MECHANICAL SCIENCE IN EDUCATION

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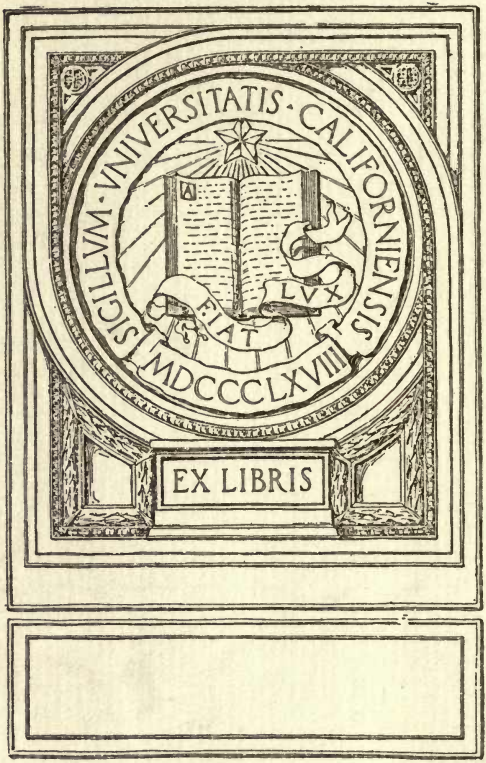
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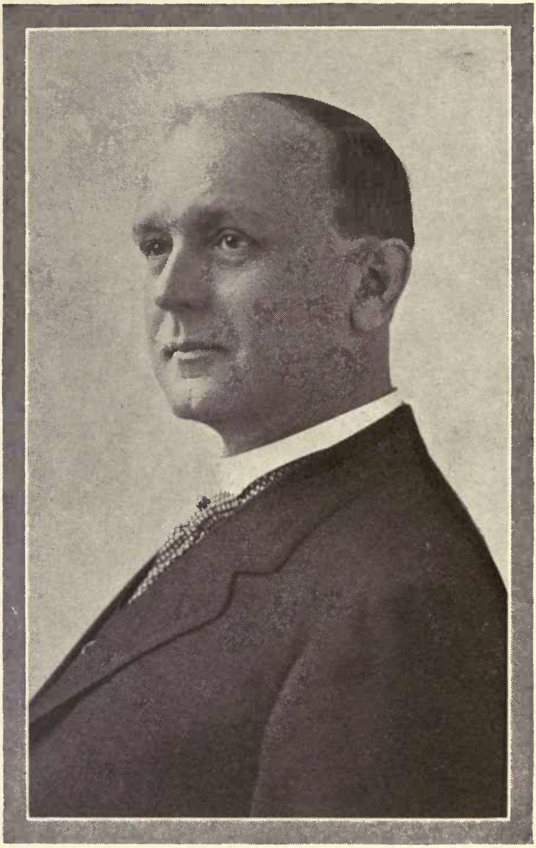

MECHANICAL SCIENCE

IN EDUCATION

BY

FRANK HENRY SELDEN

AUTHOR OF THE

MECHANICAL SCIENCE SERIES

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PREFACE

Beginning in 1909 the author wrote several articles for "The American School Board Journal." In 1910 six of these articles, all that had been published at that time, were republished in a small book entitled "Manual Training." The edition of the early reprint being exhausted, the author secured permission from Mr. William George Bruce to reprint the entire series; and, therefore, acknowledgment is due Mr. Bruce personally and the publishers of "The American School Board Journal" for this opportunity of bringing these several articles together in convenient form.

The change of title is due to the growth of the Mechanical Science work. Today this system is definitely established with well defined characteristics that differentiate it from all other systems of school shopwork or schemes of industrial education for either public or private schools. That it should bear a name readily expressing its individuality and character is too evident to require comment.

That this system of school shopwork deserves the most careful consideration by all friends of education may be argued both from the results obtained

in educational and industrial values, and because of the most emphatic approval of subject matter and methods of instruction by every educator who has become familiar with this system.

That this work is based upon great fundamental principles rather than a personality is proven beyond dispute by the unusual success of this system when taught by teachers of greatly varying temperaments and personalities. To so great an extent has the success of the work been demonstrated that any school may be certain of obtaining similar results if a fairly well qualified teacher of Mechanical Science is employed and given a reasonable opportunity. In this connection it seems necessary to caution those wishing to investigate or adopt this system to be sure that they are not deceived in regard to the schools they visit or teachers whom they employ. The safe way is to correspond directly with the publishers of the Mechanical Science texts whose every interest is to secure a complete and impartial investigation and to provide teachers who can be depended upon to use correct methods of instruction.

The articles reprinted in this volume do not give the elaborate and connected treatment of this subject that one might reasonably expect to find in a book especially prepared for that purpose. They do, however, state with reasonable clearness the author's views and the fundamental principles on which this system is based. Those who wish a

more detailed statement of the system should consult the texts and other publications by the same author. For a complete view of the arrangement of problems with reasons for the particular work of each grade the book "SUGGESTIVE COURSES IN MECHANICAL SCIENCE" should be consulted. Special class room methods are given in considerable detail in "MECHANICAL SCIENCE METHODS."

To the articles as originally published some explanations and additions have been added. These are enclosed in brackets. In most cases the terms "manual training" and "mechanical science" have been retained as used in the original publications.

Discussions which have come to the notice of this author suggest the necessity of emphasizing the fact that Mechanical Science is not a group of selected tool processes of general utility. Mechanical "hash" is of no more value than mathematical "hash" or indiscriminate pickings from any other science.

We ought also to keep in mind that Mechanical Science is not a selection of "fundamental tool processes," a phrase now used by some in discussing industrial education. If there are fundamental principles then there can be no such thing as fundamental tool processes; because the very nature of a principle requires a possibility of its application in a variety of processes and hence no one process can be fundamental in that group. As all groups of

processes must depend upon fundamental principles, then no group or any process of any group can be considered fundamental. Processes are the multiplicity of applications of principles. It is the principles that are fundamental and therefore comparatively few in number, and because of being limited in number are capable of being learned and understood by a reasonable course of study in the science. Processes are infinite in number and, therefore, to attempt to become proficient in their use by a rote learning of them is an endless task and may result in a total failure to accomplish some simple piece of work because the particular process required has not been learned altho many other processes have been mastered.

The inability of the one who has simply learned tool processes to adapt himself to modern industrial requirements is the cause of the abandonment of the apprenticeship system. The employer learned by experience that the seven years consumed in training a workman in processes did not yield a sufficient return for the cost of instruction. The student of Mechanical Science learns the fundamental principles by the use of properly selected studies, learns to apply them in the devising of processes for selected tasks and thereby becomes able to originate tool processes to fit new requirements. In practical industrial employment we call the workman who has this knowledge of principles

an adaptable workman. He is really a scientist and if a master of the science, is substantially unlimited in the variety of work he can accomplish.

At the present time most of the school shopwork is the teaching of processes, sometimes with good workmanship resulting and sometimes not, but in either case the value of the instruction to the pupil and the community is very slight and sometimes, possibly often, of a serious negative value.

Such instruction is sustained not by its value but by those students of a strong scientific type of mind who get some of the science in spite of the tendency of the instruction. The Mechanical Science work differs from these other systems in that it recognizes that there is a science of working solid materials and strives definitely to teach it by the use of suitable subject matter.

These articles, written in 1909, took what was then an advanced position in regard to fitting pupils to enter with success any one of a variety of occupations without any special training for any one occupation. Since then the actual experiences of those who have entered upon various lines of industrial activities after a more or less extended training in Mechanical Science have confirmed this theory beyond any probability of error. These pupils have established records of industrial efficiency and success beyond that which the author expected, and greatly in excess of what is

necessary to establish this theory. The greatest need in educational work today is not more theories in regard to what ought to be done but more careful inquiry in regard to what is actually being accomplished by some schools.

The fact should not be overlooked that there is not one bit of evidence from any source that can be placed against this system of school shopwork. The fact that pupils from schools having practically unlimited resources in equipment and salaries have not shown this adaptability cannot be used against this system, for equipment and salaries do not, at this time, guarantee the teaching of the science. A thoro investigation will show that some of the largest and most expensively conducted manual training schools or industrial arts schools are giving the poorest instruction as estimated from the standpoint of teaching the science.

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Manual Training a Science

It is natural for us, when the country is stirred by some new movement, to look for the cause. To find the cause and recognize it is not always an easy matter. It is usually found in a combination of conditions that differ in their relations from those ordinarily existing, and therefore requires a point of view difficult to assume by those not thoroly experienced in the new field of observation. That the introduction of tool work into the common schools has brought under observation a line of work requiring a point of view not easily gained by those accustomed to pass judgment upon our school work is easily believed because of the greatly varying opinions and suggestions which are given out as a result of those observations. It does not seem probable that in this new line of work there is no basis on which a definite theory can be placed. The present difficulty appears to be the all but universal difficulty of those long accustomed to a certain line of investigation failing to grasp the whole body of facts bearing upon the new situation.

A Paradox

So universal is the necessity for a new point of observation in the proper study and an intelligent discussion of great advances in civilization that, however paradoxical this may seem, it is, nevertheless, apt to be true that those having the most extensive training for the purpose of observing and judging of sociological conditions are unable to give to the community a full and correct statement of the value of any radically new movement in society. The work of the trained investigator appears to be to refine and diffuse after the radical changes have produced a sufficient body of material to make possible a new point of observation.

In no line of modern development is this more noticeable than in the movement for a department of school work capable of giving a larger value for those whose life's work is to be spent in some line of industry. If we will pause to consider what the new material is that is of necessity being brought into our schools as a result of this demand, we will have no reason to question this statement.

Lack of Information

Turn to any discussion of industrial education by those considered best able to lead in educational

investigation and we find the point of view substantially the same. Trained to a degree that should give them large confidence in their powers, rightly credited by all with a breadth of learning, strong in power to think out to infinitesimal distinctions along lines with which they are familiar, it is not surprising that they do not realize, nor should we censure them for not realizing, that they have lived and thought apart from a vast body of learning which is capable of supplying material for not only an education for industry, but also material for liberal culture.

To those that have lived long in the realm of books, without dealing with any line of thought to be tested out by actual working of solid materials, there is another world about them unseen and unfelt, and neither considered in their observations and search for the cause of present unrest, nor in shaping their plans for the uplift of the industrial classes.

To make this **other world** real to those who hold in their hands the destiny of education is the burden of those who live in this other world, and whose lives have been such as to give them a view of the intellectual side of modern industry.

Learning by Thinking

"We learn to do by doing," said by some one, and quoted by the millions, has so impressed itself upon this generation as to be taken as a fact, tho, as ordinarily interpreted, it is little else than fiction.

For untold centuries the world progressed, if we can call that slow and tedious advance in mechanical work progression, by doing; and, had not the increasing necessities of the increased density of population and the comparing of methods as a result of the intermingling of nationalities caused a change from the learning to do by doing to the learning to do by **thinking,** we would yet be using the mechanical appliances of medieval civilization. From the doing and doing over and over to get the "knack" or learn to imitate, the industrial advance has led to the thinking out of principles making the doing not the learning, but the test of the thinking which has preceded. This gives a foundation for growth; for there is no limit to the mind's activity. The handing down from generation to generation of tool processes or trade maniuplations gradually ceases to be a factor and more and more each generation fits for work by the applying of principles, disregarding the details of imitation. This gives freedom and the era of invention is a necessary consequence. No child feels obliged to do just as his parent did. He

has learned a principle on which the operation or process is based and feels free to make use of any muscular movement that does not do violence to the principle. The working out of these principles also eliminates many operations of the ancient craftsman because they are not in harmony with established law.

Source of Progress

The development of the science of working solid materials not only gives freedom to use a large variety of processes or methods, but also is quite as useful in eliminating many methods of work which have come down to us by rule of thumb or blind imitation, and which are neither efficient nor intellectual.

This not only leads to progress in industry, but also to the building up of an intellectual side to industrial work. It is because of this change from imitative methods to those resulting from a study of the underlying principles of industrial work that modern industry has made so rapid an advance, has become so intensive, and has made the better classes of workmen intelligent members of society. It is this side of the work that gives to it its place in the schools, and it is the failing to recognize this that makes the present discussion of manual training lead into so many vagaries and the work of so many

schools fail to produce the desired results in the industrial efficiency of their pupils.

Why They Fail

Observing the physical side of the work, and not having gone deeply into the study of the science underlying industrial pursuits, those who are in a position to do much good fail to give material aid because from their position of observation they are unable to see that there is a science underlying the working of solid materials, a science which, tho in its first stages of development, is yet sufficiently well defined to supply the material for our school shops, or that part of our school work leading to the industries.

When this fact is realized and we proceed to base our school shop work on science instead of tool processes, history, art, or what-not, there will be no call for specialization in the grades, and possibly not in the high school, nor will there be any need to separate those expecting to enter industrial lines from those fitting for the professions, because the study of the science of working solid materials is quite as valuable a part of a liberal education as the study of any other science. Nor will there be any necessity for the introduction of matter foreign to the study of this science to give either interest or cultural value. All attempts to make of the school

shop a study of things other than the science of working solid materials are abortive and an acknowledgment that the real subject matter has been overlooked.

Our Duty

Our present duty is to all pull together to gather the necessary material for the thoro establishing of this science, to eliminate the unscientific, the work that is based upon imitation, and the work that leads only to disconnected facts or details, to try thoroly each statement of principle as to its truth, and then as to its use as a part of a broad foundation for industrial work.

By pursuing this course we can soon have such a valuable science as a basis for all industrial lines that the pupil on leaving school, will be as reasonably assured of success in any industry as he now is in other lines. He will not only be free to enter any one of many occupations, but also will have a breadth of foundation that will serve him well in case at some time circumstances necessitate his changing from his chosen line to a widely differing one.

Viewed as a part of a liberal education, manual training is that branch of school work in which the mental activity of the pupil is tested by work upon solid materials.

The Subject Matter of Manual Training

To know that manual training is a science is but the beginning of the work necessary to its establishing as a part of our school work. Those who are familiar with the history of the introduction and development of mathematics, physics and chemistry as parts of our school course have a basis for comparison in anticipating the nature of the task before those working for a rational course in manual training, or mechanical science. The latter term seems to indicate very clearly the nature of this division of educational work, and I think we may use it until a better name is found.

Apparatus and Principles

The first and obvious conclusion after we learn that it is a science is that this material is in the realm of law or principle rather than in physical form. Altho, like physics, mechanical science requires for its convenient study a quantity of apparatus, yet, like physics, this apparatus is not the

science, but the means of demonstrating it. The bench, the lathe, the chisel, plane, and saw are not implements to be manipulated for the purpose of the manipulation; but pieces of apparatus to be used in certain definite ways, so that a law or principle may be learned or demonstrated. The work of the shop is not to learn a series of physical movements, but to make use of certain carefully selected movements in order to learn fundamental principles that may be used in the determining of a variety of movements.

The inclined plane and balls in the physics laboratory are not for the purpose of giving skill in rolling balls, but to afford an opportunity to roll balls in such a way as to demonstrate the laws of falling bodies. One who has no knowledge of the physical sciences might roll balls all his days, even until he became more skilled in handling them than the student or teacher of physics; and yet never even so much as surmise that there are any laws of falling bodies. In like manner the imitative mechanic may use the tools of the trades all his life and never discover that there are any scientific principles in or back of these movements of tools. In fact, a careful scrutiny of men at work will reveal that herein lies a great deal of the difference between workmen, one working blindly to "get the knack," to practice until he "catches on," to "keep trying until he gets it," to "develop skill" and the other working thoughtfully, making use of such principles as he has been

able to discover. It is the principles worked out by individual workmen and tben gathered into a course that give a basis for our manual training or mechanical science work, just as the gathering together of the laws worked out by various students of natural philosophy has given us the science of physics.

The Selection of Materials

The gathering together of this more or less crude material is but the start in getting the subject matter for a school course in mechanical science. To yield a proper return for time and effort and the large expense usually incident to the teaching of shop work the material must be thoroly sifted, classified and worked over to yield the largest possible value for the outlay. This process of elimination and refining has no limit so long as the race progresses, and therefore our subject matter can not become a fixed quantity. All we can do is to be certain that we have the best obtainable at the present time.

This naturally leads us to surmise that certain lines of mechanical work will yield better material than others, because some lines have received a larger amount of intellectual effort. I think observation bears out this suspicion, and that a thoro study of modern industries will convince us that

some occupations are much farther advanced than others; that some are well established on scientific principles, while others are yet in the stage of craftsmanship. Therefore ,we must find our subject matter in those industries that are highly developed, or, in other words, those industries that have a basis in scientific tool usage rather than in imitative processes or craftsmanship.

Eliminating the Unscientific

But this is not all. In the present state of development no industry is entirely scientific, nor is any modern industry entirely lacking in scientific principles. It is therefore a most difficult task and a matter of the most serious importance, after we have determined what lines of work to make use of in our schools, to select from each line or trade that which is scientific and eliminate that which is not.

To introduce woodwork or any other of the highly developed occupations may mean the study of scientific principles of large application and great value; or it may mean simply the making of a few articles and the establishing of habits of work that will hinder rather than help, should the pupil attempt work in any industry.

Our subject matter cannot be selected by trades or groups, but must be determined by a rigid test to exclude that which is not scientific. Even after we

have found that part which is scientific we have not done all possible, for even then there is opportunity for choice. Some of the principles may be of larger value than others, and if we will do that which is best we must make use of those things of largest value.

Universality of Principles

In our study to determine those principles of largest value we discover that many of the principles are not confined in their application to any one trade or occupation, but that they are of such broad application that when learned in one material they are easily applied to other materials, even without any study in school of the other material. We find that altho the tools and appliances used in the various industries differ widely, yet the principles governing their use are all but universal.

This relieves our school shops of all necessity of specialization or the use of detailed subject matter of special trades until these general principles have been learned. Such a division of the work is not only unnecessary, but is actually injurious to both the course and the pupil, for it tends to place in the course details not worth the time to learn and also to rob the pupil by crowding out the study of general principles which have a value as a part of a liberal education.

Therefore our subject matter for manual training is that part of the knowledge of working solid materials that is based upon scientific principles of the largest value, and the work of our school shops is the doing of such things as will best demonstrate and teach those principles.

The Attitude of Pupils

In any line of work, either in school or out, the attitude of the worker has much to do with the result. Altho this may be of no more consequence in manual training than in other branches, so greatly do the pupils vary in their reasons for taking up this work and in their attitude towards it, that the matter of attitude becomes an element of chief importance. It not only has much to do with the methods of instruction, but also with the selection of material; the position of the branch in the course and its rank as a factor of a liberal education. The attitude of the pupil may determine whether the shop work is a part of a well organized course giving a liberal education or a "patch on an over-crowded curriculum."

What Should He Think About?

As a pupil takes up his plane or other tool, or a bit of material, what should he be thinking about? This may appear to be a trivial question. The answers to it vary greatly as given by different instructors. One pupil receives a bit of wood and at once a vision of a rule, plant stick, or other object

appears. Another pupil receives a similar piece and at once the word "wood" is suggested. This is followed by visions of lumber piles and perhaps trees. Such a train of thought may continue until the pupil is day-dreaming of some trip to the woods. It may recall the pleasures of tree-climbing until the piece of material in his hands, tools, bench and school shop are all forgotten and he is mentally in the top of some tree. Another pupil with his piece of wood in hand thinks neither of wood, lumber, trees or plant stick, but recalls some similar task and begins to plan how he may use what he learned in the former task in accomplishing this one. I venture to say that if we could read the minds of the pupils in some manual training classes, we would find some in trees, some using their plant sticks in flower gardens, and very few, if any, actually engaged in the thoughtful use of the tools required to make the desired piece.

Are these the correct places for their minds? Are these pupils, whose minds are away from the bench, gaining what they ought from the work? Perhaps some will hold the opinion that the manual training class is the place in which pupils are to proceed to the ends of the earth while their hands are absent-mindedly pushing a file or drawing a spoke shave. If this is the proper attitude, then what is the actual value of the tool work? Why are the pupils given tools at all?

Movements Should Be Definitely Directed

The merest novice in physical culture would not expect to get results worth while by muscular movements not definitely directed. Can we expect in the work shop to get intellectual results from such movements? We certainly do not consider a movement of the hand or arm definitely directed, when the thought is only to get something done. To get something done may lead to the employment of another person to do it. The boy who wants a plant stick may get it by stealing, buying it or by hiring some one to make it, or by loafing about until he is given one. Any of these methods may get the plant stick. It is evident that if he is to make the stick, another element is essential and that element is the method of making; but to recognize that there is this other step is not all. A boy may want the object, recognize that work is necessary, and that it is all to a good purpose, and yet fail entirely to get the intellectual benefit from the muscular movements. He must go a step further and recognize the fact that there is a definite way in which to proceed, and that only by use of these definite methods can he get the best results in grade of work and time. There is yet another step: He must recognize the fact that these definite things are essential and must be learned, not gained by imitation. They must be to him real intellectual activities, not muscular movements copied from another. They must be things

for his mind to do, not muscular reactions for his hands and arms only. When this step is taken the shop work ceases to be so largely a physical activity, the physical side being akin to the chalk, blackboard and muscular part of working a problem or the use of apparatus in demonstrating principles in the physics laboratory.

Every Movement a Victory

The mind is no longer a "silent partner" in the work, but is actively planning and directing each movement; it ceases to look for operations to be imitated, reasoning out from what has been learned, methods applicable to the present task. The pupil ceases to ask how, rather asking why. This gives to every task a definite intellectual content, rendering the pupil capable of taking an invoice of each day's recitation, and instead of the dead subject of tool operations, requiring a taboret to get them done, the work becomes full of life. Every movement of a tool is a victory in the demonstrating of some principle in which the pupil has become deeply interested. He no longer thinks of the object, but of the thing he is learning, for he realizes that there is something to learn and that day by day he is making definite progress and gaining in ability to do really difficult work.

Desire for Power a Controlling Force

Emerson tells us, "Life is a search after power." Altho each of us might choose to express this idea in a different form, yet we all recognize that the great moving force in all human activity is a desire for power, not the use of power to oppress, not the use of power to plunder, not the use of power to gather everything into one's own storehouses, but the realization of power within. The power will be used in different ways by different people according to their moral control, or training, but the fundamental desire for a realization of power is the same in all.

We must not fail to distinguish between the condition of possessing power that is not realized, a false belief in the possession of power, and the actual possession of power which is fully and definitely realized. Herein lies one of the chief values of shop work when properly taught, for in few, if in any other subjects, is it possible to give such exact tests for the purpose of causing a correct estimation and realization of the pupil's strength and growth from day to day.

Not only should the teacher strive to gain this attitude on the part of the pupil, but realizing the harm which may come from a false estimate of one's capabilities, no effort should be spared to so arrange the work that a true estimate will be gained. A

false estimate may be established and pupils may be made to believe that they are learning and accomplishing that which is building them up in power to do the world's work, but such a false estimate is sure to be discovered should the pupil attempt the practical application of his acquisitions.

A Change in Methods

That such has been the case in some sections is evident from the reports of pupils failing to "make good" after leaving school. This has caused a change in the courses in some schools with a change in the attitude of the pupils. The impossibility of continuing to gain the attitude of study, because of former pupils failing to use usccessfully their school shop training, leads to various expedients to continue an interest which has lost its vitalizing force and the shop becomes a place to do or study a variety of things not capable of the exact tests, and knowledge for which the manual training schools were originally established.

Let Us Acknowledge Our Failure

Is it not better to frankly acknowledge our failure to teach correctly the things we have attempted and begin sifting and improving the subject matter until we can teach fundamental prin-

ciples of industrial work, striving for an attitude of study and desire for growth on the part of the pupils, rather than to bring in matters foreign to the manual training work and gain a false interest in the shops of the regular schools, making necessary the establishing of variously named schools to give the advantages that, with properly taught shop classes, could easily be given in the regular schools?

To secure this attitude of study on the part of the pupil, should be a controlling factor in the organization and teaching of the shop work. It should determine the first lesson and make it of such a nature that the pupil will see in the shop work a means of gaining power and fix the mental attitude not upon acquisiton of material things, but upon the increase of power which results from a definite realization that every stroke of the plane means not alone a trued surface, but increased power to true a surface; that every nail driven means not alone a bit of work completed, but an increase of power to do work. When finally the surface is trued, the attitude should be not that of a disagreeable task done for the purpose of a true surface or a plant stick, but a realization of power gained, and a wish for more surfaces to true.

The warrior who sat down and wept for more worlds to conquer had simply taken a course on a large scale in the gaining of power. I am not in sympathy with the subject matter of his course, but

I do admire his attitude toward his work. Give to the boy or girl the manual training work with hammer and saw, instead of sword and spear, so that they will gain the same attitude because of each day having a definite realization of increasing power, and there will be no lack of properly qualified hands to do the world's work, either mechanical or professional. Degrade the work by making it a task for a prize, whether it be a card, a medal or a taboret, and your pupils will go out into the activities of life, not looking for opportunities to use their strength, but inquiring by what means a taboret can be most easily obtained.

Manual Training and Industry

We come now to a very important part of the manual training problem, for, altho manual training is believed by many to be equal in rank as a factor of a liberal education to any of the old line subjects, yet in the final test it will undoubtedly stand because of its industrial worth, or fall because it does not demonstrate its special value for those who engage in some branch of manufacturing. It is well, therefore, to consider carefully each detail of the work that we may give to the school shop the largest possible industrial value consistent with this branch being a part of a course yielding a liberal education. We may discover that when the work is properly taught there will be no conflict between the industrial and educational values.

In developing a branch that differs in so many ways from those considered as fixed subjects of our school course, it is not easy to determine what its scope shall be to yield the results desired. In fact there is not yet a unanimous agreement as to what ought to result from the teaching of shopwork in the public schools. At the present time we may profitably consider both that which is needed to fit the pupils to do the work of a tradesman as at

present carried on and also that which will best lead toward ideal efficiency and the highest type of manhood and citizenship.

Two Factors Necessary

Two factors are necessary for the highest type of workman aside from general intelligence. First is competency to do the work. Second, often of as much importance as the first, is adaptability, the power by which the workman is able to change employment with a minimum of loss, both to himself and to his employer. This change may be for the purpose of developing a new line of work without change of employer, or it may be a change from one establishment to another. The first factor may result from long experience with limited intellectual activity. The latter can come only thru a thoro knowledge of the principles common to a variety of occupations.

Industrial education cannot wait for the development of some theory, but must show some results worth while as the theories are being worked out. Neither can we expect the public to tolerate experimenting, based only on the theories developed apart from the actual activities of occupational life. We should, however, aim not simply at the production of a class of workmen on the level of present industrial life, but ought rather to strive for the

advancement of the work to the best system of production, and the advancement of the worker to the largest efficiency and highest type of workman.

Great Diversity of Industries

We may gain information to guide us in planning our new line of school work by a study of industrial life. Such an investigation leads at once to the observation that our industries comprise an extremely wide range of activities. It is, therefore, necessary to decide whether a pupil should be fitted for only one industry or given a training that will make possible the successful entering of any of a large class of industries.

Should we attempt to fit for a single industry, we meet the serious difficulty of various practices in identically the same line of work. Many illustrations can be given to prove this point. The following statement in a technical periodical is sufficient: "It is always interesting to note the various ways in which the same class of material is handled in different shops. Of course, this difference is sometimes a case of necessity rather than choice, as a shop is often originally planned and equipped for an entirely different class of work from that for which it is finally used, but even where shops have been fitted up expressly for certain similar lines of work, the divergence in methods or tools is often very marked."

This variety in methods in the same industry as well as the great diversity of industries, is a factor to be reckoned with in every community attempting any sort of specialization in the schools. So evident is this multiplicity of trades and occupations that it seems that those who believe the schools can fit for individual trades have the burden of proof on their hands, and until there is a reasonable proof that the communities can be generally accommodated by such schools, we may reasonably assume that the public school cannot develop a line of trade schools sufficiently comprehensive and diversified to accommodate the public as a whole.

Even if by application of the rule of the greatest good to the greatest number, we succeed in establishing trade schools in various communities, each accommodating the leading occupations of its community or city, are we doing the best for the community as a whole? Can any division of our population receive the best that is its due if the boys and girls are born to an occupation as must necessarily follow such a community specialization?

Two Types of Workmen

A further evidence of this variety in shop detail and the inefficiency of simple trade instruction is shown by the different degrees of success met with by men as they move from one shop to another.

Some change from place to place, each time advancing in their work; others, on leaving the shop where they first learned their work or trade, find themselves unable to meet the conditions of the new place. They are obliged to begin again, making little use of their first training. A thorough study of these types of workmen reveals that one has been ever a student of principles, the other has worked just as hard learning tool manipulations and may be fairly capable of studying the work in the other manner, if properly directed. Shall the school courses be organized on the plan of actual shop life, permitting each pupil to progress under instruction similar to that of actual apprenticeship training, teaching tool manipulations and processes with only the exceptional pupil gaining a knowledge of principles? Or, is the work to be made a real school subject and handled according to well established pedagogical laws so that every pupil will be led into the broader field of trade work?

In determining the name and character of our schools, we must not overlook the fact that a school may be called a trade school and yet do much more than teach a trade or a certain number of trades and also that a school may be named the very opposite of a trade school and yet teach only trade manipulations of very limited value. Excellent illustrations of this statement are to be found in some of our most prominent schools.

School Shops Should not Drill for Skill

To treat the shop work of the school as craftsmanship, drilling for skill in some special line, or in certain selected tool manipulations, whether from one trade or from several trades, is to turn out a class of pupils of more or less efficiency with but a small percentage capable of adapting themselves to a sufficiently wide range of occupations to insure more than ordinary success, and this is now gained by a large number of boys without the advantage of a mechanical school. Unless the school shop can show returns exceeding, to a considerable extent, the ordinary conditions of training, there will be great difficulty in sustaining them at public expense. That pupils may receive some advantage because of opportunities to learn drawing, mathematics, etc., and because of this show themselves superior to the ordinary shop apprentice, is no excuse for not giving the best possible shop training.

In our enthusiasm, we ought not to overlook the fact that there are several things that may increase the standing of the young mechanic. If a boy who has completed a certain course goes into a factory and is advanced over boys who have had substantially no schooling, it does not prove that every branch of the course has been what it ought to have been, or even helpful. In so large a number

of subjects, the sum total may be helpful while some of the factors are decidedly harmful. It is not a question of making one boy better than another, but rather of making each boy the best possible

Strive for Larger Things

It, therefore, appears that if the school shop is to give results to warrant its cost, it must turn to the larger successes of trade life, a large percentage of those who pursue its courses. This does not mean that they are to train for foremen, superinendents, or other executive positions, but that they are to give to a large percentage of pupils such a training as will lead them to a thoro knowledge of the principles underlying the every day details of work, and because of this, to use a high degree of intelligence in their common occupations. This does not mean that the special aim of the manual training school is to make of the boy an intellectual citizen. This is already accomplished by the old line subjects. The special feature to be added by this new line of school work is the making of his daily labors such as will require and continually build up his intellectual activities. This necessitates not simply the teaching of the boy to do a certain line of work, but rather the teaching him to do his work in such a manner as will cause a large use of his mind and consequent growth of intelligence.

Shopwork in school is not so much for the purpose of teaching tool work as for the purpose of improving the intellectual and manhood factors in the work. In one sense, its purpose is similar to that of teaching literature. That is taught not for the purpose of teaching reading but for the purpose of getting out of reading that which will build up the larger and higher intellectual activities. Shop work should be taught not simply to make the pupils work, but for the purpose of getting out of work the highest and noblest that is possible.

Make the Workman Intellectual

We must not forget that a higher grade of intelligence can be maintained only by making the work of a more intellectual nature. To attempt to lift the workman by patching on to his education a little superficial knowledge of various outside lines of "culture" or by teaching him a lot of details in his own trade which he is not likely to use while leaving him to do his daily tasks by blind imitation and the muscular reactions which result from skill alone, is to fail in our efforts to elevate the tone of industrial life; for, unless we train the workman so that his mind is built up by the work on which he is daily engaged, his power to benefit by extraneous training is sooner or later lost because of the impossibility of a mind more or less dormant through the active working

hours continuing to respond to outside influences.

Industrial education should aim to make the task of the industrial worker as highly intellectual as possible, replacing in a continually greater degree, "rule of thumb" and imitative methods by the highly developed scientific methods of modern mechanical science. It should mean not simply more boys entering industrial lines, but also a larger intelligence in industrial work. It should mean a constantly increasing number of workmen that put independent intellectual activity behind the routine and muscle of their daily tasks.

Makes Labor Honorable.

If the work of the tradesman is given the intellectual basis which it ought to have, there will be no lack of those to enter these lines, for such a foundation for the work must necessarily give it a standing and respect before all that will tend to make honorable the entering upon the life of a scientific worker in materials. To say that all work is honorable and try to create a respect for labor by having pupils perform certain tasks having some of the characteristics of daily toil is only to burlesque the whole matter. Take away from the commonly called lowly occupations of mankind, the long hours, the continued routine, the special conditions under which the laborer exists

and the necessity for labor and they cease to be lowly occupations. None of these conditions of the laborer are possible in any sort of a free public educational institution. On the other hand, make the laborer a student of the laws governing his work, cause the whole community to realize that there is a foundation in law capable of being treated as a science for all the laborer does and that he actually knows this science and is governed by it in his daily work, and he becomes a respected member of society because the intellectual obscures the physical. Allow the intellectual to subside and the physical to predominate and that man enters again the ranks of the "toilers." Respect is of the mind and its appreciation is for that which shows mental power.

Not a "Fad."

This we believe is the ideal aim of shop work at public expense. If so, it is neither a fad nor a patch upon the public curriculum, but the legitimate result of that advance in mechanical work which has changed the working of solid materials from cut and try and imitative methods to those based upon scientific principles. It is not the forcing into the schools of matter outside the legitimate lines of public school work, but rather the reaching out of the schools for a new and advanced line of intellectual activity to give to the curriculum a yet stronger

and more efficient means of supplying to all a liberal education.

And why may not this be the aim of this new branch of school work? No shadow of evidence exists showing that by striving for the larger values we will lose any of the lesser advantages. No more equipment is required, no longer hours are needed. No less interest in the work and no less usefulness can be the result on leaving school.

Boys and girls who have learned to put intelligence into the common tasks of life can do them quite as quickly and as well—we do not need to argue that they can do them better—while over and above all they can live better lives as common workers, and, should opportunity offer, they are ready to do something larger for the benefit of themselves and the community that fitted them broadly for a life's work.

Methods of Instruction

Following our inquiry in regard to the nature of manual training, the subject matter of instruction, the attitude of the pupil in the classroom, and the relation of manual training work to the industrial world, naturally arises the question of actual classroom methods in such a system of manual training. It is not necessary that at this time we enter into a consideration of the datails of classroom practice, but rather touch upon some of the more important features that distinguish scientific manual traning or mechanical science from that of trade instruction or craftsmanship.

To those who look upon the shop work as necessarily a sort of recreation period, the teaching of a science with the pupils hard at work studying a text book and working to demonstrate principles, seems an impossibility, yet this is what actually takes place where scientific manual training is properly taught. Methods that will give this result are not so difficult as some suppose, as has been demonstrated.

That the attitude of the teachers and their knowledge of the work has much to do with the methods of instruction is too well understood by all school people to require any argument. We will assume

that the instructor is fully prepared and thoroughly in earnest. That such instructors cannot be found at present for all schools need not be considered in this connection.

Lessons Should Be Definite.

The first thing that the pupil is to take away with him is a definite feeling that he has learned something. Therefore the first lesson should be planned with a definite idea in it that is within the reach of the pupil. The instructor must ever keep in mind that the thing he is teaching is not history, botany, physics or even mechanical engineering, but the science of working solid materials, and must therefore use such methods as will draw upon this science for the ideas to be taught. This does not hinder such a consideration and correlation of other branches as may be gathered around the mechanical science with it as a center and basis for the whole.

The giving of this definite idea in the first lesson necessarily compels a very careful planning of the lesson, not only to be sure that the idea is in the lesson, but also that the pupil will actually get the idea instead of doing the work by blind imitation of certain muscular movements. This difficulty is akin to that of getting the pupil to understand a rule in mathematics, a proposition in geometry or a law in physics rather then merely committing the words

by rote. The instruction of the shop, however, has a great advantage over that of any other branch, because it is possible here to make the demonstration so vivid that an attempt to do the work by blind imitation is sure not only to be discovered by the instructor, but also to be realized by the pupil to such an extent as will compel a study and understanding of the idea behind the movement of hand or tool. Therefore one of the most important things is to start out in a manner to gain this study of the principles to avoid the doing of the work by imitation.

Limit of Accuracy.

Questioning should be the plan of instruction rather than telling. Working for a knowledge of the principles rather than grade of work should be the aim. The degree of accuracy to be required will than be determined by whether the point being taught is well understood. To reach a close measurement or to keep the corners and edges sharp is not a matter of skill but of knowledge of principles. To have a certain fraction of an inch as a standard to work to is certain to defeat the purpose of the work, for this leads the pupil to employ any method that will bring the material within the allowed variations. To have no standard other than the demonstrating of the principle must necessarily

result in a large percentage of the work being brot to a very much higher degree of perfection than it would be safe to place as an arbitrary limit, at the same time leaving an opportunity for the passing of particular pieces that for special reasons are not as accurate as usually required. It is the same in principle as expecting absolute accuracy in arithmetic with the occasional accepting of a problem in which all the chief operations and principles are correct but the answer out because of a slight error in a minor operation. That this method in shop work does actually result in a high degree of accuracy is evidenced by the fact that teachers using the set standrad of a certain fraction of an inch are unable to understand how the pupils in scientific manual training work to such close limits.

Again, this standard of excellence is not to be determined and attained by a continued criticising and compelling of the pupil to go over and over his work correcting little errors pointed out by the instructor, but rather it must be attained by a definite working to a satisfactory standard by the application of the principles taught. It must be the direct and legitimate result of the application of the principles without the aid of the instructor in pointing out small variations.

A shop method that permits a pupil to hesitatingly work first to an approximate size and then rework and rework, gradually approaching the line,

is as pernicious in the shop as the writing of an answer to a problem in arithmetic and then guessing and trying to fill in the various operations.

The principle should be understood as a result of a step by step progress from the known to the unknown, and the result in the shop should be as certain and direct as the solving of a problem in mathematics. There must also be this advantage in the shop work, i. e., each problem must be so graded and adapted to the pupil that a reasonable effort will result in a correct solution. This of course excludes from the shop all wild, half thought out schemes of the pupils. In fact, proper methods of shop work will result in the pupil asking advice of the instructor for the purpose of selecting a project that will be of large value in what it will teach rather than in filling some material want. Probably in no other feature of the shop work is it so difficult for the layman to distinguish between that which tends to scientific manual training and that which does not as in the larger problems or projects.

The "Cants"

The boy who "can't" or knows he "can't" should be taken in hand and made to see so clearly that he can if he will study his text, that he will realize his failure is his own fault because of not studying. If the teacher has a proper knowledge of the work

and methods of teaching, the "can't's" will rapidly vanish, for as the scientific treatment of the work reduces the matter of skill to almost a negligible quantity, success becomes almost solely a matter of study and mental activity, and, therefore, every pupil having normal mental power is with reasonable application able to succeed. This is not saying that all pupils will attain the same grade of work, but rather that all will attain a successful minimum. Further, this minimum need never be below a thoroughly well finished problem, and cannot be if the instructor use such methods as compel the learning of the principles and their definite application to each problem.

Demonstrations

The method of presenting the instruction is a matter of chief importance. In the teaching of scientific manual training there should never be given a demonstration for a whole class. The need for class demonstrations can come only from a wrong attitude towards the work on the part of both the teacher and pupils. After the pupil has studied the textbook and has done all in his power to learn and apply it, he may fail to grasp some point. It is then the duty of the teacher to find out exactly what is lacking and by some means help the pupil out. This may often be done by questioning on

the text. Sometimes additional directions may be given orally. Sometimes the teacher may answer the definite question of the pupil by the use of a tool. It is not necessary for me to argue that this answering of a definite question is essentially different from a demonstration lesson, altho a part of the very same operation may be performed. In one case the pupil is looking for something to imitate, in the other he is thinking and looking for an idea to complete his thought.

The class demonstration continually weakens the pupil by increasing his dependence on another. The texbook and explination method increases continually the pupil's strength by making him capable of doing without any personal assistance. In fact, as has been proven by experience, he soon learns to reason out step by step from what he knows difficult problems that are not answered even in the text. This continued through a fair school course gives the pupil power, on leaving school, to enter any of a large number of industries and with little or no assistance or "showing" reason out the needed new processes from the principles he has as his stock in trade. If he finds his stock too limited or incomplete in some detail, he has learned to go to books for help and will likely have no difficulty in finding a book that will give the desired assistance.

The Nature of the Text

If so much is to be gained from the study of mechanical science by the use of a text, it is evident that the character of the text is of great importance. As the chief value of the text is not to give information but to lead to generalizations and a knowledge of principles, it is essential that the text be such a carefully and systematically planned course as will give this result. For this reason the basing of the work on reference books, or the use of methods or projects that require a large use of random references, is certain to cause a failure to get the intellectual out of the work.

If the pupil is allowed to plan his work and carry it forward by use of reference works or by the assistance of the instructor he must necessarily base his course on the project, and this in turn necessitates the steps in the project determining the order of study, and the getting of something done the ultimate aim. There is, therefore, no power to cause the pupil to study a single principle underlying the work he is doing. All he requires and all he will get is a process or so much of a process as he needs on his project. This bit of detail or information is not necessarily connected with anything that precedes or follows, and therefore, having no logical connection with anything is soon forgotten. The result is that definite progress is not assured

and the completion of such a course no evidence of ability to handle new problems. It is not certain that the pupil can repeat the very problems worked out in his school course, for each detail having been learned for immediate use and not connected by any underlying principles with other details is often forgotten as soon as used, so that at the end of the course the only things noticeable that the pupil carries away from the school are a poorly executed problem and a large over-estimate of his knowledge of mechanical work. The writer has often seen this demonstrated by pupils who have applied to him for advanced credit after completing a part or all of the work at well known institutions. It may be found that this method of class demonstration and the attempt to complete a course in school shop work by basing the instruction on the project instead of following definitely planned courses by the use of regular texts is the chief reason why so many pupils from the manual training schools fail to make good in industry. This naturally leads to the demand for other types of schools for the teaching of industrial work. If the root of the difficulty is in the methods of instruction employed in the common schools, would it not be wise first to improve these methods before going to the large expense of establishing separate schools? Investigation by those in authority ought to bring about such a comparative study as to determine the best methods.

Failures in Old-Line Methods

The writer has found much evidence of the failure of the old-line methods, not only in his work with pupils in the grades and in high school, but also with those who have been prepared by well known institutions as teachers of manual training. These people, graduates of what are supposed to be our best schools, were found to be unable to perform in a proper manner many of the elementary tool operations. On taking up scientific manual training they have confessed that their former course has somehow failed to provide them with the information, but that until actually studying the scientific principles of working materials they did not realize that their course was so defective. The comparison made by some of these pupils, those ranking high in their credits in old-line work, would be considered gross exaggeration by those not familiar with the two systems of work.

Lack of an Established Standard

There can be no question but that the most serious difficulty at present in the building up of a course in school shopwork and the establishing of proper methods of shop instruction is the lack of proper and well understood standards with which to compare results. The work is established in a

school or possibly in an entire school system and the work done is thought to be ideal. Teachers and pupils are delighted. Large and showy projects are made and pupils, teachers and parents believe that wonders have been accomplished. Eventually some of the pupils find employment in shops or factories and the school shopwork is credited with the success. No careful analysis is made to determine what part of the work is responsible for the results. Seldom if ever are the methods of school shopwork and the methods of instruction definitely criticised, and last but not least, the fact that boys have entered shops and factories in large numbers and have met with success without any school shopwork is overlooked. The determining of a standard for comparison will aid greatly in answering the question: Are the methods in use in the school shops actually producing results with the pupils that especially need this work? There is another question that has not yet been satisfactorily answered in many sections: Are the results of a permanent character, or only those contingent on the work being new and appealing to a superficial interest by its novelty?

Spoiling Work

Another method peculiar to scientific manual training is the conducting of the class work so that

a piece is seldom spoiled. Only in a very exceptional case is any pupil given a duplicate piece of material. This tends to a careful planning of work, care and system in the work, and the largest possible thought factor in every detail. It is the logical sequence of teaching principles which proceed from the known to the unknown by such steps as the pupil is able to take with certainty, and therefore there is little opportunity for spoiled projects or spoiled pieces of even small size. This avoiding of spoiled work is not to be accomplished by having the pupil lay aside his regular work from time to time and practice the various operations on extra material. With the study of principles rather than processes there is really nothing to practice, for if the principle is well understood the result is correct the first time; if it is not understood, the proper course to pursue is to get an understanding of it before attempting to apply it in the working of the material.

Although this avoids waste of material and reduces to a considerable degree the expense of carrying on the shopwork, yet its chief value is in the constant increase in the power and confidence of the pupil that naturally follows the doing of tasks each more and more difficult and yet without any failures.

For pupils to demonstrate to themselves by the use of properly graded shop work that they can by

proper study and effort do new and difficult tasks with a certainty that they will succeed is one of the largest possible benefits that can come from any sort of school or educational work. Is it not therefore reasonable to place a very high value on methods that will yield this return and on a system of work that readily affords an opportunity for such methods?

Our Duty Toward the Manual Training Movement

This series of articles would be incomplete were they to close without pointing out some ways in which this movement may be aided by those interested in the welfare of our educational system and the children. It is not an easy task to point out what is needed to be done without noticing some of the deficiencies of the work as at present given in our leading schools. As we have worked and observed the work of others almost since the first manual training schools were established, we have been unwillingly forced to the conclusion that the greatest harm done to the cause is the withholding of just criticisms for fear that some one would be led to believe that the whole manual trainiug idea is wrong. To such an extent has this feeling prevailed that even those striving diligently for the right have been forced to yield to improper methods of work because of the popularity of superficial and showy attempts by others to get results that would appeal to those having no knowledge or understanding of the larger values of manual training work.

In our criticisms and attempts to point out ways and means of aiding this movement, it must not be understood that we believe no good has yet come from the various attempts at school shopwork. "The past has taught its lesson, the present has its duty, the future its hope," and without taking space to review what has been done, let us consider our duty at the present, not as passive recipients of the good the work is doing, but as factors in advancing this branch of school work. This subject, though well enough established to leave little doubt of its continuance as a part of school work, is yet new and immature when compared with the possibilities before it and, therefore, has a claim on all for whatever aid is in their power to give.

Our Chief Difficlty

Perhaps our chief difficulty lies in placing too much emphasis on what has been accomplished, for as we review the long list of benefits already received we feel that our duty to the movement has been discharged and that now all we have to do is to continue along present lines, or, in other words we fail to realize that we are dealing with a new and most powerful factor that is to develop into one of the most important factors in a system povinding a liberal education.

Because of our experince with other subjects of the school course we make use of a false standard and fail to realise how much more can be accomplished by this new subject. We rest content, feeling that its limit has been reached when in reality the results obtained are insignificant compared with what should be accomplished. No doubt this lack of a proper standard for comparison is the cause of much of the slackness in the administration of this part of our school work.

Should we criticise the work in any other subject of the school course we would judge it as to whether it taught the thing intended or not and we would permit no indefinite guessing as to what was to be taught. If we were to pass judgment on the value of a composition on American history, we would not ignore the errors in historical facts and call the paper excellent because the writer had made a fine appearing paper by aid of a writing machine, nor would we condemn a historical paper of a high order because the writing was only ordinary.

Yet we see shop work judged excellent because the pupil, or teacher, selected an artistic design, although the construction is of an extremely poor quality and lacking in all the more valuable features of manual training work. We also see other work condemned because the design is not the most replete with curves and surface decoration, although it shows not only excellent workmanship, but also

demonstrates large growth in both mechanical efficiency and intellectual power. To such an extent is the work based on design and superficial appearance in one of the most noted manual training schools of this country that the advance in knowledge of working materials is all but a negligible quantity throughout the course, except with such few pupils as have a sufficiently large natural ability to dig out these principles in addition to any requirements of the schools. In fact, the only pupils that appear to be advanced to any noticeable degree in the line of mechanical work, or to receive any intellectual growth from the use of tools, are those who would "dig out a trade" without a teacher if given tools and a place for work. Are we doing our duty by the pupils and the taxpayers when we establish expensive manual training schools and allow such methods of work as permit the shops and mechanical courses to be only passive elements in the school work.

Not Finding Fault

This is not finding fault with good design or art, but as no one has yet given any reason whaterve why we cannot have these things together with the learning of the things for which manual training was established, it seems that some one has a serious duty to perfonm when

we see schools in which various other lines of work have largely or entirely displaced the manual training work, although making use of the forms and tools properly belonging to the manual training. One does not need to visit many leading manual training schools to find, if he will take the trouble to see exactly what is being done, pupils who have passed through the woodshops with no apparent growth in ability to work solid materials nor with any of the intellectual growth that should result from a thorough and definite study of mechanical science.

Teacher's Qualifications

Closely allied with our duty in criticising the work is that of careful scrutiny of the teacher's qualifications. As an example, Mr. G— secured a position in one of our largest cities as instructor in shopwork in a ward school. He was recommended by a school known to substantially all educators as a school especially qualified to fit pupils for teaching manual training. The actual preparation that this teacher received was some of the school's theories and shop practice, consisting of the making of a "plant label" and partly making a "plant stick." On being asked how he managed to get along on such a limited knowledge of tool work, he replied that for the first three months he

watched the pupils to see how they did the work. At the time the writer visited this school the work was still crude attempts at making articles, mostly of doubtful value, with very little learned.

The writer's observations confirm the statement of many practical men that there is altogether too large a percentage of people in the school woodshops who have nothing to teach in the line of woodwork and are therefore bluffing and trying to make a showing by pointing to the "design," the "art," the "self-activity of the pupil" and various other outside matters to cover up their total deficiency in knowledge of working materials.

Another Example

Again, in a city especially favored with an enthusiastic superintendent and abundant means, various systems of manual training were supposed to be tried out and conclusions reached. The writer, anxious to get the best to be had, took occasion to attend as a regular pupil the classes of one of the instructors. You can imagine the writer's feelings on discovering that this teacher, supposed to be at or near the top in his line, had never thought of any principles of tool work and was grossly ignorant of many simple tool operations. In fact, he had literally nothing to teach. At best he had only a few muscular movements to

go through before the class for the pupils to blindly imitate. It is no wonder that this city, after a variety of such experimenting, should now be trying a trade school. It is the duty of some one to change this condition.

Why Trade Schools?

Should we dig to the bottom of the present agitation for a dual system of schools there seems little doubt but that we will find the cause of the difficulty in the employment of incompetent instructors in the shops of the regular schools.

Scattered throughout the country are a few teachers who actually know what they are trying to teach and actually teach it; but mixed up with these in all sorts of official relations are those who have substantially no knowledge of the fundamental principles of working solid materials and are therefore putting up all sorts of bluffs and makeshifts to take the place of actual instruction in mechanical lines. That some one has failed to do his duty is plainly evident. Our present duty is to take nothing for granted and go carefully into the details of our school shop-work so that no one may be misjudged. Those doing good work should be encouraged and helped to do more and better, while those bluffing at the job should be eliminated.

Duty of Superintendent

There are many ways in which the superintendent of schools can help the manual training movement. As most of these officials have had no opportunity to study this line of work either by actually doing it or teaching it, there is exceptional need for school principals that have a thorough knowledge both of the theory and practice of shop instruction. Therefore the superintendent has an opportunity to aid much by encouraging the school principals to spend the necessary time to get a thorough knowledge of the work. Also in employing principals he can give the preference to candidates satisfactory in other respects and up in manual training work. He will be able to aid very much by encouraging all his teachers to get as large an understanding of the shop work as their time will permit. His chief aid, however, is in helping to form a healthy public sentiment.

Basement Shops

We may help to get the shops out of the dark cellars and basements. It is impossible to teach the principles of shopwork in a satisfactory manner unless there is an abundance of well diffused light. It is not enough that a pupil may be able to see

the lines on his work by holding it up to the light. In order to learn the correct methods of doing the work, the pupil must be able to see all the lines definitely with the work in proper position on the bench. This is impossible with the ordinary basement light, and especially so where it enters from but one side. While a pupil may turn a book about until the light is effective, the shop work often cannot be thus turned. Everyone having to do with the manual training work should aid in creating a sentiment that will make the use of an improperly lighted basement for shop work entirely out of the question. If room is insufficient and a basement must be used, then use it for some class that does not require so much light. Other recitations usually require half the time and therefore it is a matter of good hygiene to use the rooms for such recitations as will change the pupils about often, keeping one class in the unpleasant surroundings for as short a time as possible. With properly conducted courses, the noise and litter of the wood-shop need not hinder its being located in any schoolroom. We are rapidly passing from that stage in the development of shop work when its success is to be measured by the amount of noise made and the piles of shavings and materials, possibly spoiled pieces, littered about the room. We have almost reached a point when we can say that the actual value of the work is inversely as

the amount of noise and also the quantity of materials used. It is therefore true that the school shop has no greater claim on us all than to have this fact recognized; and then be placed in a respectable part of the school buildings.

Is the Pupil Thinking?

Another duty that can be successfully performed only by those familiar with the educational processes and able to judge accurately of the intellectual activities of the pupils, as well as having an exact knowledge of the shop problems, is the careful analysis of the work to determine whether it is resulting in actual thinking or only in simple perceptions. Is the pupil merely receiving, bit by bit, such fragments of information as he requires in the making of his project or is he forming generalizations and learning fundamental principles that he understands and will be able to apply to other and various problems? No more important task is before those able to carry on this line of criticism, and no other line of criticism will do so much to establish the valuable and eliminate the worthless.

To place correct values on each detail of the work, although a matter of no small labor, is also a matter of no small importance. It is neither just to the shopwork nor to the pupils to permit extraneous matter to be traded for the real values of

tool work, nor can we hope to make definite progress so long as this substituting is permitted. Only by this careful analysis of the work and by placing true values on each part can we hope to strengthen the weak places and eliminate that which is not primarily manual training. To-day we are religiously holding to certain methods of work because in the past they have been compared with others even more defective, and found better. Such a method of elimination can lead only to confusion. We should rather, however great the task, see that we are comparing correct values, or at least not settle down to a fixed conviction until such a comparison can be made. Should we undertake such a review of our conclusion we may find that all the confusion that has been so characteristic of the manual training movement has been caused by drawing conclusions from imperfect data.

Judgments are formed and the possible values of school shopwork determined by inspecting work that is entirely void of any of those values found in Mechanical Science work. Conclusions are formed without any knowledge of the science as exemplified in that high type of workmanship now found in leading American industries. Erroneous judgments are made because of seeing some finished project that is apparently satisfactory

without inquiring as to methods of accomplishment or as to how much superior results might have been accomplished by using such subject matter as properly forms the content of a school shop course.

German Schools and Our Problem

Always in search of the best, never satisfied with the present, the patriotic American does not hesitate to go anywhere for information or suggestions that promise assistance in making or keeping this nation in the lead. It was necessary for some one only to hint that another nation was likely to surpass us in certain lines of school work to start a series of pilgrimages to that foreign land in quest of those better things in education. As we look upon the accumulation of reports, some public, some private, that have resulted from these pilgrimages we can scarcely help believing that something awful is in store for our beloved land if we do not at once move some of those German schools bodily over the sea and fill them with American boys.

Just how all this began is difficult to determine. Perhaps now it does not matter. Certainly, if we can pause long enough to get our bearings and determine our present duty, we shall have accomplished much. To accomplish this, let us refuse

to theorize, and devote our attention to some facts from a different source than those usually supplied in the discussion of this great problem in education.

A Question of Mechanical Efficiency

As this is, in the end, a question of commercial or mechanical efficiency we may reasonably expect to find some very definite data to guide us in our conclusions. We may not treat a matter, so definitely in the realm of the exact, with hearsay testimony or the generalizations of the mind that has been schooled largely by reading fiction. Neither can we grant the claim of immunity from criticism because of professional courtesy. The world of business, though possessing many of the higher ideals of human relations is, nevertheless, run on what is, rather than what might be, and when we wish to develop a school to increase the efficiency in the industrial world of the rising generation we must be very careful to deal with what is, rather than what seems to be, because of careless or incompetent conclusions.

It is not necessary to take space to repeat the many variously-worded statements so often met with, all of which may be summed up in the one sentence: that Germany is getting the markets of the world away from us and this is the result

of Germany's schools that train a superior body of workers for her industries. This statement readily divides into two parts: the getting of the world's trade, and the means by which it is accomplished, or superior German schools.

Casual Statements Have Passed as Authority

As I have read report after report and article after article by those usually credited with care in their statements I have been quite amazed at the reckless manner in which casual statements or mere guesses have been passed along until they have been clothed with all the authority of carefully established facts. Where did the notion come from that Germany is getting the markets of the world away from us? Who first said so, and on what authority? A glance at "Uncle Sam's Almanac," the Annual Report of Commerce and Navigation, does not tell any such thing, nor even hint at any such conclusion. Why, our exports of manufactures are growing so rapidly that unless something unusual is to happen we shall soon not only be the leading nation of the world in the export of manufactures, but literally dominate the world's markets. Look for a moment at these figures: In 1820 we exported $2,925,165 worth of manufactures ready for consumption. The figures for subsequent years are: 1850, $17,162,206 worth: 1870, $56,329,137

worth: 1890, $132,257,050 worth: In the year 1900, $331,995,684 worth: in 1908, $489,469,958 worth: in 1910, $499,215,329 worth: and in 1913, $776,297,360. Add to this about one-half as much more of articles on which we have done as much of the work as we find profitable and we have an even stronger showing.

Another Item of Exports

There is another item to be added to our total exports of manufactured articles that usually is entirely overlooked. We are apt to think of all farm products as the very beginnings of raw materials. This was no doubt true when the grain grew almost unaided by cultivation and the dairy and meat products were taken from the roving herd. But today the wheat and corn, the butter and beef, is largely the last product of a co-operation in production which begins in the iron mine and the coal mine as well as in the field. Could we but see the millions of wheels that turn as a part of one gigantic machine to grind out the corn and wheat from the soil, we would not wonder that we do not have to go to the ends of the earth to gain a competence by selling manufactures.

From your own knowledge and experience of affairs calculate the amount of iron and steel and wood in the shape of agricultural machinery and

the machinery with which the agricultural machinery is made, to produce an average farm crop. To think that the load of wheat represents a gift from the soil, or even a large percentage of it, is to overlook our modern methods of production.

Therefore, when we ship our cargoes of wheat and meat, we are shipping the produce of the thousands of factories and shops, from the blacksmith shop where the farmer has his horseshoeing done, to the great farm implement factories and railroad shops that supply him with engines, machinery and means of transportation.

As American farmers use much more machinery in their work than those of any other country a larger percentage of our agricultural exports should be credited to our manufacturers than to any other country. Just how large a percentage of the total of about $450,000,000 should thus be credited cannot be determined. To know that a great amount of capital and a large number of employees are interested in the manufacture of agricultural machinery is but a partial estimate, for even a larger number of men and a greater amount of capital is used in supplying machinery and materials for these agricultural machinery plants. In our study of modern education we are altogether too apt to think in terms and meanings that apply only to conditions prevailing before the advent of modern industrial methods.

Is Germany Flooding This Country?

But someone says, Germany is flooding this country with her manufactures. Perhaps, and perhaps not. Nearly everyone finds it really profitable to purchase something of his neighbor and it does not seem out of place for us to buy of Germany. Better not set down the deal as unfavorable until going carefully over the bargain and making certain just how it is made and who is getting the larger benefit. What do you see about you that bears the "Made in Germany" mark? Scissors, pocket knives, fancy articles, cheap jewelry, picture postcards, dolls, etc. and occasionally some larger and more pretentious article; but the list as you would make it from your own observation would not differ greatly from the list found in the government reports.

Most of the articles are imported in such small quantities as not to be worthy of consideration. Compared with our totals in industrial life they may well be likened to neighborly housewives occasionally exchanging a pie or cake or helping one another with a tin of biscuit.

One of our large items is books, maps and printed matter, about one and a half million dollars' worth a year. Were this all in picture postcards it would be about three per capita.

This ought not to worry us. About one-half as much in value of bronzes, one-fourth of a cent per capita of buttons and about one-half a cent per capita of clocks and watches. In china, porcelain, Parian and bisque ware we import less than four cents' worth per capita. In "Iron and Steel and Manufactures of", the total amounts to something less than six cents per capita, including less than two cents per capita of cutlery.

This is a Large Country

We must keep in mind that this is a large country and that we have many foreigners among us who still retain their prejudices for things made in the fatherland; also that many of our merchants import articles not because they are better, but to cater to the never-ceasing call for variety or something that bears the mark of having been brought from a great distance.

The Competitive Imports Are Few

Eliminate from our imports from Germany such items as these, and those in which she has a special advantage because of raw material, and the total dwindles to insignificance. Take away also those of a nature we do not care to make and the remainder diminishes almost to the vanishing point.

What Germany is actually selling us in many lines is well illustrated by a statement made by the head of the purchasing department of one of our very largest firms selling tools and machinery for a great variety of purposes. Their trade extends to every country on the globe using or making tools of commercial value. He says of Germany that there is only one mechanics' tool that his firm gets from that whole empire, and that is the little German bit of a cheap quality that manufacturers in other countries do not care to make, as they can find something better to do with their plants.

What Does Germany Buy of Us?

Supposing you were in Germany, what would you find bearing the earmarks of Uncle Sam's workmen? Typewriters, shoe machinery, fine tools, precision lathes, machine tools and, in fact, the best of a large line of manufactures requiring a high grade of mechanical knowledge and selling at a high price per article. Many of our machines found in German establishments sell at from two thousand to six thousand dollars each, while scarcely any machine tool of American make sells in that country for less than two hundred dollars How many dolls can we import in exchange for one of those machines? How many pocket knives can we get for

a typewriter or adding machine? How many "Made-in-Germany" razors can we get for one safety razor? It is reported that our safety razor manufacturers are making great headway in the German market. We sell them enuf agricultural implements to pay for the cutlery; about an even exchange of automobiles, clocks and watches; dental goods enuf to pay for the philosophical apparatus we get of them. I need not suggest that we get the better end of that bargain.

Add to the above a million dollars' worth of builders' hardware, saws, tools, etc.; as much more for cash registers and similar machines, and yet another million for machine tools. Sewing machines and shse machinery amount to another million, while typewriters passed the million dollar mark in 1907. With all these items we have yet another million dollars' worth of exports in miscellaneous machinery not itemized. All told we sell to Germany $274,178,712 worth, and import from Germany $142,935,547 worth. (Totals for 1908.) Not a bad showing considering the size of our nation and its many varied wants. The question for the American people is: Are these good bargains? These dealings indicate that we make such exchanges as we find profitable and that because of the superior training or education of the American workman we are able to deal on a basis very advantageous to the American manufacturer.

This is Not of the Past

Lest someone may think that all this shipping of our manufactured products to Germany is a matter of the past, we quote from the Department of Commerce and Labor, Special report on German Iron and Steel Industry, 1909 (page 56) :

"When the United States began to supply itself with wire nails of its own manufacture, that was a distinct loss of trade to Germany, but the loss became much more acute when the United States invaded the Orinet and captured a valuable market for wire products. This market it has since held, and Germany has sought compensation by trying to increase her exports of other iron and steel products to the United States. During the last year American competition has interfered seriously with Germany's shipments of steel sheets to England.

United States Increasing Its Exports

"The United States on its part has been increasing most of its exports of finished products to Germany. In spite of the protective tariff and of the efforts of the German manufacturers to provide agricultural implements, the importations from the United States continue above

$1,000,000 annually, tho some of them undoubtedly are for reshipment to other continental countries. In metal-working machinery, notwithstanding all the efforts of the German manufacturers to provide machine tools of their own construction, and notwithstanding their own exports, the American makers hold their ground. This is partly due, it is claimed, to the inability of the German manufacturers to develop an inventive spirit, their chief reliance still being on copying American designs. Builders' hardware, saws, and hand tools also form a prominent list of importations."

From another Daily Consular and Trade Report we quote: "The excellence of many classes of American goods finds foreign markets, even tho their cost is materially greater than that of similar competing lines, which should encourage American manufacturers and exporters generally to maintain at all hazards the present average high standard of American goods."

We Compete With Germany in Other Countries

Did space permit, it could be shown that we are competing with Germany in many other countries in a similar manner; that we are selling large quantities of such articles as require a high degree of intelligence on the part of the workman and leaving those of the cruder sort to be supplied by others.

But let us go one step farther and determine as nearly as we can just what the conditions are. The important question is: Are the German workmen better trained for their work? Perhaps these examples from trade are not representative of their actual ability or training. What we want to know is whether there is in all that country a class of workmen in mechanical or trade lines superior to the United States. That this question may be answered with certainty seems reasonable, for it should be possible to gather very reliable data for such a comparison.

The Highest Type of Workmanship

Those familiar with the trades and high grade workmanship along mechanical lines will invariably agree with the statement that the highest type of workmanship or mechanical ability is found in those lines known as machine tool construction. If any nation is superior to another in industrial intelligence it will be shown in these lines. Therefore by a careful study of this one branch of manufacturing we may know with certainty which nation, if either, is superior industrially. These tools are capable of receiving the most exacting test; they are always thus tested and the testing will be known by a class of people thoroly capable of passing correct judgment. An auto-

mobile may be praised by one and condemned by another because, possibly, neither party is capable of forming a judgment upon the actual merits of the machine. An expensive machine tool is usually purchased on the recommendation of an expert on that tool. After being purchased, the tool is sure to be thoroly tried out by many days of carefully checked work.

It is therefore pretty certain that a thoro study of the machine tool trade will leave little doubt as to which nation is really leading in mechanical enterprises. Such a study becomes all the more conclusive when, as in the present case, there are no definitely determined data from any source contradicting the conclusions to which the machine tool trade forces us. The fact that one of Germany's prominent manufacturers, after a casual trip thru our country in 1904 wrote that Germany had nothing to fear from the United States, is not sufficient to settle the question. These casual observers are often good at making interesting reports, but that nation that shapes its policies on such reports will some day awake to find itself making dolls and cheap cutlery instead of the highest grade of machinery and tools.

The report of our Captain Godfrey L. Carden, special agent of the Department of Commerce and Labor, is definite and reliable as to which nation, Germany or the United States, is really

leading in mechanical enterprises. Our people should be proud of the fact that we can send abroad a man so generous and yet so painstaking and exact in his investigations——a gentleman not only willing to give all countries and all manufacturers their just dues, but also able to recognize products of other lands made after American designs.

The findings of this officer, which show every mark of the most careful, conscientious and thoroly competent investigator, are interesting indeed and ought to be printed in large type for the benefit of some of our countrymen.

Not only do his reports bear the marks of the most exact investigations, but they are being continually substantiated and emphasized by reports thru the daily and other official reports of our consular service. I feel that we may therefore take his statements as thoroly reliable, and base our conclusions upon them. The entire reports are interesting and valuable. For our purpose I will make use of but a few typical passages.

United States Has Led the World

From the introduction we quote,* "In the manufacture of high grade machine tools the United

* Machine Tool Trade in Germany, France, Switzerland, Italy and United Kingdom.

States in the past decade and a half has easily led the world. During much of this period the enormous demands of the home market have taxed to the utmost the output capacity of many American manufacturing plants, and the foreign orders in these circumstances have necessarily suffered. Despite, however, the insistence of the domestic field the exports of machine tools from the United States has each year steadily increased, but this increase has been due, not so much to the efforts of American manufacturers in the foreign market as to the recognition abroad of the inherent merits of the best grade of American-built tools.

"Broadly speaking, the best grades of American machine tools excel both in design and workmanship, and in the accuracy of working results, the foreign-built tools."

These are rather strong statements. Let us now consider some of the facts upon which these conclusions are based. One of the first plants visited was a machine tool works in Berlin. Captain Carden, in concluding his report on this visit, says, "While the Loewe managers naturally rate their own products high, it is most interesting to note that they concede the most advanced form of chucking machines, radial drills, upright drills, circular and universal grinding machines, planers and the bevel-gear shaping machines are to be found in America."

Another machine shop visited is apparently considered one of the very best in Germany. This firm is reported as doing conspicuously good work on milling machines. The most interesting part of the report is that the firm controls and manufactures these machines under American patents. There is also a long list of machine tools of American make found in these works.

Another firm, evidently opposed, on patriotic principles, to using any foreign-made tools, is making a specialty of a machine, no doubt largely copied from a leading American design, and is also using American-made grinding machines. Yet another plant, using a few American machine tools, is especially favorable to our measuring tools.

Germans Trained in the United States

On the outskirts of Berlin is a plant that is exceptional both in equipment and management. Mr. Carden says, "It would be refreshing for some of our American manufacturers who believe that we alone understand the term 'shop efficiency,' to take a walk thru these shops, and I believe that a glimpse of the workings of this particular plant would cause a realization of what there is ahead of America in foreign competition. To make this clearer, it should be known that the methods in vogue at Borsig's are practically those followed in

similar large works in the United States. Herr Neuhaus, who has charge of the shop work at Borsig's, spent three years, I understand, at the Allis-Chalmers plant in Milwaukee, and I learn that this same gentleman while there had much to do with the designing of the big Allis-Chalmers engine which is now in operation at the Ludwig-Loew works in Berlin."

After giving a list of American firms represented in the machine tool equipment, follows the statement, "Only American pneumatic tools are used." This is probably due to the fact that this firm has an exceptionally accurate method of testing the efficiency of such tools, these tests showing conclusively the inferiority of the German tools. Yet another concern, having its quota of American machine tools, uses exclusively American ovens in its tool hardening department.

German Uses Only American Tools

In a summing up of this chapter, Captain Carden states: "A German manufacturer of machine tools, when recently building a new shop, equipped it thruout with American machine tools. He did not even draw on his own makes. These latter statements are facts which are not generally known in the trade." And "The best American machine tools, and all new and special tools possessing merit

other than mere ingenuity, will find a market in Europe." On page 64 of the report we read: "I found in Soligen a firm which in previous years has enjoyed a most enviable reputation for its high standard of saws, and yet I was informed at this establishment that its German business has been practically ruined by an American saw made at Philadelphia." Are not these facts enuf to convince the most skeptical that the American is undoubtedly in the lead and with reasonable care likely to continue at the head?

American Tools in France

Should we go to France, where there is a more even chance with Germany for American tools, we will find yet more to encourage us. On the first page of the report on "Machine Tool Trade in France," we learn of one firm having "no less than forty-five Brown & Sharp machines." Then follows a long list of other American firms represented.

In another French plant was found many American tools, but most interesting was the finding of a Gray (American) planer and a copy of the same make made by a German firm and the satisfaction of knowing that the German copy was recognized as inferior to the American original.

But why multiply these statements that are

so nearly uniformly in favor of American tools? One large French concern uses 1,743 machine tools, of which 1,300 are of American manufacture. The remainder, largely for the rougher work, are from Germany, France and other countries.

Competition in England

In England, Germany does not appear to be able to keep American goods out. Some catalogs of leading tool firms of England that I have at hand show large lines of American tools. I am unable to find any tools of German make listed. Is this no index of the industrial rank of the two nations? When we pause to consider the fact that the world at large is unworked territory for the fine tool trade and that the needs of the nations in this line are beyond the possibility of our manufacturers to supply for many years to come, should we not hesitate to adopt a system of schools that has not yet given one single high grade mechanics' tool to the world?

As we enter the English machine tool plants we are met with conditions similar to those found in France; American machines taking the lead and German machines of German designs or imitations of American designs, taking second place. To list the American machine tools in foreign countries would be to make an almost complete

directory of our first-class shops and their products. To know that these tools are in other lands because of the superior qualities given them by the American workman is a matter of national pride.

Conditions Similar in Other Countries

The reports cover several other countries and with like results. The conclusion that must follow is that Germany is a nation of copyists and not likely to ever lead in high-grade mechanical lines. Belgium, tho too small to become a serious competitor, undoubtedly is exhibiting more of the spirit of independent advance and far more likely to be our rival in grade of workmanship and design than any other European nation. Russia has a plant that may in time compete with us but this is rather a compliment to our country and our schools for it is a thoroly American plant, except the workmen. The moving spirit is an American, American trained, and the entire business is run on American lines and largely with American machinery.

America Superior in Other Lines

Although the machine tool trade undoubtedly is sufficient to answer our question, yet we will find abundant evidence of American superiority in

many other lines. Although the first printing press was invented in a foreign land long before the solitudes of this continent had been disturbed by industrial life, yet long before we could be called a manufacturing nation, we gave to the world the "Washington Press" that has remained the best of its class, and have continued to lead in most of the improvements since. An American press manufacturer claims that the sun never sets on his presses as they are sold the world over in competition with the best productions of England, Germany and France. It is no doubt true that this can be said of many of our styles of presses.

Statements showing the superiority of American goods might be brought together in numbers to fill a volume. America has led and is leading and will lead, because of the superior type of intelligence of its workmen. Our laws, our society, our intermingling of peoples all tend to a freedom of thot that yields an especially acute and progressive type of manhood. No man, and especially no mechanic who has felt the impulse of our civilization, feels bound to any system or method of activity because others did or do follow it. The very air suggests improvement and when our manufacturer has made a great iron planer that beats the world, he is as restless as ever and yet "sails on and on" until he makes a machine that other nations cannot even duplicate after he has made it. Should you visit

the works where the "Gray Planers" are made you would find today no less effort at improvement than in the past, and when the German mechanic has made a copy that will pass for equal to the "Gray" he will still find his neighbors importing "Gray Planers" with features of which he has not yet learned.

The Chief Obstacle

The chief obstacle to our sales abroad is not the inferiority of our products but rather the lack on the part of the foreigner to appreciate the superior quality of American goods. One of the greatest aids to the extension of American trade would be the establishing of schools in foreign lands to teach the use of and merits of American manufactures.

We Need Not Fear

We need not fear losing our trade because of other manufacturers copying our products. There are two sides to all questions, even to this one of copying American products. It not only proves beyond any possible argument that we are the intellectual leaders in mechanical lines, but it also shows that the Old World is awakening and taking on somewhat of the American characteristic of change and inquiry. Could a nation copy

and stop, returning to its conservatism after copying our best machines, then would their markets be closed to us indeed. But one may as well attempt to hold back the torrent after the dam has broken away as to attempt to stop a people from continuing to want the latest and best after once thoroly breaking up the old conservative idea that what has been is good enuf. To America this means that copying of our machines will lead only to a greater inquiry for the best and a larger use of our products, and always of the later and more profitable productions with an ever-widening and increasing sale for American products, providing we continue to keep the American spirit and ideals of progress.

Therefore, what can we conclude but that the German workmen, as a class, are the victims of their own schooling rather than the product of initiative in independent and progressive study; that the imperialistic atmosphere which pervades all activities, even the special schools, gives to them a form and discipline that makes of the German youth a follower and respecter of that which has been, rather than a progressive workman full of initiative and ambition to excel. We can form no other jndgment than that such influence as their schools exert, tends to make the nation something less than the best in spirit and action in the industrial world.

Preserve the American Type

Let us not frighten ourselves over what others are doing, but bend our energies to preserve and magnify the American type of workman. To do this we must keep American ideals. And of all things American, no other is so distinctly our very own as the free public common school where every boy may start out on a common level to work out his own destiny with no shadow from king or aristocracy to obscure the pure light of his chosen star. Instead of sending over to Germany tradesmen or men of classical education to study their "trade schools," send the scientific mechanic who is capable of judging the actual conditions and differences and who can bring back information that will aid in advancing our own scientific knowledge of working materials. Such men are obtainable in almost any large manufacturing plant and their investigations would be of the greatest value.

Follow American Practice

We must not fail to note that not only do European shops of the better class draw largely upon America for tools, but that they also follow American practice in factory management. In

many cases the active influence is a man of superior type who not only has all his native country could give, but has also a training, the result of years of work and study by actual employment in American shops. In Belgium there is a manufacturing plant that appears to have more of the real American spirit and ideals than are found in any other plant in all Europe. Of this concern Captain Carden says, "The Mellotte equipment, composed as it is, almost exclusively of American machine tools, and operated on American lines, gives the Remicourt shops practically all the advantages of an American plant plus the further advantages offered by a lower wage scale. Melotte carries his American ideas to such an extent that nearly all the office furniture is of American origin. The desks are for the most part of the Mally type, and the Warren Manufacturing Company, of Chicago, has supplied most of the boxes used for filing away small tool parts. An American card-index system is in use."

Germany May Study Our Schools

The success of this plant is but a type or forecast of what might be accomplished by German concerns should they enter fully into the American spirit, and come to realize in all its force what American methods and machines mean in the com-

mercial manufactory. Perhaps they will not only buy our machine tools and send representatives over to work in our shops and study our methods, but also do as Belgium has already done, study our schools. As I look on a copy of the report of the Honorable Omer Buyse on American industrial education, published by the Belgian government, it seems to me a remarkable coincidence that the nation gathering this data and publishing such a voluminous report should show such marked signs of leading all Europe in the spirit of modern manufacturing. Can it be possible that we must go to Belgium to discover what it is in America that makes us the copied of all the industrial world? Is it not possible that we are like the absent-minded grandsire who searched and searched for his spectacles, but without the least success, until informed that he was looking thru them. Perhaps we will discover that we are searching for a system of education while possessing one that has already asserted itself as the greatest of all and the very power by which or thru which we are making the search and seeing such great things abroad that are really only the reflection of what we have accomplished.

[Since the above was written there have been published various reports confirming these views. The recent war has done much to disillusion us in regard to the merits of German schools.]

Imitation a Confession of Weakness

In contrast to the German manufacturers' aspirations and what they are doing notice the following quotation from an American machine tool circular: "We hold to the belief that imitation is an indication of weakness and that a firm, seeking success in a large sense, must possess originality." The result is that this firm, tho but a few years in business, has advanced rapidly in this country and their machines are known and used in many foreign lands, and are acknowledged superior to any machines for a similar purpose made in Germany or any other foreign country. This is indeed a typical statement that well illustrates the attitude of the American manufacturers and workmen, for not a few of the men who today are the leaders in manufacturing took the motto of "no imitation" as workmen and because of it are in their present positions.

Develop Our Schools Along American Lines

Perhaps after all we shall find that our problem is not to import some educational theories to be patched onto our great and original free public schools, but rather to cut away some foreign patches and strengthen our schools by develop-

ing them along purely American lines with pure American ideals as our guide and ambition. That there is a cry against the present products of our public schools no one will deny. That with the schools thru which the present generation of workmen came we have surpassed the world is quite as evident. Then let us set hard at work to know, not guess, at where the weakness lies and work out our problem like true Americans, reaching out for the larger things by holding to the ideals of the manufacturer who says, "We hold to the belief that imitation is a confession of weakness and that a firm seeking success in a large sense must possess originality."

What is a Liberal Education

So much is being said about practical education that it may be well to pause for a moment to try to renew our acquaintance with liberal education. Perhaps after our long time spent in contemplation of the newer we may see the old in a new light. Perhaps we shall discover that we have, all this time, been looking at the same thing.

It is not at all impossible that the reason for these newer forms of education, or new names for old forms, is simply the necessary protest against calling an education liberal that is only the liberal education of another and bygone period in the development of civilization, and not at all a liberal education of to-day.

It does not seem necessary to argue that what has been a liberal education for a past generation cannot be for today. We have only to cite some factor in what one may set up as a standard for such an education, and then trace this factor back to its rise as a part of human possessions, to establish the fact that the definition of a liberal education must be progressive. Our present task is, therefore, not to determine what has been a

liberal education, not what it may be, but rather, what it is at the present time.

Education is Progressive

Our next step may be to call attention to the fact that if this matter of education is progressive, then to argue that certain elements have constituted a liberal education at some time in the past, is also to argue that they cannot constitute a complete liberal education of the present. We must either take the position that the factors of a liberal education are fixed or we must admit that the liberal education of today must represent developments of civilization that did not exist yesterday.

When this basis of argument is settled our problem is one of a search after those things brot about thru the progress of the race that are suitable factors of a liberal education. We cannot search and say that none can be found. To fail to find some new elements is only to admit our weakness. The very fact of progess establishes the fact that such material exists.

Must Maintain its Relations

Then again we may argue that if a liberal education is to have any bearing upon one's relation to society, then as there is progress in society,

the form, degree, or factors of the education must change in order to maintain that relation. It is not necessary for us to quibble over the fine points in a definition of education of any sort. Make the definition what you will, so that it is at all reasonable for any specified time and it is inevitable that there will be a necessity for a change from time to time as the conditions to which it is to respond change.

How must these factors change? There can be but one answer to this question, and that is: They must change in harmony with the progress with which they are to keep pace. There can be no guesswork or theorizing about what changes are to be made. To theorize or experiment in regard to the fundamentals of these changes is to admit incompetence to deal with the problem.

Patching no Remedy

Again—as civilization does not develop by accretion but by expansion, we cannot meet this growth properly by patching onto the system or ideals of education of yesterday. No doubt it is at this point that our attempts to improve our schools have parted from the possibility of success. No doubt this artificial method of enlargement has caused not only a failure to produce a successful growth, but has also led to the

most inefficient methods of studying the needs and the most erroneous selection of material. No doubt the method of accretion, the patching on of fads and frills, is the easier way of presenting an apparent growth, but as none of the vital life-blood of the system ever circulates in these patches no matter how tightly stuck on, they soon become only a burden and waste. This has often been observed by each one who has made any considerable study of the present attempt to bring our schools up to a satisfactory present standard.

A Definition

May we not then take as a definition of a liberal education, that education which is to the civilization of today what the liberal education of yesterday was to the civilization of its day. Does not this definition define fully for our purpose and provide a standard for all who may wish to assist in the present efforts for the universally desired better education? No matter to what school of philosophy or pedagogy one may belong, the definition will be helpful and point the true method of procedure. Take what view one may of what a liberal education should be, determine its factors for yesterday, and then advance it to present conditions. If it cannot be moved up in harmony with the

advance in civilization, it never was in harmony and never could be considered as liberal. In our consideration of what was a liberal education we must begin far enuf removed from the present to eliminate the influence of present-day discussions. With a clear idea of the liberal education of yesterday we may then proceed to determine the essential for today.

The Factors in Progress

In what has been our progress? We need not attempt to determine all these factors. There is no serious disagreement in regard to these matters. To establish the general principles would set at work an army of individuals thoroly competent to work out the details. The difficulty at present is, that we do not admit the principle that this progress must control the advance in education and determine the selection of the subject-matter which our schools should use. A very casual observation or the most searching study of the question will alike reveal that those who control our educational institutions and systems hold to the idea in both theory and practice that the factors of a liberal education are a rather fixed quantity and that to change by assimilating new factors is to weaken rather than strengthen the result. It is not many years since an elaborate argument for

this view was made by a thoroly representative person, and one need not search long in current publications to find similar arguments.

A False Assumption

What are all these attempts at a dual system of schools but the result of treating liberal education as unable to deal with the progressive factors of society? Those who advocate the special schools may not have considered the problem from this point of view, yet there is no denying the fact. We cannot deny that the theory of special schools is based upon the assumption that civilization has developed factors requiring an educational effort outside of the possibilities of a liberal education. This is simply stating either that there is a constantly increasing number of persons incapable of receiving a liberal education, which is simply saying that we are going to the bad; or, that we have become too good to make use of a liberal education. Those who believe that we are degenerating as a people may settle their notion with their bad digestion. Those who believe we are advancing and yet that a liberal education cannot meet all requirements of the present as it has of the past, have the burden of proof upon themselves.

The first step in advocating special schools is to prove that we have developed a condition that

regular schools cannot meet. This will be difficult considering what has been accomplished.

A Liberal Education Sufficient

I, for one, believe that a liberal education has been sufficient, is now sufficient, and always will be sufficient in so far as the public schools are concerned with the education of all the children. Private institutions of learning have existed parallel to the public schools and no doubt always will be patronized by some for certain reasons with which the public is not concerned. Then why all this cry for practical education, trade schools, special schools, and the like? Simply because our public schools have long since ceased to give a liberal education.

It is not my purpose at this time to discuss the details of a liberal education. I wish only to call attention to the principle by which these details must be determined, knowing that persons in different environments, differently educated and of different temperaments will apply them differently, and that a proper application of these principles must lead to the establishing of a really liberal education by all these various classes. Uniformity in details is neither desirable nor possible, but uniformity in the general application of the fundamental principle is not only possible, but essential.

Where We Have Failed

Then wherein have we failed? In not recognizing the fundamental principle that a liberal education of any time or period is the outgrowth of the civilization of that period. We have failed to recognize that the liberal education of today is the liberal education of yesterday, grown out by internal expansion to the things of today. We have acted upon the belief that education must become bigger and bigger in bulk and to accomplish this have stuck on, not only some of the things that are the outgrowth of progress, but also many things that belong to the dead and buried past; things that have many times been used in attempts to improve education and always have failed. Failing to apply the rule that in civilization's progress must be found the new factors, we have lost entirely our means of selection, and have found ourselves quite as active and earnest in attempting to annex things of the past as of the present. We have so completely lost our standard of measurement that substantially every acquisition and activity of the race, past as well as modern, is advocated as an essential of some form of schoolwork. Our ideal of bigness has known no bounds and everything that could add to size or bulk has been annexed by some means to some

part of the curriculum.

No sooner has someone found a subject that they think of use to a certain class than they ask for a law making it a part of the school work. I need not take space here to enumerate the subjects taught that everyone will admit are not of value to every pupil. Some are not of value to any pupil. Should I compile such a list each one who reads this article would praise me for including most of the names and censure me for including others. Not one subject could I mention that has not both its friends and foes among prominent school people. As a whole our curriculum is made up much as some appropriation bills in Congress, in which each member asks for the insertion of his pet measure. All pass in a lump because no one dares to oppose another's measure for fear of losing his own, altho little good can be said about the bill as a whole. I do not care to make a list, but suggest that each reader make a list of the subjects taught in his own school and then pencil off those thot to be useless or injurious.

Patching, Not Growing

I believe the cause of this abnormally and unscientifically arranged curriculum is that we have tried to patch on rather than grow, because we have had no definite basis of selection with which to keep out the useless or harmful, because we have

failed to realize that the fundamentals of education are always the same as expressed in the age for which the education is given and therefore have made our selections of new material from superficial reasons rather than by the application of a fundamental principle. Such a method of selection must necessarily lead to choices because of personal preferences, the adding of quite as much injurious as helpful material, and an interminable series of discussions and plans leading nowhere in particular. Does not a careful consideration of the present situation indicate that the discussion in all parts of this country is at present in this very condition?

Its Application

Without going further into the general subject let us now consider the application of this principle to the present problem of "Industrial Education."

Why is it that there is such a general demand for industrial education? If our premise is correct, the answer must be that civilization has advanced beyond our system of education. If this be true, then the difficulty is not the decline of apprenticeship, but the advance of industry which hae rendered the apprenticeship system inoperative and set a standard of requirements for a

liberal education which the schools, as at present organized, are unable to fill.

Decline of Apprenticeship

The decline of apprenticeship might be discussed at length would space permit, but for the present we must be content with the general statement that it is the result of progress in industry. It is not because employers cannot find time to train apprentices as they were trained in the past, but because such a training as the typical apprentice received is no longer worth while. The average proprietor of a century ago trained apprentices because he found the training which he could give of value to him and a profitable investment. The proprietor of today does not, as a rule, train apprentices, because he has discovered that such a training as he can give by the established methods of apprenticeship does not as a rule produce a satisfactory workman. These statements do not apply to such school shops as are maintained by some employers.

Probably Mr. Nasmyth was the first eminent engineer employer to discover that industry demanded something which apprentices did not get, and that some boys with no apprenticeship possessed a mental equipment and education that made them superior to regularly trained appren-

tices. So emphatically did these boys demonstrate their superiority over the apprentices that Mr. Nasmyth avoided employing apprentice-trained boys as much as possible.

The Training Needed

We may now ask, "What training had these boys that made them desirable as workmen in the employ of the great mechanic?" The answer is simply this: They belong to that same type of mind as Henry Maudslay, a type that the age had developed and expressed by more or less numerous specimens in many communities. They were the few type individuals who represented the intellectual advance of the race, and so long as the higher grades of industry were so limited in extent, such as these were fairly sufficient to supply the demand. Were this type of industry static rather than dynamic the few type individuals would always be sufficient to supply its limited needs. But this high type of industry develops by artificial stimuli to such an extent as to require a large percentage of similarly qualified workers, while the natural development of those able to fill the positions proceeds but slowly. Consequently, the demand exceeds the supply and the lack of qualified individuals finally reaches such a stress as to be a public problem. This is

where we are today and are told that the remedy is to re-establish the apprenticeship system, either by establishing trade schools, or by patching on to our present education by compelling our young people to attend school at night or part days after entering industry. In none of these schemes is there any stated purpose to develop the higher type of individual required by industry, nor is there claimed to be used any subject matter differing in essentials from that of the regular schools plus an apprenticeship training. A somewhat extended inquiry both by correspondence and by personal visits to our most noted public schools of this class has fully convinced the writer that the curricula of substantially all these schools consist of a combination in varying proportions of these two elements. If it be true that the real problem as indicated by our definition is not the training of apprentices or establishing of trade reactions, but of a later type of education, then the present scheme for these special schools is doomed to failure in its attempts to aid industry, quite as much as has been the failure of the common and unscientific manual training work to yield an industrial value. The writer does not wish to be understood as questioning the value of the various efforts now being made under the name of night schools, extension schools, etc., to teach boys and girls the simple fundamentals of a common school

education, — to teach these young people what many of them studied for long years in the common schools but failed to learn.

Present Efforts Not Satisfactory

At first thot the writer may appear to be overconfident of the application of this principle and to be asserting a personal opinion against established facts. A careful inquiry will, however, reveal that very few if any of the present attempts at public industrial education are satisfactory to their friends and none are without the criticisms of some of those high in educational circles, all of which should keep us in search of some fundamental principles big enuf to control the situation and broad eunf to permit each individual to proceed toward the goal without doing violence to any well considered ideals of public education. Does not the definition here given of a liberal education supply this principle?

Two Classes

Progress is the one word that expresses the cause of all the trouble, and therefore it is by advancing a larger number of individuals toward the front rank of intelligence that we shall be able to meet the demand. Those of large natur-

al endowment will then, on leaving school, be fitted for the large places of industry; those of lesser endowment will take their places according to their several abilities; but all will have become more useful and in harmony with the developments of this age. It is at this point that the two great branches of educational activity are formed. The one does not recognize the element of progress as the cause and does not seek the remedy in an advanced and higher type of education. The other recognizes the element of progress as the cause and supplies the need by an education that will force all classes of individuals toward the most advanced type.

The vital difference between the two lines of effort is not that one thinks any more or less of our system of public education as at present operated, but rather that the former would supply the need by taking certain individuals and attempting to fit them by giving certain information and reactions to special details of industry, while the latter would develop all towards the type and depend upon environment and capacity to place each individual in the most suitable kind of employment. Much of the lack of employment that usually prevails is due to the inability of individuals to adapt themselves to opportunities. By emphasizing special courses and special schools we are likely only to aggravate the difficulty.

What Material to Use

When we clearly recognize this distinction we can have no doubt as to which plan of procedure should be followed by the public schools of a democratic country. It then becomes only a question of what material to use as a part of our school course to produce this result. This brings us again to our principles of selection and we proceed to inquire what have been the chief elements of progress. This may be answered by a consensus of opinions, by a study of present civilization, or by a careful search of the advanced type form. I believe that either method will yield the same result—that by any fair means of inquiry we must find the great advance of today in the power of man over solid materials. This is not in his power to pile up pyramids, or to wear away his life in carving a minute image, but rather in his power to deal with and shape solid materials by the direction of his intellect rather than by muscle. It is not that his arms are any stronger than those of the workman of past ages, for they are not. It is rather that his mind is taking the place of muscle and that his scientific knowledge of the working of solid materials gives power infinitely beyond that which has ever been possible by the strongest arm or the most skilful hand.

In brief: This advance is in the displacing of muscle by mind and the displacing of skill by science in shaping solid materials to serve the purposes of man.

This advance, then, has given us another science which should form a part of the subject matter for our schools. By use of this subject matter we may force the development of the desired type of individual. We then have no revolution in education to be brot about, no patching on of "fads and frills", no cleavage in our system of public schools, no changes in our general plan of courses,— only the adding of another science with its laboratories and its teachers and the usual re-adjustments that must follow the taking on of a recently developed subject. This subject takes no special place, asks no special favors, except such as may be accorded because of its exceptional value. It has a special and fundamental reason for its existence in the school in its necessity as a part of the material with which the mind must deal in order to reach the advanced development necessary in modern industry. It also has the claim of being the latest development of the race, and therefore, from our definition, it may claim a very essential part of a liberal education. It gives us as a result of our inquiry what was well understood by the founders of the manual training movement,

that is, that the best liberal education and the best industrial education are one and the same. It is not necessary for us to claim that Dr. Belfield realized the full significance of the statement, "The Chicago Manual Training School was founded to train the mind by the use of the hands." Every movement must be subject to growth. Those who have studied thoroly the work of that school cannot doubt but that the germ of that idea was present from the first inception of the school. Those who had the privilege of association with Dr. Belfield as had the writer, can have no doubt of his belief in this ideal thruout his connection with the school. His tenacious holding to this ideal against most active opposition after the school was connected with the University of Chicago, is fairly good evidence that it was a fundamental principle in his ideals of "shop work" in school.

The Mistakes of Friends

Then why has not the work developed along this line? Why do we see two such radically differing branches developing from the same trunk?

The fate of the manual training movement has been the common fate of many good ideas. When Dr. Woodward in the early fight for manual training prayed that the movement might be

delivered from the mistakes of its friends, he no doubt saw with a clear vision what was to occur. It was so easy to see the smoke from the great chimney, so easy to see the tools and machinery, so easy to hear the saws and the ring of the anvils; but so hard to grasp the spirit of a movement which was based on such a high ideal and dealt with subject-matter so recently developed and entirely outside the experiences of the average individual.

More than one great individual visited the school and caught some of the enthusiasm and much of the form, but none of the ideal, and returned to his own city to establish a school in which to build a big chimney and make lots of noise, but without either the ideals or the spirit of "training the mind thru the hands."

Handwork Instead of Science

It was a line of work subject to many changes while keeping some of the physical forms, and soon "handwork" became the cry from Boston to San Francisco. The fact that this work came into existence to utilize a line of subject-matter that is the result of the latest advance in civilization was entirely overlooked. Instead, anything that could call the hands into use was drawn upon to furnish the desired variety of "occupa-

tions." Altho to the well-intending enthusiasts the work seemed to be the same or a little better than that of the Chicago school, it missed entirely the subject-matter which should have been taught.

Almost at the first we see the importation of teachers and ideals from a country that knew substantially nothing of modern industry. We were soon treated to the peculiar spectacle of seeing this imported and utterly un-American and anti-modern system of handwork which possessed none of the real subject-matter, eulogized by our great American educators who should have known better.

With such an introduction is it any wonder that all that represented the later developments of modern civilization in the working of solid materials was driven out of our school shop work and even the original ideal forgotten by many? With such an abandonment of the very fundamental principles on which the work was founded, is it any wonder that chaos should reign in the school shops of the country and that the products of these shops should not make good in modern American industry? Is it any wonder that while recognizing the failure of the "handwork" to make good educationally, those controlling the situation should bring into the school shops all sorts of extraneous matter

in their blind attempts to gain the results that all intuitively feel should result from the working of solid materials?

A Constant Shifting

With an utter oversight of the subject matter of the school shop, because they have absolutely no knowledge of it, we see teachers of "handwork" shifting from kites to engines, from doll houses to full-size buildings, only to meet the same dissatisfaction with results after their work has been in operation long enuf to permit modern industry to place its stamp "No Good" upon it. It is a constant and mad rush for something that can be patched on to an antiquated ideal of education; a persistent determination to worship the past ideal and intellectual attainments rather than to receive the newer and stronger as the basis for a liberal education. With no possible middle ground this conflict must go on until the stronger wins, unless in our educational life we do as our educators advise others to do and submit the question to arbitration.

The Remedy

If we are agreed thus far in our consideration of the question, what is a liberal education, we

should have no serious difficulty in finding a sure remedy for our educational ills.

First of all, let us be far more particular in judging of the work at present given. Let us be very careful to determine just how much benefit each pupil receives, and to what definite part of the work the benefit should be credited.

If a school gives a course in manual training and some of the pupils go out into some industrial line and make good. do not jump at the conclusion that it is a result of the manual training instruction, for many boys have made good most remarkably who have had no such manual training experience. The same will apply to an investigation of trade or technical schools. Let us also not overlook the failures; "count your failures" is a saying of one of our greatest educators.

Also, be sure to study carefully the pupil who leaves school and makes good in a line entirely different from the one for which he prepared while in school. Above all else, we must know what this pupil got from his school course, or what he possessed by nature that survived the school course that has given him success. Some interesting and valuable records have been gathered showing that some pupils go out from special classes into occupations differing materially from those for which they were fitted by their special work.

A Childish Argument

With these facts in view there can be no more childish argument advanced in support of our present system of education or of any trade school, or special school of any kind, than to call attention to the successful life work of certain individuals. The requirements for admission to some schools are such that few if any boys are admitted who would not likely have made good in almost any line of industry had they gone directly into industry, omitting entirely the school work that is now given credit for their success. Any of these people who have completed manual training or trade courses can be matched by those who have been in school little or none at all, and therefore unless we can show that these successful individuals owe their success to the schools, we have nothing with which to refute the statements that they were simply strong enuf to succeed in spite of time wasted in school.

The test of educational efforts is not the successes of a few selected individuals but the amount of advance produced on all those who attend school. Unless it can be shown that there is a general advance all along the line of the various types and capacities of pupils then the school is a failure, no matter to what eminence

certain individuals may attain. In fact, I do not claim that they are; but if our public schools are organized for the purpose of starring certain individuals to the neglect of the masses, they are not only failures, but utterly unworthy the consideration of a democratic people, and those who are intentionally organizing them for this purpose, if there be such, are traitors to our government and the ideals of our people.

Educate All Pupils

The remedy lies, therefore, not in attempting to segregate a few individuals to be trained for exhibition purposes but rather in searching out such subject matter as will lift the entire student body to higher planes of life and social efficiency and using it for the benefit of all classes of pupils. We should attempt by the artificial means known as public education to advance the entire rising generation toward the standard set by the type individuals that lead the advance of the race.

When we have thus secured the proper subject matter then we should actually test it out. We should not be satisfied with some nominal tryout that omits everything but the mere form, as we have been in our attempts to determine the efficiency of manual training, but rather make

such a test as will actually show the values of each element as measured by the needs of society as it is constituted at the present time.

Harmful Studies

In making these tests we should not overlook the possibility that some subjects of study may be harmful. If our definition of a liberal education is correct, if the call of industry is for a higher type of mind, then we must be extremely careful lest we compel our students to study that which tends to develop a type of mind unsuited to modern needs. The writer's experience with certain schooled individuals causes him to urge a most careful investigation of this feature of the problem. He is so fully convinced that our educators as a class wish for the best as to feel that the chief factor in determining a remedy is to determine what subjects and methods tend to supply the mental equipment desired and what are of neutral or negative character.

If such an inquiry is made, with our definition of a liberal education to indicate the subjects to be most carefully scrutinized, the remedy for our industrial needs will appear so conspicuously that no one will dare to stand in its way.

Such Work Does Succeed

This is not the time to discuss a Mechanical Science course, yet this article would be incomplete without stating that the conclusions drawn in regard to the requirements of a practical education are backed by sufficient actual demonstrations as to leave no doubt in regard to the proper course to pursue.

To claim today that the regular schools cannot give a line of shopwork that is all that can be desired in fitting boys and girls for active industrial occupations is to admit one's ignorance of what is actually being accomplished. The fact that some of the most conspicuous public school systems are doing the most extremely useless and even injurious work in their attempts to teach "handwork" is not a sufficient excuse for ignoring the good work that is being accomplished elsewhere. It is a question as to whether our school work is to have the same definite and uncompromising tests as would be given to a modern business enterprise. To use a common phrase, Are we to have "scientific management" in our schools or are we to strive in a general way for the best with a set determination that certain theories and policies are to remain, regardless of their injury to progressive education?

The following is a reprint of an address by Mr. Selden as published in the Proceedings of the National Education Association of 1914. This address is used because it calls attention to the one most serious difficulty in the advancement of public education. This difficulty results from the tendency of those now in control to interpret attempts at improvement in terms in harmony with the established order. It is very difficult for those who have been long in public school work to see the advantages of the new in terms of the changed social conditions that have become general since these eminent educators became static in their work.

Problems in the Successful Teaching of Mechanical Science

Briefly stated, the difficulties of introducing mechanical science courses are the same as those attending the introduction of any improvement. It is the tendency of the established order to interpret the improvement in terms in harmony with itself and to make it in reality nothing but a changed form of something in the old order, and then, after having taken all the newness out of it, to discard it as being no improvement and of no value. In tracing the school shop movement, we learn that this is exactly what has been done and that we are now in yet another stage—that of attempting to find some new material after the original movement has been rendered abortive and set aside. To state the principle concretely, the school-shop movement has been robbed of its vitality, and now attempts are being made to gain the values that should have resulted from the original movement by the establishment of all sorts of trade, continuation, vocational, and similar schools. It is not my purpose to name

any specific remedy for the present condition, but rather to point a sure method that will lead, not only to finding the remedy, but also to a certainty of its being applied.

I believe you will not object to the ideas I advance simply because they are new, or because, from a superficial consideration, they may appear to be the same as have been considered in times past. Nor will you give them less attention because they appear to be at variance with the doctrines of some of our most esteemed leaders of educational thot.

I can do no more than suggest some plan of action that will lead to the determining of what is best; for the duty of bringing the best out of these conditions rests upon the administrative part of the educational machinery. However much we may wish to shift some of this responsibility to superintendent or teacher, yet in the final analysis the board is responsible. Many a superintendent would do more effective work if he thot his board members were so thoroly informed of what was being done that they were definitely in sympathy with his work. Many teachers would work harder and get far better results did they know that the details of improvement were known and appreciated by those in authority. When, by such a searching inquiry as I suggest, the administrative factor is thoroly informed, there can be

no doubt as to what action will be taken, for the great majority wish our schools to yield the largest possible returns in good to all. Last, but not least, the whole educational machinery would run smoother and accomplish far more if every unit felt that there was such a definite knowledge of what was being done that there would be no mistakes in rewarding the efficient and in eliminating the inefficient.

It has been my opinion for some time that the most urgent need in solving the present problems in education is a more extensive study of these problems on the part of school-board members. As I have listened to the many eloquent addresses at this meeting, this need has been greatly emphasized, and I have been compelled to add to the list of serious difficulties that of **the great power of the highly trained intellect to enforce with great appearance of wisdom the most ill-advised theories in regard to the school-shop movement.** This appears to result, not from any lack of desire to say and do that which is best, but rather from the difficulty of getting a proper grasp of a movement that is based upon subject-matter with which these people had no experience as they passed thru their school work.

To gather the necessary information on which to base judgments is not easy. May I encourage you to take up this important task with a convic-

tion that nothing but first-hand facts are to be used by those in administrative positions. May I also suggest that there is sometimes a vast difference in the conclusions that are drawn from casual observation and from the searching inquiry. We have in our administration of schools too many judgments formed upon casual observation and hearsay testimony. We see men in these positions deciding important questions on information of a kind that would be given no weight whatever in determining their business activities.

Probably the most common error in judging of any part of school work is the neglect to consider the personal factor. We should not consider what the pupil is on leaving school, but rather to what extent and in what manner the school has worked a change. This is especially true in determining the school value of any mechanical or industrial work. We need to make a close inspection to determine how many pupils are helped by the school shop and how many simply survive it. To know that certain boys go out from the school shop into industry and succeed is of no consequence whatever in determining the value of the shopwork; because there are in every community boys who will succeed in spite of bad schooling. That which must be determined is the actual effect of the work by tracing the various pupils thru the school and out into industry. As

has been said, we must count the failures, we must determine the number who have been helped and also those who have fallen out by the way, and then we must determine whether in any school or by any system of work these failures could have been avoided or to any extent lessened. It is "dead easy" for a teacher to point to a few successes and then lay the blame for the failures to the lack of ability on the part of those who fail. In any American community there are both boys and girls who can do most excellent work in wood and metal if provided with tools, materials, and a place in which to work. Therefore if the teacher can point only to some nicely finished projects as the result of his work it is quite possible that the money spent for that teacher has been wasted. The pupils who have not achieved success, those whose work usually is not shown, are the ones whose records should be most thoroly scrutinized. It is the special duty of the administrative part of education to determine with certainty whether these failures are due to the pupil or to the mistakes of the administration in selecting an incompetent teacher or an incompetent superintendent who is not getting the best out of the teacher.

From a somewhat extensive study of this particular question in regard to shopwork, I can say that with pupils of similar talents attending

various schools the proportion of failures to successes varies from nearly all failures in some schools to nearly all successes in other schools. This means that the administrative part of the educational machine is badly out of repair in some cities; it means that those in authority are being satisfied with results far below what should be gained. And I may add that I have sometimes found those who are the most deserving of censure to be those who are most outspoken in their certainty that their shopwork is of the best.

But this is not all. The pupil of limited talent is the very one who needs help, and, however limited his talent, if he is above idiocy, the greater is the necessity of raising his level of industrial efficiency, for he is certain to join the ranks of industry, while the one of large constructive talent, tho making a record in the school shop and helping out on exhibition day, is almost certain to enter some other line. For the constructive faculty that may shine in industry is the same as that which makes the great business man and the great professional man.

Now why this great difference? For neither the efficient nor the inefficient teaching is confined to any particular class or type of schools or to any particular geographical area. I think you will find, if you investigate with proper care and thoroness, that it largely depends upon whether we

teach principles or processes. It matters little by what name the work is called or in what kind of school it is given. You will find many gradations from the all-process to the largely-science teaching in schools of all grades, and sometimes great variations in the same school system, even in the same building. I have seen excellent instruction in science in the common graded schools and the merest sham at teaching processes in keeping with the methods of bygone ages in nationally known trade and industrial schools. This could not be were the administrators actually performing their full duty.

The fundamental principles of working solid materials may be taught successfully aud thoroly by the use of wood alone in the one-room country school, in the consolidated school, in the regular high school, and in the technical school. On the other hand, pupils may spend long hours in the making of things from toy doll houses to real dwellings, from the useless sloyd models to sets of furniture; they may work every material from plasticine to steel, and yet thru all this extensive course in either common or special schools they may not learn one single principle of working solid materials. They then go out into industry with the ideals and mental equipment of the ancient Egyptian craftsman rather than with those of the modern scientific workman. It therefore is not

safe to judge of the work of any school by the magnitude of the institution, the extent of the equipment, or the credentials of the instructors or even those of the principal.

The cause of all this interminable discussion, this ever-increasing demand for efficient workmen, lies not in the fact that young men as they enter industry cannot make things and make them so they will be salable at some price, but rather in that these young people have been trained to be craftsmen rather than modern scientific workmen, and therefore are unadaptable, incapable of grasping modern ideals of workmanship, and cannot produce work on a profitable basis. How may we expect to remedy this condition unless those in authority have a sufficiently definite knowledge of what is being done to distinguish between the craftsmanship of bygone days and modern scientific workmanship?

We may build industrial. special, continuation, or what-not kinds of schools until we have duplicated our present system, and we shall yet be as far from solving this question of efficiency as we now are, except in so far as we teach in those schools the science of working solid materials rather than the processes.

What then are we to do? Simply get right down to a thoro study of the problem from this standpoint and determine what is essential to the

teaching of the science and also determine what forms of work lend themselves to the illumination of the study of this science. There should not be the least objection raised by anyone to such an inquiry, altho there are many reasons for objecting to a superficial or partial investigation. For one not an expert in this line to make a proper study of the shopwork of any school will require considerable time; and it will be found far better to visit a few schools and come away with the actual knowledge of what is being accomplished than to rush thru many schools and form erroneous conclusions, which I know to have often been the case.

We must not go into this study with our heads set in favor of some special method or model and dead set against some other. There is no question but that the set of models usually thot of as representing the Russian system was originally used to teach tool processes to the entire neglect of the science. Yet some of those models have been used with great success in teaching the science.

Permit me to make a few suggestions in regard to what constitutes authority in an investigation of school-shop work. If one wishes information in regard to teaching Greek, he goes to one who both knows Greek and knows how to teach it. If one wishes to know how to teach mathematics, he goes to one who both knows mathematics and knows how to teach that subject. Then may I ask you,

as you pursue your investigation of school-shop work, to take with great caution the advice of those who neither know the subject-matter of school-shop work nor have shown any evidence of being able to teach even the most elementary lessons in this work.

I care not who they are nor how eminent are their positions as educators, if they wish to establish their ideas in regard to teaching this subject we must ask them to prove by some means that they have the requisite material from which to formulate such theories; and, when they wish us to accept their theories in refutation of demonstrated success by those actually engaged in this work, I caution you to hesitate before permitting the assumption of authority to override actual demonstrations. It is at this very point that most of our troubles entered. Trace the early work, and we will find that it is largely because of accepting the advice of those not familiar with the school-shop movement that the work lost its value, and we are by no means away from this same difficulty.

Today we hear much said about educational shop work in our regular public schools under the name of manual training, manual arts, and similar appellations. Usually the advocates of these kinds of work claim for them great educational values and also claim that they have not and ought not to have any industrial value.

If we trace the history of this kind of work and these claims, we shall learn that this work is simply the shadow of the real educational and industrial shop work as at first established, and that only after the utter worthlessness of this shadow as a preparation for industry had been demonstrated did its advocates crawl under cover by claiming that it was purely for educational values and that it should not be expected to yield industrial values.

I, for one, most seriously doubt the statement that there is educational value worth while in such work. If my experience counts for anything at all, the industrial value of school-shop work will keep pace with the educational value, and when the industrial value ceases all values worth the expense have ceased. To say that the work is educational is to attempt to cover up a failure. There is no such thing as educational manual training apart from industrial manual training. The very elements that are essential to give educational value are the very foundation values of industrial efficiency. Put these values into the work and you have the very best possible industrial education, tho it may be given in a regular school. Omit them and you have only educational bluff no matter by what name the instruction is called or where it is given.

My final message which I wish to leave with

you is no longer to take the word of anyone in this matter but to make for yourselves the most thoro inquiry in regard to the values of the school-shop work as at present given in your own schools and also in other schools.

Manual Training Equipment

There is a great diversity in the equipments now in use and little can be learned by merely asking what equipment is possessed by some school, for a close inspection may reveal that the equipment purchased at large expense and generally reported as "the best" is known by those in a position to know the facts to be thoroly unsatisfactory.

There may, however, be a wide diversity in equipments because of local conditions. The school board that puts a plank on brackets against the side wall of a schoolroom and provides a chest of but a few tools because the community cannot do more, is deserving of quite as much praise as the community of larger resources that is able and does provide a complete equipment. The boards that deserve to be censured are those that will not do what they can to provide for this essential part of school work, and those who go to the other extreme of filling up their rooms with

equipment selected because it is expensive and for the purpose of making a show, exposing their ignorance and bad judgment rather than an interest in the welfare of the pupils.

Purpose of Equipment

Manual training should be in the schools for a definite purpose and every tool and part of equipment of any sort should be selected with a view to carrying out that purpose. As we believe that the purpose of manual training in the public schools is to study the science of working solid materials that the pupil may gain in intellectual power, general intelligence and ability to make good after leaving school, we would select for equipment only those things that tend to this end.

It is, therefore, very evident that serious mistakes may be made in the selection of tools. To place wood files in the hands of beginners in wood work will result very much the same as to give to the beginners in arithmetic a key to that book, or to give to the student in Latin "a pony" for his translation. Those who have not made a study of the scientific principles of working solid materials cannot realize the loss in intellectual growth, interest, and ability to do a high grade of work that results from the use of such "pony" tools and therefore, we find well intending school officials

lowering the value of the work by supplying files and coping saws. No doubt teachers may be greatly aided by the refusal of the board to permit the use of such tools and thus encourage a better line of work. There is really no excuse for continuing the use of such equipment, for there are excellent texts to be had that provide an abundance of problems entirely freed from all temptation to "pony" the work.

Permanent Equipment

No longer do school boards need to fear that the equipment will soon be cast aside because of the "fad" passing away. Neither do they need to fear any changes that will render the equipment obsolete, provided they secure those things that are required for a high grade of work. There is no doubt about the tendency at present being toward a higher grade of work, and the use of such equipment as will make this possible. It is scarcely possible that there will ever be a return to the shabby work of the past. Therefore, if a good standard equipment is installed there will not likely be required any changes except those which occur from time to time because of improvements in tools or new inventions. This progress will be slow and therefore, if the best for our purpose today is supplied, it will likely

be thoroly satisfactory until worn out. It appears to be the duty of those who purchase the equipment to see that every article is first class, not necessarily the most expensive, but exactly the thing for the use intended.

Definite Specifications

This leads to the suggestion that the usual custom of submitting lists to several dealers for bids, altho the proper thing to do, often fails to get a fair comparison of prices, because of indefiniteness in the specifications. The writer recalls a case that is typical of many. Two leading firms in the manual training equipment business bid on a large bill of equipment. The prices submitted totaled almost alike, one firm underbidding the other but a small amount. Naturally the lower bidder got the order.

On receiving the goods it was discovered that the bench brushes, altho answering the specification, were worth about twenty cents each and were unfit for school use, while the other firm would have supplied a fifty-cent brush. The difference in value of the brushes was about double the difference in the totals of the two bids. We do not advocate the purchase of large equipments without getting prices from various houses, but rather the most complete specifications in all cases.

We must not leave this topic without referring to another type of purchasing. There is one firm that probably surpasses all others in its constant advocacy of the purchasing of the "best." This sounds all right, but when we consider that this firm's interpretation of the word "best" does not mean quality, but the most expensive styles, then we take issue.

A certain school was equipped on this plan by this firm, their equipment costing some eight thousand dollars. A judicious selection would have obtained a far more useful equipment for four thousand dollars. In fact much of the equipment is of such a type that it is in the way rather than helpful. It may justly be compared to placing on the desk of every sixth grade pupil an unabridged dictionary. This school is crippled permanently unless some one comes to its relief with sufficient grit to dispose of much of the equipment and replace it with that suitable for the school work.

Controlling Factors

In the ordinary selection of an equipment two factors govern: the grade for which it is intended, and the amount of available funds. That we may get a basis on which to work I shall suggest an equipment for the fifth, sixth, seventh, and eighth grades, and note such modifications

as would ordinarily be required for a two years' high school course in wood work for a community able to provide a thoroly satisfactory equipment. With this as a basis less favored communities can reduce the expense by limiting the number of individual tools, etc. I will not attempt to cover the work of other grades or other subjects. The same principles apply to all the grades and all materials suitable for school shop work.

The number of pupils in a class determines the number of benches, number of tools in each set, and also the number of some of the general tools. For convenience we will plan for grade classes of twenty and high school classes of the same number, altho if the room is of sufficient size and a good text book used, thirty pupils can be well cared for in a high school class.

Benches

The first and most expensive part of the shop equipment is the benches. There are two ways of making benches, much wood and little work or less wood and more work. Weight is of importance but of little value if the joints are not rigid. To successfully demonstrate the principles of mechanical science on unsteady benches is practically impossible. To purchase such benches

as a matter of economy will result in serious waste, for the larger values of the work will not be realized. Instead of that steady thotful use of the tools that is essential to proper study you will have nervous, jerky movements and the study element omitted.

To make a substantial bench, a good framework is necessary. With a good framework it is bad business to leave the space under the bench as waste room, and go to the expense of providing cases of drawers at the sides of the room. Side cases have been used to avoid stealing from the bench drawers, as the cases were apart from the pupils where the teacher could watch them.

Master keyed locks on the drawers are of little value unless of a very expensive type, and then often unsatisfactory to such an extent that schools have hesitated to make use of them. These difficulties are now all entirely overcome by a locking device that makes thieving from drawers practically impossible and places the locks under the most perfect and convenient control.

There is, therefore, no longer excuse for the inconvenience and disorder resulting from keeping either tools or materials apart from the bench. See that the framework and paneling actually tend to strength and rigidity. Benches for the high school should be similar to those for the grades. They may be supplied with lathes. This saves

room and for many schools is the best arrangement, especially for second year or advanced work.

Vises

Each bench should be supplied with one vise set far enuf from the end to avoid the temptation of using it in sawing. Tail vises are not needed, and besides being in the way, will do more harm than good. No doubt the best style of vise is a quick action iron vise. It should, however, have a continuous screw and no springs or other parts gripping the thread, for the pulling and pushing of the movable jaw requires too much strength at the best. Here, as in every part of the equipment, simplicity should be an important item. Tho a mechanic might find it no trouble to spend a minute now and then adjusting or oiling a few little pieces, in the school room five pieces to be looked after at each bench totals a hundred for the teacher, who alone must watch these things. A few tools that will not work properly, a few vises that occasionally stick or slip, a few benches that are constantly becoming shaky, a few keys lost or that won't unlock and no way to open the drawers or cases, a few small pieces of work lost or damaged because of no safe place for them, just a few of these little things in each line and an expensive equipment with a competent teacher becomes little

more than a waste of money and time. The board cannot be too particular in seeing that everything is simple, substantial and durable. Good vises, substantial benches and drawers under thoro control play a very vital part in this result.

Edge Tools

For the grades few edge tools are required at first. If a properly arranged course is followed the chisels will not be needed in the first work and the pupils will advance to work requiring them with a continued interest not possible if all the tools are used in the first lessons. As these tools, including the planes, form an important part of the equipment, insist on having those that bear the name of some reputable manufacturer who makes a specialty of these tools. In planes choose the most simple iron planes having both screw and lateral adjustments, with thin bits that can be readily rounded.

Individual Tools

Each pupil should have his own edge tools, because for different work these tools are fitted differently, and to teach the science of using them they must be fitted exactly right for each problem. Pupils cannot be held responsible for

edge tools used in common without consuming time seriously needed for other work. A pupil should become accustomed to the peculiar characteristics of his edge tools, and this is impossible if they are being changed by others. As a matter of economy individual tools will last enuf longer to make their use a good business investment. Without individual tools pupils will often be using those not in the best condition and because of this fail to get proper returns for their effort, falling behind when it is not their fault, or doing poor work because they thot they could get along with a plane or chisel not in the best condition. It matters little whether they fall behind because of attempting to use a dull tool or by taking time to sharpen one dulled by another. In either case the keen enjoyment of the work is lessened. It is the realization of honest returns for honest effort that gives the large interest and value to the work and that cannot be had if pupils' efforts are dissipated by the carelessness or neglect of others.

Note:

The original article, as published in the "American School Board Journal," gave a complete list of equipment. As the changes in con-

ditions from year to year render such lists of value for only a brief time they are omitted from this reprint.

The publishers desire to be helpful to all those interested in equipping schools for Mechanical Science work, and therefore will gladly furnish up-to-date lists of tools and other equipment on receipt of a request. They should be supplied with information stating the number of pupils to be accommodated, grades in which the work is to be taught, and amount of funds available for equipment.

The Mechanical Science Series

This series of texts presents the work of the school shop as a definite science rather than as tool processes or methods of making things. The entire course is arranged in definite divisions with each division arranged according to a definite and logical sequence based on the demonstration of the fundamental principles of working solid materials. Altho this restricts the course to very definite portions of subject matter, yet this subject matter may be studied and the necessary demonstrations made by use of a great variety of materials and projects. This variety is largely provided for by many suggestions in the texts concerning modifications of designs, use of different woods and various methods of finishing.

The important and especially interesting fact in regard to the **Mechanical Science Series** is that its proper use invariably yields results far beyond that of any other line of school shopwork. It not only results in a greater interest and far better executed projects, but also yields a value in preparing for industrial occupations that has not been approached by any other system of school shop instruction. For complete information in regard to these texts, address

The Maudslay Press
VALLEY CITY, N. DAK. CRANESVILLE, PENN.

Woodwork for the Grades

This is the text to be used in beginning shop-work in Mechanical Science in whatever grade the work is begun in both grades and high school.

This text contains a large variety of material so arranged as to afford opportunity for selecting exactly the right project for each pupil. There is no question but that in actual practice the use of this text leads to a more perfect adapting of work to individual pupils' needs than is possible with any other text or system of instruction. It is a thoroly practical text and pupils who complete the work as given show exceptional interest and ability in doing work at home. No other text will compare with this one in giving power to do work with tools outside of school, as records of pupils show, thereby proving this to be a text of exceptional value in developing initiative and industrial efficiency.

The Mechanical Drawings are arranged and graded with great care so that the average boy will, in using the book, learn, without any special effort, to read drawings. The text contains many complete working drawings of projects from simple one-piece projects to chairs and tables.

This is the text that has the enviable record of always having its pupils win first prize whenever their work is placed in competition with work of other systems and they have been in charge of a competent instructor.

Mechanical Science Methods

This is a text for use in Normal Schools; it is also a most helpful handbook for teachers using the Mechanical Science texts.

It gives in great detail the exact methods to be used in presenting the Mechanical Science work basing the directions on the first lessons. It is well understood by teachers of Mechanical Science that the first lessons are extremely important and that if they are properly taught, there will be little trouble about the others.

This text is based upon the experiences of many teachers and is a thoroly practical and reliable guide. It is not only valuable for the teacher, but is also a most helpful book for the principal and superintendent, as it supplies exact information as to how the work should be taught. The superintendent who requires of his teacher the standard and results called for by this text will find his patrons highy pleased with the interest and values resulting from his school shop.

The Maudslay Press

Valley City, N. Dak. *Cranesville, Penn.*

Elementary Drawing

This text is for use by those who have had no previous instruction in drawing. It covers the first essential elementary problems in great detail. The instruction given is so very complete that this book may be used successfully as a home study text or in schools not provided with a special teacher of drawing.

All of the problems correlate very closely with those of the shop texts of the Mechanical Science series. This is of great assistance in both shopwork and drawing. The text on drawing may be referred to for aid in understanding the shop drawings and the drawings in the shop texts may be referred to as examples and additional illustrations of the problems in drawing. The text on drawing contains several modifications of the problems given in the shop texts. These will be found very helpful.

This text should be used in whatever grade the study of mechanical drawing is begun. If conditions permit, the work should begin in the seventh grade with only a very limited equipment. By the time the pupil has completed the eighth grade he should be able to read any drawing that would be given to a boy in regular employment, and should be able to make free hand sketches and simple mechanical drawings.

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