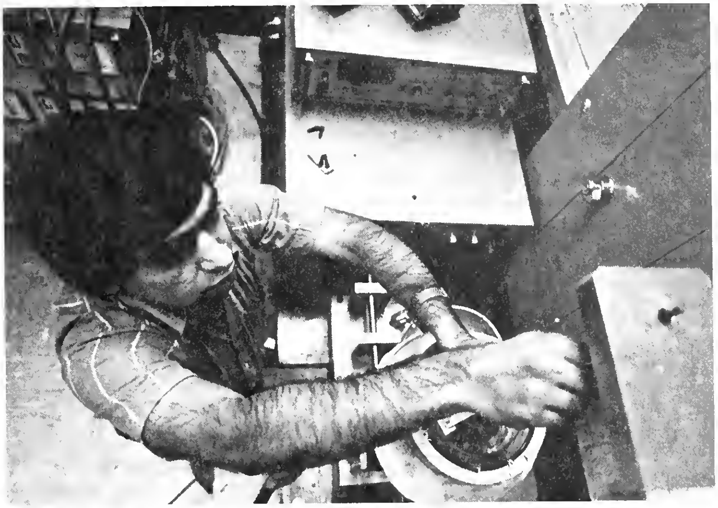
But friends can also be rivals. Given stable leadership and direction, China may become a "manufacturing empire." Japanese competition in the automotive and electronics industry could just be a foretaste of things to come. The future development of Chinese economy and industry could send tremors throughout the world.

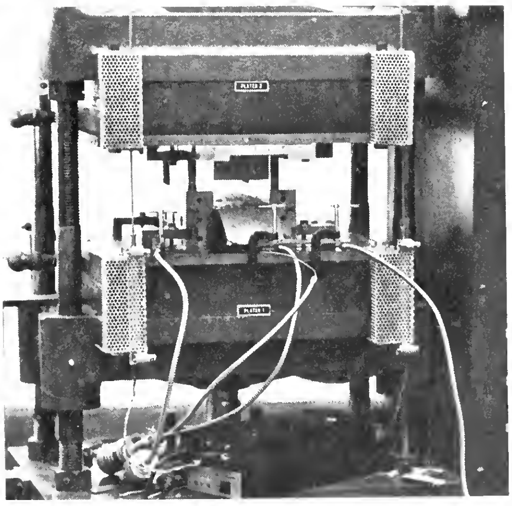
Yet China has many challenges to meet of her own. The communist system for years has protected the country from crime, pornography, beggars, inflation and other "Western" evils. Many of China's old guard ask "if we open our windows, won't we let the flies in?" Deng, their leader, counters that they must open the windows and then fight the flies. The only other option would be to suffocate.

There is a great deal of speculation, especially when Westerners try to understand a culture and people hidden so long by the "bamboo curtain." But as the mists clear and the preconceptions and stereotypes are shattered, idealogical differences pose fewer threats and potential for friendship emerges. This is the challenge as the two richest nations, one in material wealth, the other in human, stand in front of one another and ponder their future. ■

Polymer Processing

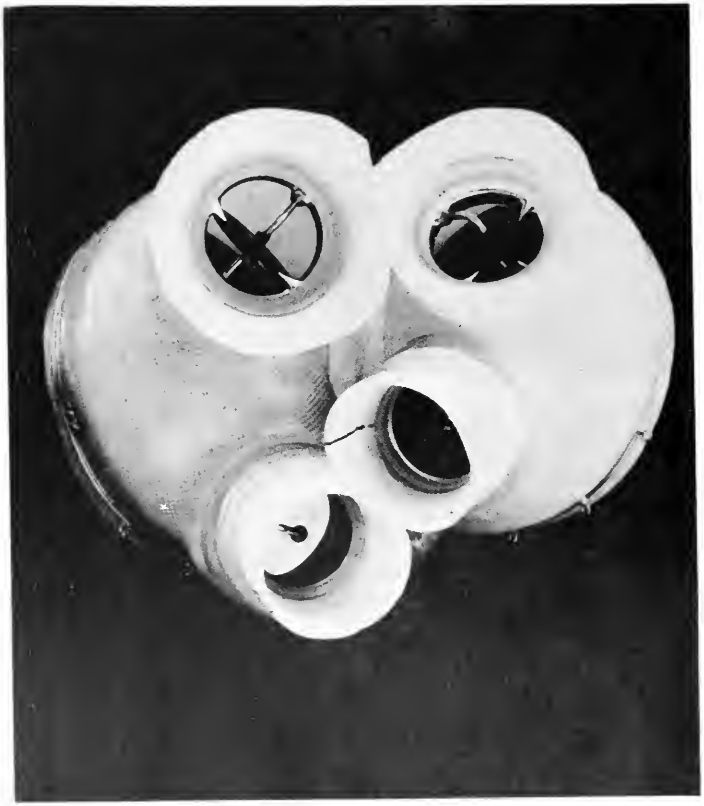
Polymer processing is the examination of the various processes used to predict material and realogical properties of polymers. Graduate student projects under the guidance of Professor Charles L. Tucker include compression of laminate material molding, fibre orientation, and injection fibre reinforced material molding. Counterclockwise from upper left, Ari Ruebin, graduate student in ME, fabricates test pieces to be used in a compression molding experiment; Tim Osswald, graduate student in ME, works on a mold filling CAD simulation used to calculate the finite element mesh of a truck wind deflector; shown is a compression molding press; Ari Ruebin checks to see if compression molding platens are parallel; and Suresch Advani, ME graduate student, uses short fibres in a viscous liquid to simulate how fibres flow when sheared *(Photos and text by Jay Zeff)*.





Engineering Human Tissues

Raplecing human tissua involves mora than simply choosing materials: special care must be taken to find materials the body will accept.



The Jarvik-7 artificial heart, the state of the art in bioengineering, is just one expample of using man-made materials to replace human tissue (UPI photo).

Since prehistoric times, man has utilized the elements present in the Earth for producing items to enrich his quality of life. Today, however, material science (the study of the structure and properties of substances), coupled with a working knowledge of biology and medicine, can improve – even preserve – our lives through the production of synthetic materials that can mimic the functions of human tissues damaged by disease, age, or other biological factors. Development of prosthetic devices such as the Jarvik-7 artificial heart, synthetic heart valves, joint replacements, and man-made vascular (artery and vein) grafts would still reside in the realm of fiction were it not for the foundation laid by biomaterials researchers.

Synthesizing the substances these devices are composed of requires patience and perseverance on the part of the engineer/biologist. One such scientist who possesses much experience in the domain of biomaterials, University Professor Samuel I. Stupp, explains that success in development requires a systematic, two-pronged approach by the principal investigator (PI) – the head research scientist.

The primary task of the researcher is the discovery of a basic material whose properties closely resemble those of the tissues he desires to duplicate. In other words, biomaterials research does not attempt to reproduce precisely the actual

Scott Brun

chemical structure of living tissues. This would be an arduous undertaking due to the complexities of the composition of the human body. Illustrating this line of development is a synthetic bone cement (developed in part by Stupp) which shares a closer structural kinship with plexiglass than with its living counterpart.

In the quest for a material suitable for a specific physiological purpose, the PI begins by scrutinizing the three fundamental classes of materials: metals, polymers, and ceramics. Polymers, long chain carbon compounds, tend to be used for soft-tissue replacements such as the pumping chambers for the artificial heart and experimental ligament, cartilage, and vascular implants. For prosthetics that are subjected to greater physical stress such as heart valve and joint replacements, metals and ceramics (inorganic, non-metallic materials) seem to be favored. Following this initial selection, the investigator begins to "build" the properties he desires into the material by designing the microscopic structure of the substance, relying heavily on his knowledge of physics and chemical interactions in the process.

After painstaking toil and a lengthy time investment, the PI may have contrived a model material that displays all of the characteristics that he desires. However, his job is far from complete, for now attention must be devoted to the second vital phase of his work: dealing with the issue of biocompatibility. Although the material may comply with the desired physical parameters, its presence in the human body could provoke adverse reactions. At times, a substance may create more problems than it solves, thus defeating the entire purpose for its creation. Foremost among these difficulties is the problem of thrombogenesis, or blood clotting. While every substance foreign to the body induces clotting, steps to combat the effect do exist, such as applying specialized coatings on the surface of the biomaterial. Other complications include immune system responses, inflammation, and possible toxicity including carcinogenesis. Moreover, reactions the substance may undergo in adapting to its physiological environment, such as the heat-releasing setting process of bone cements, may cause biological damage if not properly regulated.

To forestall such dire consequences, the investigator performs numerous biocompatibility studies before even contemplating human implantation. Cell cultures are grown in dishes ("in vitro" experimentation) in the presence of the biomaterial to examine local effects on surrounding tissues. In these histological studies, the researcher prepares slides of the samples and scrutinizes them for abnormal growth caused by biological interaction with the material. Additional methods of biocompatibility determination include implantation of the material in various sites in living laboratory animals in order to observe effects on the organism as a whole and scaled-down functional tests of the specific prosthetic device, such as testing a human finger joint by using it as a cat's knee. Only after the collection of reams of data will the Food and Drug Administration consider granting permission for limited experimental use of the material in human beings.

At this point, the materials scientist must consult with a surgeon in order to develop a technique for delivery of the device or material. Returning to the example of bone cements, a method for surgically implanting the material at the fracture site is required, along with a means of solidifying the paste-like substance internally. Following experimental implantation, the investigator's task nears completion. If the material performs to expectations in a real-world situation, marketing on a widespread scale can begin. If not then there is quite a setback, as the entire developmental scheme requires years to complete.

The diligence and dedication of biomaterial scientists may appear extreme, but when one considers that the fruits of their labors may result in longer lives for many, the rewarding nature of the profession becomes apparent. While artificial heart valves, joint replacements, and synthetic vascular grafts are commonplace, new wonders are constantly coming into existence. In various stages of development are tracheal implants, synthetic intraocular lenses, ligament replacements, and biodegradable materials that produce a healing electric current as they decompose. An interesting twist in biomaterials that Stupp believes will occur in the next few decades involves employing biological molecules in non-living systems, such as using DNA strands to store information for computer circuits—shades of Asimov and Huxley. Possibilities such as these make biomaterials an appealing field to people who wish to aid humanity while satiating their curiosity and providing an opportunity to help the fact in science to outpace the fiction. ■

Students Cross the Oceans

Many complain of isolated Champaign-Urbana but never seek solutions. With a little effort, you could find yourself studying in the land of your dreams.

Have you ever dreamed of walking the streets of Paris? Of skiing in the Swiss Alps? Does the intrigue of the East ever captivate your thoughts? Could you really get a cab in Bogata with that four years of Spanish from high school?

If you have entertained fantasies like these consider this—they need not remain fantasies.

College is a time of opportunity. You'll probably never be more independent than now. Sure exams are tough and you need to slop pseudo food in the cafeteria to buy beer, but the bottom line is that you really don't have many responsibilities or commitments. You can do what you want, follow your dreams.

If foreign soil beckons, go. Approximately twenty five of your engineering classmates are headed worldwide this year alone. The only thing they have that you don't is a passport.

It's easy to get started. The procedures are straight forward and there are many people to help you out: namely Andy, Joan, Joanne, Sally, Susan, and Roletta. This group can be found in room 306 Coble Hall—the hall across Wright Street from the Admininistration Building. They make the Study Abroad office come to life with enthusiasm that never quits. And the best thing is, they LOVE to talk to you. Even if you think you only, possibly, maybe, perhaps, might like to spend some time overseas, they still love to talk to you. Especially if you are a freshman, give them a call at 333-6322 to set up an appointment. The earlier you get started the better.

Cambridge University is one of many throughout the world that offer students the chance to further their formal as well as cultural educations.

Cheryl Danke

The first appointment is about one half hour long. Show up a little early because they will have you fill out a quick form asking for your name, major, etc. Then one of the advisors will sit down with you and tell you about the different programs and answer any questions you have. Don't be intimidated by cost. The Academic Year in Britain (AYB) costs about the same as a year at the University plus travel. There are also exchange programs in France, Germany, Portugal, Brazil and Columbia. If a year is too long, they can tell you about semester and summer programs. As a matter of fact, they can probably tell you about a program to fit your needs. If they can't, they can tell you where to look next in the office to find a program that does.

Beware though, you'll be the only engineer in there unless Andy is around. As a group we're sadly underrepresented. Business and LAS student have taken the cues, but the idea of going abroad is a little fresh north of Green. While the universe may be expanding, the world is not. As an engineer you'll probably be faced with international situations some time in your career. Engineering is becoming an international profession; respect and understanding for foreign cultures is mandatory for success. Not only will time overseas give insights to others, it will give a rare opportunity for personal growth. It can be the liberal arts education your technical training lacks.

Some engineering students worry that they won't graduate in four years if they study at a foreign university. It is a valid concern but it shouldn't stop you. College deans are flexible people. If you plan ahead and talk to the deans about transferring credits before you board the 747, chances are good that things will work out. It cannot be stressed enough that you must resolve the credits issue before you leave. The problem is not tough to solve, but it is necessary.

Perhaps studying abroad is not for you but the world is. Dean Howard Wakeland has a fantastic program for you. It is called IAESTE which is an acronym for International Association for the Exchange of Students for Technical Experience. Quite a mouthful but quite an opportunity. Companies all over the world offer technical summer internships through IAESTE. As an engineering student you complete an application listing your qualifications and country preferences. With a little luck you will be matched up and headed for one unforgettable summer. This summer over fifteen University students are destined to places like Japan and Great Britian. Last summer one courageous engineer from among our ranks headed out to Thailand. About fifty countries participate and only about fifteen have language requirements. Job responsibilities are as varied as the countries, but the main thrust of the program is the situation. You will be working with technical people from a different culture. In your host country, you'll see how the economy works from the inside. Need it be stated how that would look on a resume? You'll be paid for your work which usually covers living expenses, but travel is extra. As one IAESTE alum remarked, "How can you assign a monetary value to a chance in a lifetime?" If you are interested in this chance, Dean Wakeland in 207 Engineering Hall will give you more information and an application.

If adventure is your middle name and you want to completely immerse in a new culture, consider the College's China program. Again, the time spent abroad is over summer break. During your summer you will experience college life at the University of Wuhan or at the East China Institute of Technology in Nanching, China. You'll also work part time in a factory with the Chinese people. Weekends are for road trips and cultural events with two weeks set aside for traveling to other destinations such as Hong Kong. No need to worry about room and board, they will be provided. What you have to provide is some proficiency in the Chinese language. To help you out, there is a Chinese class offered here. You don't need to buy a plane ticket to get started; a short excursion to 207 Engineering Hall is all it takes.

Another terrific cosmopolitain opportunity is the International Minor. This program is for those of you who want college credit for your experiences. It can work in conjunction with the programs already mentioned, or it can open some doors of its own. The first thing to do is pick a geographic location you that want to study. With a dean's approval, almost any non-English speaking area will do. Then choose at least twenty one credit hours of cultural and language courses related to your country. Most of these can be taken within the mandatory eighteen hours of humanities and social sciences. The finale consists of an eight week "lab" – eight weeks living in your chosen location. The engineering deans can help with the arrangements. For the internationally minded, this program cannot be passed up, or surpassed for that matter. Think about it.

The programs listed here are by no means all-inclusive. Once you start looking, you will find countless opportunities. The programs are not meant to be educational finishing touches but rather starting blocks to a lifetime of education. The Study Abroad Office can give you names of former study abroad students who are anxious to share their experiences with you. If and when you spend time abroad yourself, make the most of it. Record your adventures, trials, and insights. Keep an open journal. . . and an open mind. ■

Technotes

Outstanding CS Undergrads

The University's computer science department has initiated two awards for undergraduates in its curricula. Both awards were named in honor of recently deceased faculty members.

The Daniel L. Slotnick award will consist of money for tuition, books, and supplies, as well as "a modest stipend." Slotnick scholars will be picked from undergraduate computer disciplines. Slotnick, who was on the faculty for twenty years prior to his recent death, had been in charge of the ILLIAC IV, the world's first parallel computer.

The other award is named after James N. Snyder, longtime head of the computer science department and a 35 year faculty member. It will be given every year to two sophomores: one in the math-computer science program in the College of Liberal Arts and Science, and one in the computer science program in the College of Engineering.

Presents from the Governor

Under Governor Thompson's proposed 1987 budget, funding for Illinois higher educations will increase by 9.5 percent to a record $1.7 billion. A significant amount is earmarked for engineering and technology programs.

The Governor recommended expanding opportunities for minorities to gain advanced degrees, especially in math and the sciences. His budget also increases the state's support for the National Center for Supercomputing Application at the University and provides funds for hiring more faculty in engineering and other high-demand areas. Thompson defended this budget increase in a period of tight budgets as "the best investment Illinois can make in its future."

Richard C. Alkire

ChemE Professor Awarded

Richard C. Alkire, professor in chemical engineering, is the winner of the 1985 Professional Progress Award of the American Institute of Chemical Engineers. He received the honor for his contributions to the development of "electrochemical processes using chemical engineering principles." Alkire was also recently elected president of the Electrochemical Society.

Off-campus Degrees

Soon it will be possible for engineers in Illinois companies to receive off-campus master's degrees in electrical, general, mechanical engineering, and in theoretical and applied mechanics. The courses will be taught at the companies by electronic blackboards and videotapes. The entrance requirements to the program will be the same as those for regular master's degree programs on campus.

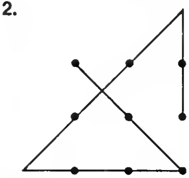
Bob Janssens

Tech Teasers Answers

1.

$$\begin{array}{r} 21978 \\ \times \quad 4 \\ \hline 87912 \end{array}$$

2.

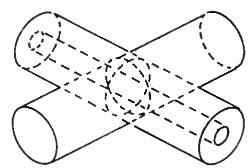


3. a. Here is last issue's answer: the square root of one equals one.

b. Here is the second solution: eleven (in roman numerals) equals eleven (in arabic numerals).

Thanks to Professor Ibbs and Professor Munse, both in civil engineering, for independently pointing out this second solution.

4. A pair of cylinders of equal size, intersecting at right angles, with a hole drilled through one.



Tech Profiles

Simon M. Kaplan, assistant professor of computer science, recently joined the faculty in the fall of 1985. He received his B.S. degree in computer science from the University of Capetown, South Africa in 1981. His B.S. [Hons] degree (similar to a master's degree) in computer science was awarded by the University of Capetown in 1982. He has completed his doctoral research on developing programs that will take a set of information and create an appropriate compiler program. In June of this year, Kaplan will receive his doctorate from the University of Capetown.

Kaplan's current research deals with two aspects of software engineering. In one area of research, he is developing a flexible programming environment that would work with the programmer in writing programs. This type of environment would offer suggestions to the programmer and allow him to create programs in a less restrictive programming language. Kaplan is also investigating formal models of computer systems to determine if the system design and component interactions are correct.

During his first semester here, Kaplan taught a graduate course in formal approaches to programming. This semester he is teaching CS 221, Machine-Level Programming, and plans an advanced compiler class for the fall of 1986. In addition to his teaching and research, Kaplan is a member of the Association for Computing Machinery.

Although his leisure time is limited, Kaplan does find time to pursue his other interests including squash, sailing, and listening to early classical music such as Beethoven, Mozart, and Bach. Kaplan also claims trips to the *Institut National de Recherche en Informatique et en Automatique* (National Institute of Research in Computer Science and Automation) as a convenient excuse for visiting his favorite city, Paris, four times.

W. Dan Leonard

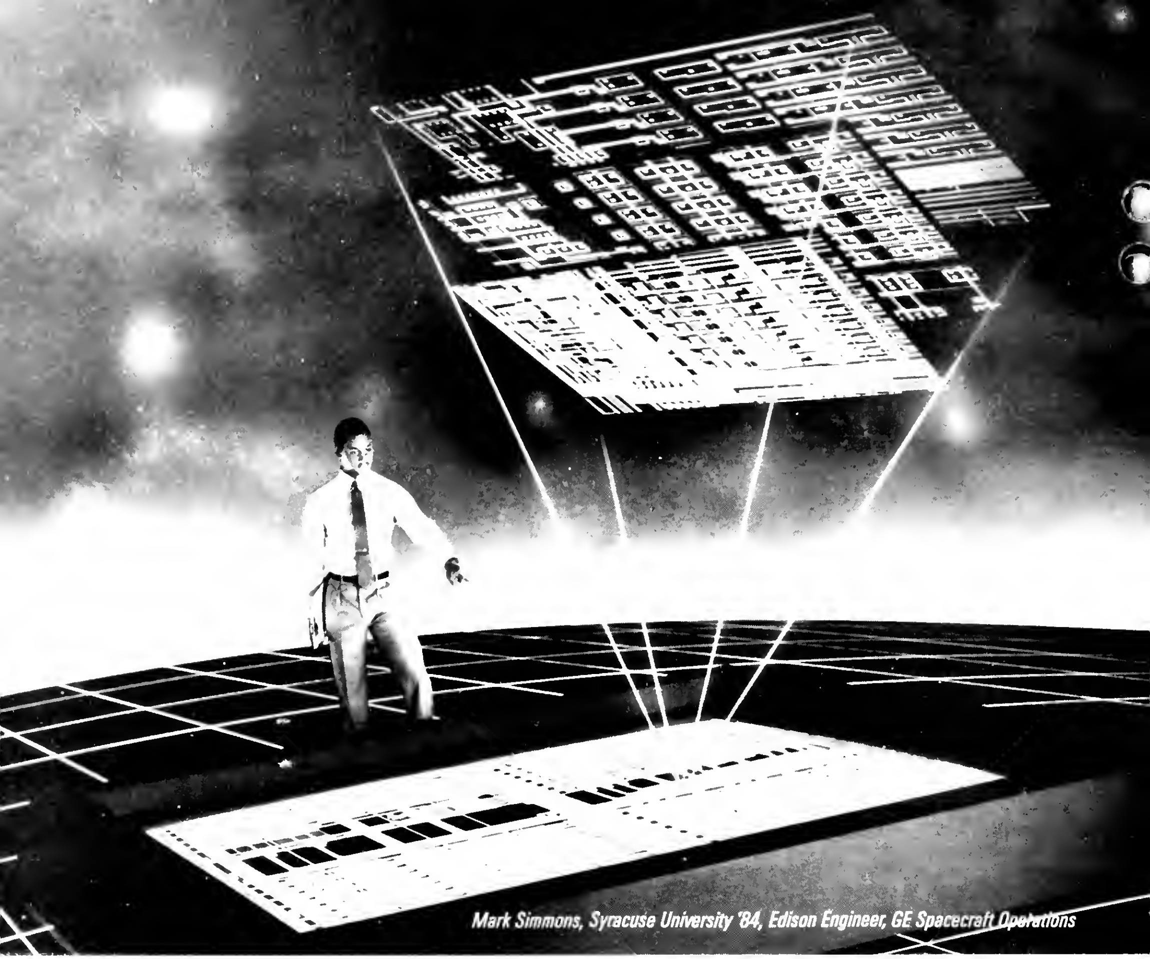
Shao Lee Soo is a professor of mechanical engineering at the University. He began his education in China where he graduated from Chiatung University. After being offered a scholarship to Georgia Tech, he moved to America and received his master's degree, then he went on to Harvard for his doctorate. Professor Soo came to the University in 1959 after teaching for some years at Princeton.

Most students will have contact with Soo in graduate level classes: ME 301, Thermodynamics; ME 401, Thermodynamics and Transport Properties; and ME 402, Multiphase Flow. He enjoys teaching students in class, but particularily likes teaching graduate assistants in the lab because of the degree of personal involvement. His work in the lab is not restricted to teaching alone: he is currently working on a number of projects. His main work is in the area of multiphase flow, a term he coined in 1964. It is a fluid science dealing with the flow of a mixture made of different phases, such as oil and water. Supported by the State of Illinois, another of these projects involves the removal of sulfur from coal before burning it to obtain a greater energy yield. This would help Illinois industry and its economy.

Soo also does work for various agencies like NASA, simulating zero gravity and observing the effects on the flow of liquid vapor systems. These results could be applied to certain gasses to be used in future space station fuel systems. As a member of the USEPA, Professor Soo often travels in order to debate new pollution policies and change existing ones. He has published five books and over 160 articles during his career.

As busy as his career keeps him, Soo seems to truly enjoy his work. When he is not working, however, he likes gardening and spending time with his wife and family.

Paroo Koya



Design an Expanding Universe on the Ultimate Chip

At today's GE young engineers like Mark Simmons are pushing micro-electronics to the limit, and beyond In design applications that take them from the ocean floor to the automated factory to outer space

With each breakthrough, an amazing revolution takes place As each new GE chip design multiplies micro-processor capacity, so grows our capacity to design more powerful, more accommodating chips

Consider some recent GE develop-ments. Our custom-designed Graphics Array Processor converts massive amounts of information into simulated 3-D images. With far less time and expense than conventional computers require

Or GE's Advanced Very Large Scale Integrated Circuits With feature sizes a hundred times smaller than a human hair

What's our "electronic blueprint" for the future? Solar energy chips that power their own intelligence and pave the way for deep space exploration Fifth generation computers that build on the astonishing speed and capacity of chips taking shape today Plus start-ling ideas still in the minds of our engineers

If you're drawn to the challenges of microelectronic design, you should have designs on us. At GE locations throughout the USA, we design, manufacture, use and explore breakthrough applications in micro-electronics

Come contemplate the infinite universe Flex your gray matter with the great minds at GE

If you can dream it, you can do it.

General Electric is an equal opportunity employer

A registered trademark of General Electric Company