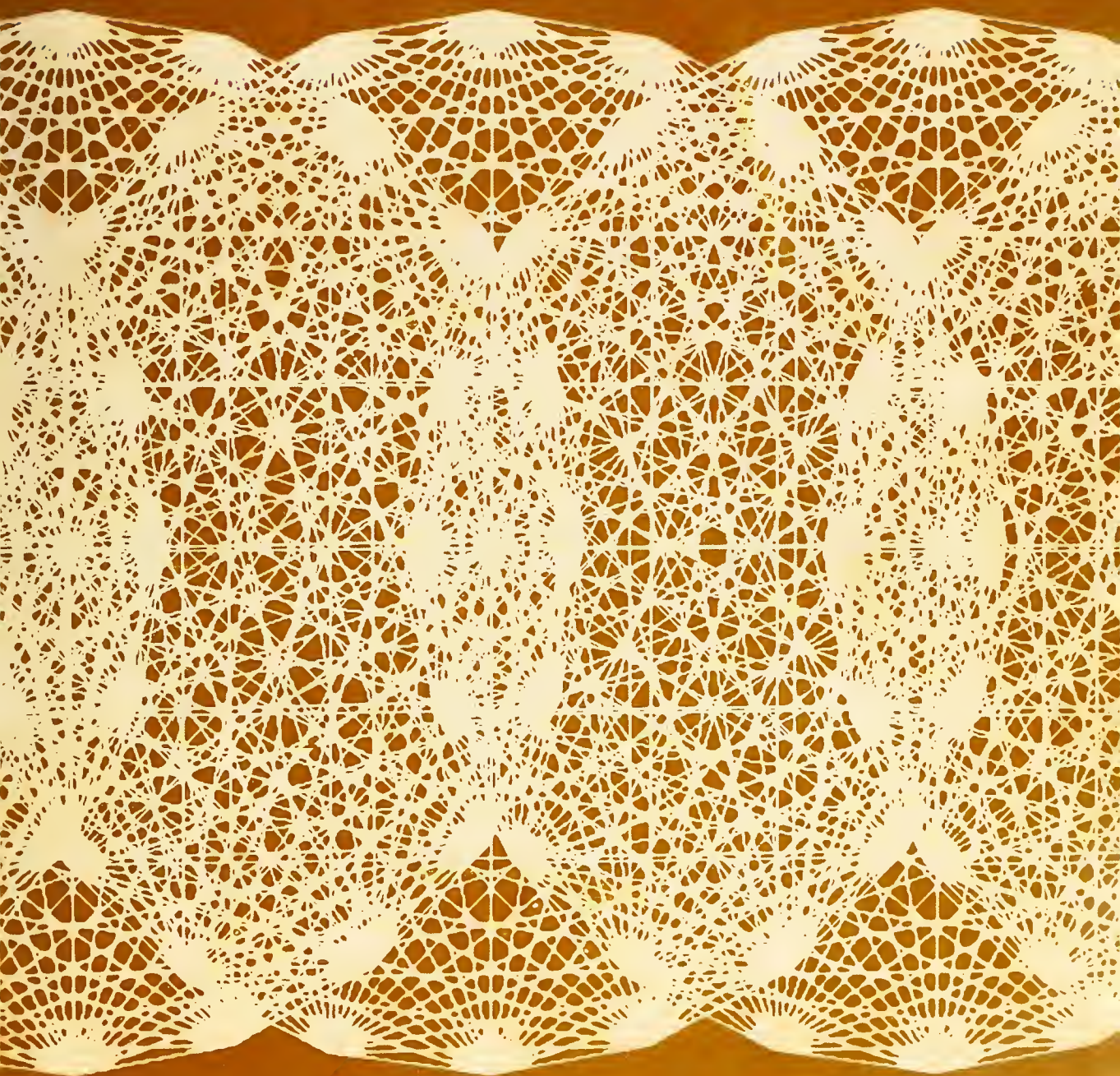
# Seminars in Population Dynamics and Economic Development



Sponsored by
The Office of Population
United States Agency for International Development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# Seminars in Population Dynamics and Economic Development

By The Population Dynamics Group
Paul Handler, Director
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This program is supported by:
The Office of Population
United States Agency for
International Development

# Participant Information

The Seminars in Population Dynamics and Economic Development have been developed as research and educational aids for government officials, planners, and students interested in the impact of rapid population growth on economic development and social problems.

The Seminars use computer-based educational systems, such as PLATO (Programmed Logic for Automatic Teaching Operation) and POPDYS (Population Dynamics System). All programs are available on either system.

These systems are effective teaching and research devices that are easy for participants to use. No special mathematical skill or computer experience is required of participants. Each participant works independently and studies the country of his choice.

The Seminars have the flexibility to meet various needs. Any combination of the subject areas described in the following pages can be studied.

Seminars are available at the University of Illinois at Urbana-Champaign, at the Office of Population, A.I.D., Washington, D.C., and at other selected locations in the United States.

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# Table of Contents


| | | |
|---|---|---|
| I. | **Participant Information** | Opposite Page |
| II. | **Seminar Information** | |
| | Seminar Topics | 2 |
| | Seminar Methods | 4 |
| | Research Opportunities | 6 |
| III. | **PLATO And POPDYS Program** | |
| | Population History and Projections | 8 |
| | Interacting with the System | 10 |
| | Population Subgroups | 12 |
| | Migration and Urbanization | 14 |
| | Generations | 16 |
| | Food and Energy | 18 |
| | Education and Health | 20 |
| | Labor Force | 22 |
| | Educational Costs and Economic Growth | 24 |
| IV. | **Workbook And User's Manual** | 26 |

## POPULATION PROJECTIONS

**Trends in Population Growth: Past, Present, and Future.**
Introduction to POPDYS or PLATO. Population history of preindustrial and modern societies. Population projections for the world and countries of interest.

**Fertility and Mortality Rates and the Growth of Populations.**
Definitions of various fertility and mortality measures. Use of age-specific fertility and mortality rates in population projections. Individual use of the POPDYS or PLATO System to study projections of total population for each participant's country with various fertility and mortality rates.

## THE IMPLICATIONS OF CHANGING FERTILITY AND MORTALITY RATES

**Age Composition of Projected Populations.**
Relationship between age composition and patterns of growth. Use of POPDYS or PLATO to study the number of fertile women, school-aged children, infants and aged that a country might expect from various fertility and mortality changes.

## IMPACT OF BIRTH RATES ON PUBLIC EXPENDITURES

**Cost of Education**
Number of students, operating and expansion costs. Participants, using POPDYS or PLATO, are able to project educational costs for their country under various assumptions regarding fertility, mortality, and enrollment rates.

**Cost of Health, Welfare, and Other Governmental Services.**
POPDYS or PLATO can be used to study the demand and costs of various social and governmental services under changing fertility and mortality rates.

## ECONOMIC DEVELOPMENT

**Population, the Labor Force, and the Economy.**
Introduction to the economic growth model in the POPDYS or PLATO System. Definition of labor force, gross national product, capital and investment. Participants can make projections such as the future labor force with different fertility and mortality rates and various labor force participation rates.

**Economic Development and Population.**
The effects of population growth, changing rate of technological growth and labor and capital inputs on national output. Use of POPDYS or PLATO to study the implications of various demographic and economic conditions on the future growth of per capita income.

## NATURAL RESOURCE ADEQUACY AND SPECIAL TOPICS

**Resource Requirements.**
Demand for food, energy, water and minerals. POPDYS or PLATO can produce projections of food and resource requirements for a given country with various levels of consumption and with changing fertility and mortality rates.

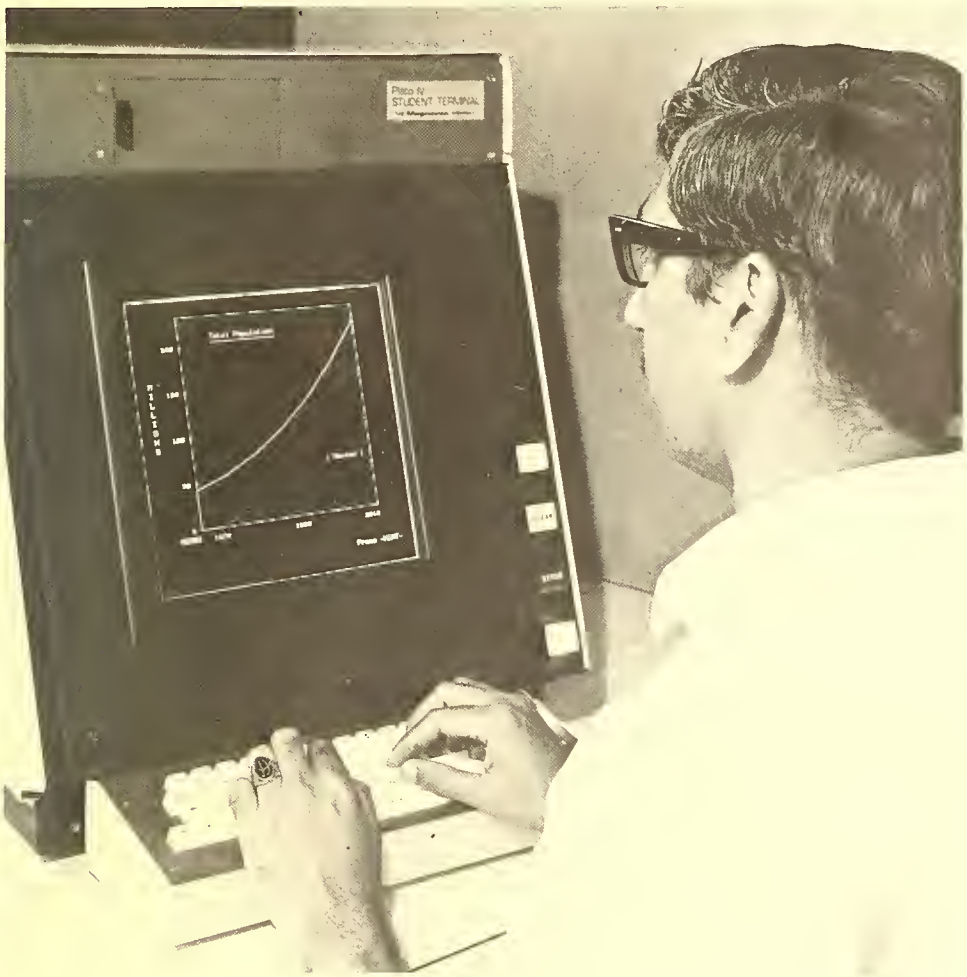
**Special Study Topics.**
Participants can use POPDYS or PLATO to study special demographic techniques such as the construction of life tables. Other subjects are: internal and international migrations, analyses of age-specific fertility and mortality schedules, and age-specific labor force participation rates.

These seminars use the most modern teaching methods to demonstrate, as quickly and effectively as possible, the basic principles of population dynamics. In order to supply concrete and useful information to each participant, the principles are applied to an analysis of the population of the specific country of interest to each participant.

Participants communicate with POPDYS or PLATO by pressing keys on a simple keyboard. Within seconds after a student asks for a projection, the calculations are completed and a graph is drawn.

Every effort has been made to keep the system both easy to use and flexible enough to meet the needs of each participant.

All displays can also be printed on paper with the aid of another system; thus, students can keep permanent and accurate copies of interesting projections.



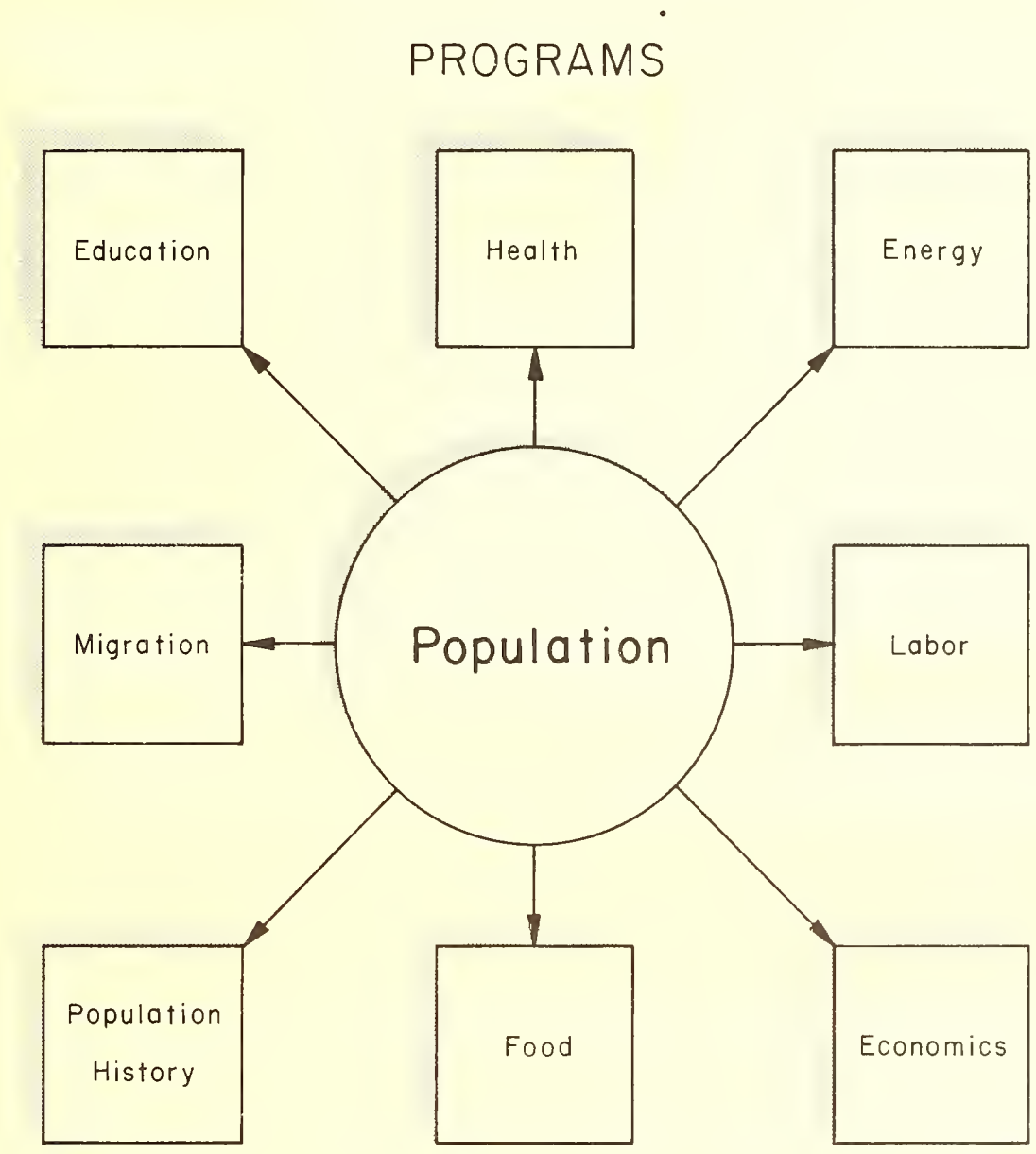
A participant views a projection of the size of the population of Mexico to the year 2010 on the console. Students use the keyboard to communicate with POPDYS or PLATO.

The Population Dynamics and Economic Development program has been designed for use as an independent research aid. While a limited and guided lesson plan is often used as an instructional tool for seminar participants, the entire program is available to both seminar participants and independent researchers.

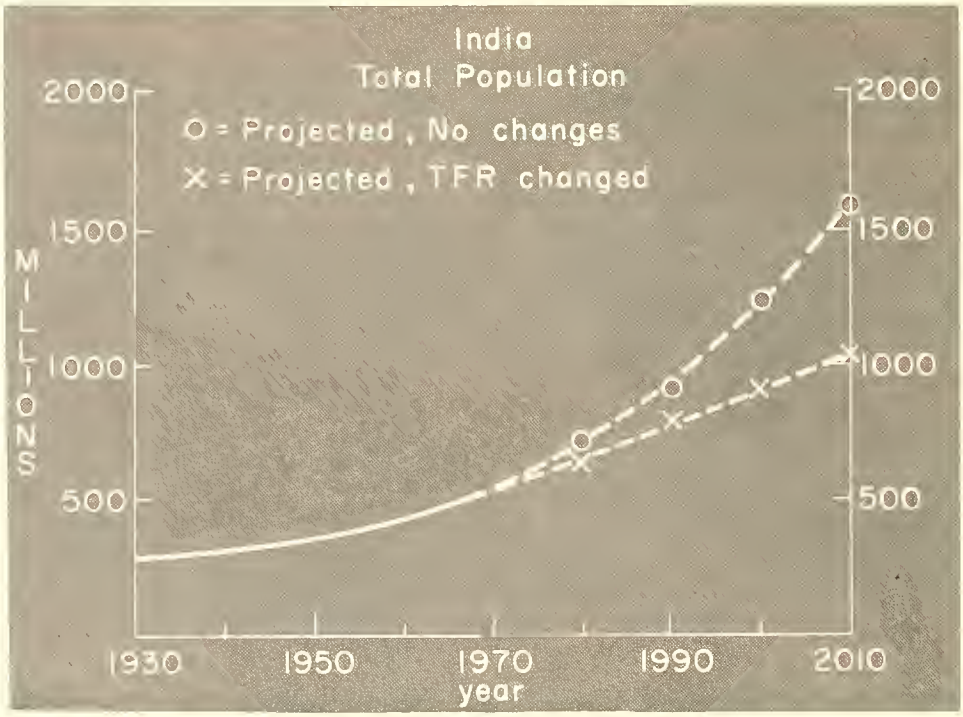
The Population Dynamics Model projects the size and age composition of a population and shows the implications of various alternative policy measures on future population. Various other supplementary models have been developed to enable planners to study the effect of rapid population growth in relation to the demand for food, growth of per capita income, demand for natural resources, and the quantity and cost of needed social services. The projections are based on the most current demographic and economic data available.

Participants can instruct POPDYS or PLATO to make extensive changes in demographic variables such as birth and death rates, age compositions, total population size, and sex ratios during the course of any projection. In addition, participants can study the effects of projected changes in other applicable variables. For instance, labor force participation rates, school enrollment ratios, investment rates and many more variables can be changed. A participant can tell POPDYS or PLATO to change any of these variables from its present value to any new value over any period of time in the projection.

Presently, the data base includes demographic, economic, and other data for most less developed countries as well as for many developed countries.




This diagram illustrates the central relationship of population to the many programs which together form the Population Dynamics System (POPDYS).




Line graphs are used to view the growth or decline that occurs in a quantity over a period of time. The continuous white line on the graph shows the actual historical growth of the total population of India. The dashed line labeled "O" shows the population that India can expect if fertility and life expectation remain at their present values. The dashed line labeled "X" shows the expected population if the Total Fertility Rate is reduced gradually from 5.3 to a value of 3.0 live births by 1990.

All projections are completed and drawn on the screen within a few seconds after they are requested. Projections are displayed in several formats to meet various needs. Participants choose the display format they want from a numbered list.

Participants often wish to study a detailed analysis of a present situation or projected conditions. POPDYS can display data lists and age composition graphs to aid in this analysis.

The graphs can begin at the current year or at a prior year, if the historical data are available. Actual historical growth can be viewed along with projections of future development of many economic and social aspects of a country, thus giving students a basis for comparative study.

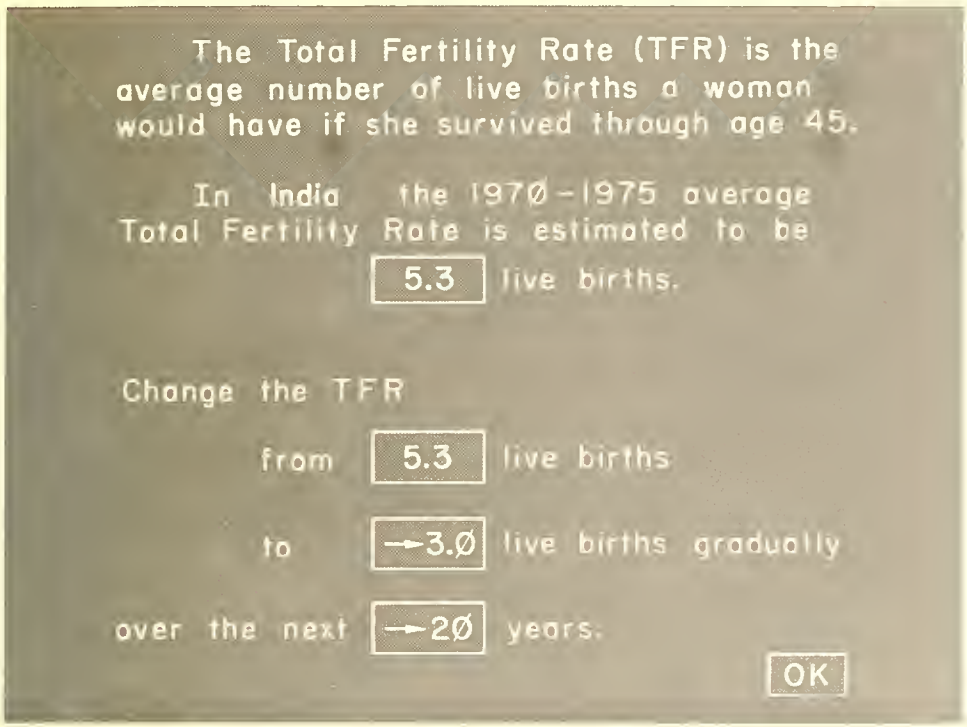

Age composition graphs show the number of people in each five year age group. In this display, data for 1970 appear on the left, and the projected age composition data for 1990 appear on the right. The graph shows that there were almost 6.7 million children aged 0 to 4 years in 1970. The projection indicates that there will be 12.9 million in this same age group in 1990, assuming no change in the current growth rate.

POPDYS can also show any present or projected data such as mortality and fertility rates, and age composition in tabular form. Any number of projections can be shown together on the same axes to aid comparative studies. Two age composition bar graphs under different conditions can be displayed side by side for comparison.


Illustrations such as this show what participants see on the screen. In this case, a student has just chosen to study projections of India. India is number 6 in the list, so the student has typed "6" next to the arrow; this "tells" POPDYS which country will be studied. The list that appears here is representative of the list of 80 countries available for study.

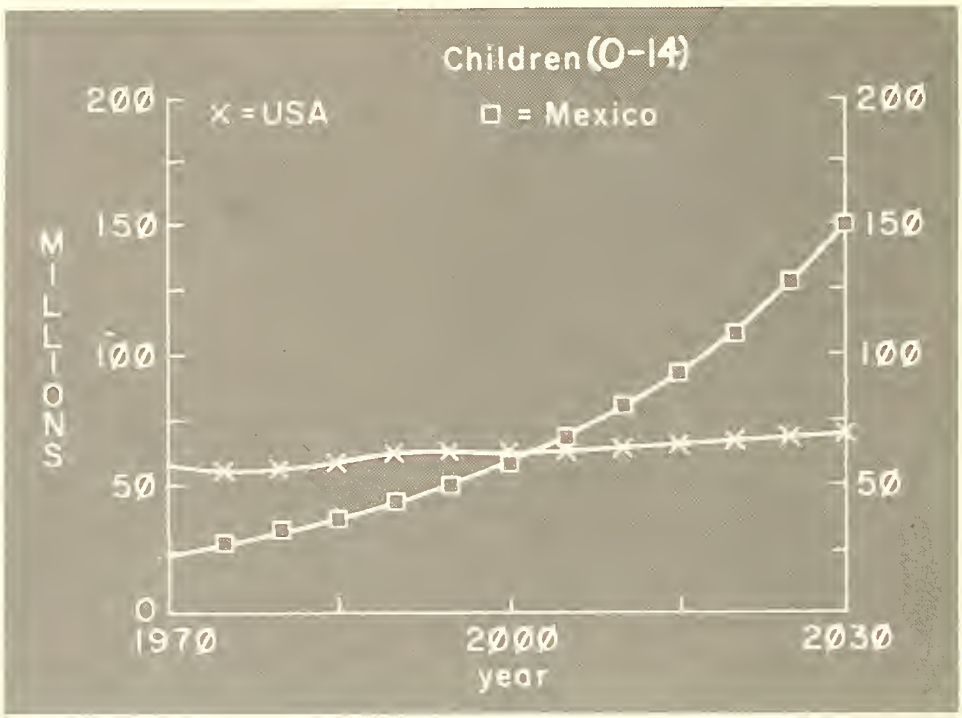
POPDYS utilizes a high-speed digital computer that produces any requested projection within seconds and then displays the result on a screen.

Communication with POPDYS is conversational. POPDYS writes simple sentences which ask students to pick, for purposes of examination or study, a country, a model, or specific variables from a numbered list of possible choices. Students use the keyboard to type the numbers corresponding to their choices.




This same student now directs POPDYS to change the "average number of live births per woman" from 5.3 to 3.0 gradually over the next twenty years when calculating the projections of the population of India for him. POPDYS answers "OK" each time it accepts and understands what the student has typed.

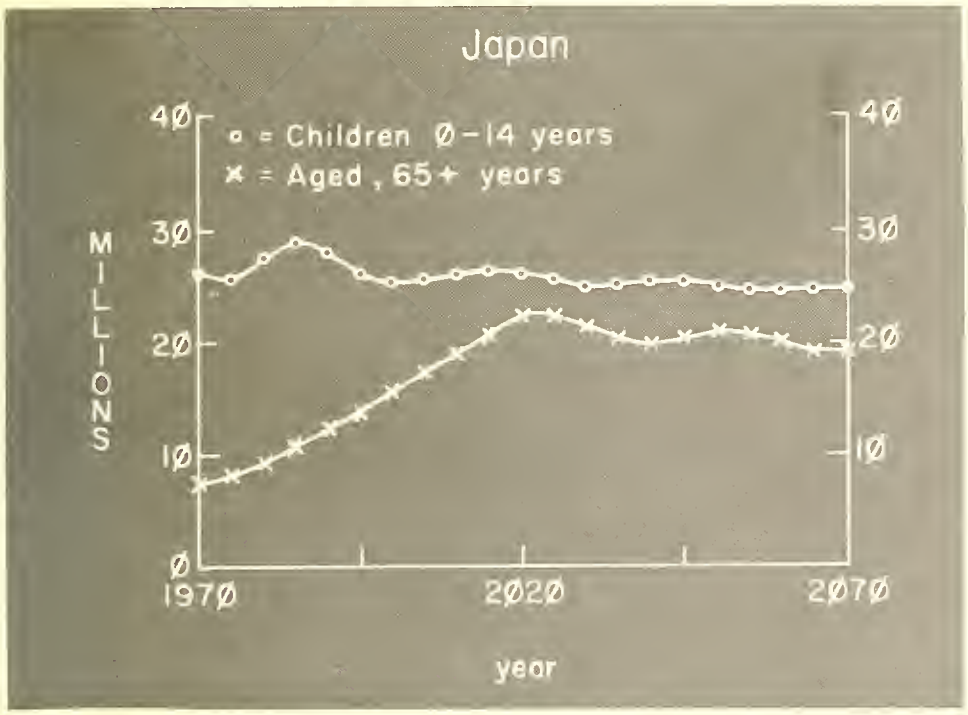
**To change a variable, the student simply types in the desired change.** POPDYS accepts the message and makes a projection based on the new data introduced by the participant.



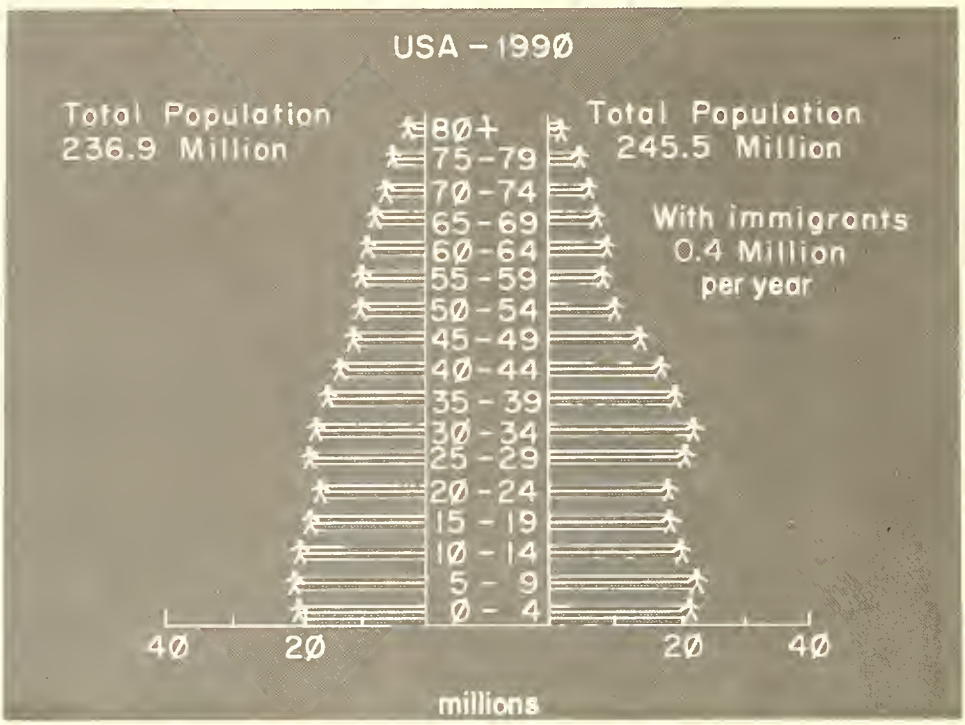

This graph is used to study relative growth in the number of children in the USA and Mexico. The number of children under age 15 is projected for sixty years. In both cases, 1970 fertility and mortality patterns are retained over the entire period. The USA shows a small increase, but the number of children in Mexico doubles by the year 2000 and surpasses the number in the USA by the year 2005.

POPDYS can project the size of any age group of the population and display the result. The population subgroups include any desired age span, such as all people aged 19 to 22 years or aged 3 to 71 years. Also, the system can project standard groups, such as school-aged children, the elderly, and women of childbearing age.

Many different projections can be displayed together on the same axes. These may include various projections of one subgroup made with different changes in projected fertility and mortality.



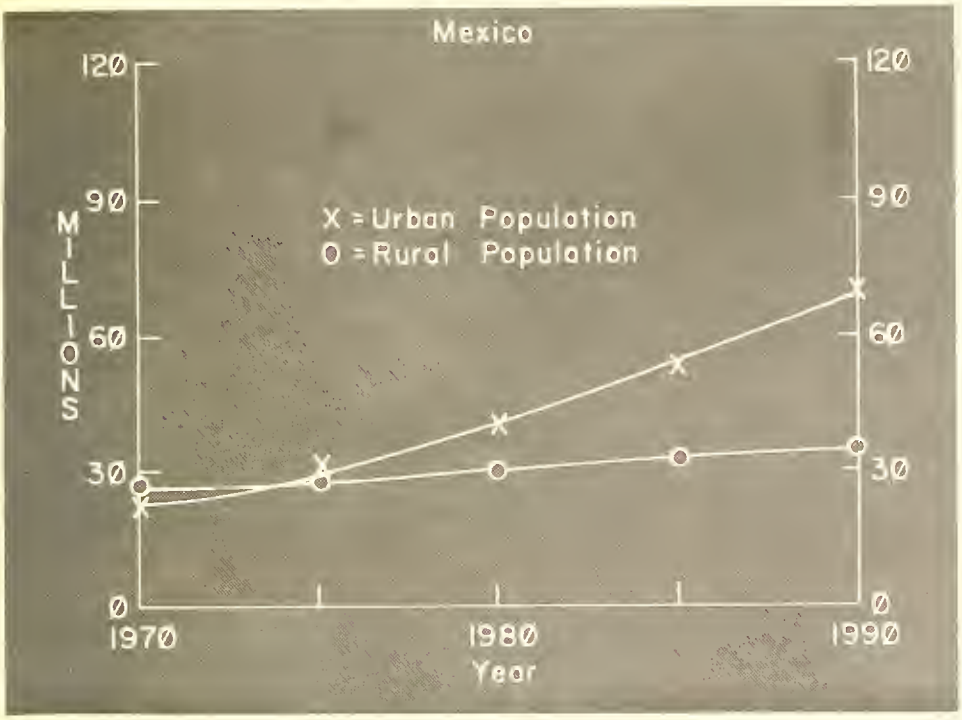

Linear plots can be used to study the relative growth of various age groups. While the number of aged people in Japan will almost triple over the next 50 years, the number of children will show relatively small changes if present patterns of mortality and fertility remain unchanged.




The effect of approximately .4 million immigrants annually on the growth of the total population of the USA is shown here. The projected population of the USA in 1990 is 236.9 million if immigration between 1970 and 1990 is omitted; this projection is shown on the left side of the graph. Eight million immigrants are expected to arrive between 1970 and 1990. When the projection includes these immigrants and their descendants, it shows a total population of 245.5 million for 1990; this projection is displayed on the right side of the graph.

Participants use the migration model to study both the effect of immigration on the size of the total population and the effect of rural out-migration on the urban-rural composition within the country.

Displays have been designed to help students understand at a glance the impact of immigration-related growth. For a country where immigration is a factor in growth, the age composition graph shows two projections, one including the immigration factor and the other omitting it. During the course of their projections, students may change such migration rates as the number of immigrants per year. The age composition of the immigrants may also be altered by the students to reflect foreseeable changes.




A student asked POPDYS to calculate the projected urban and rural population of Mexico using the current estimate that 2% of the annual urban growth in Mexico is the result of migration from rural areas. The resulting projection is shown here; a majority of the Mexican population will live in urban areas by 1975.

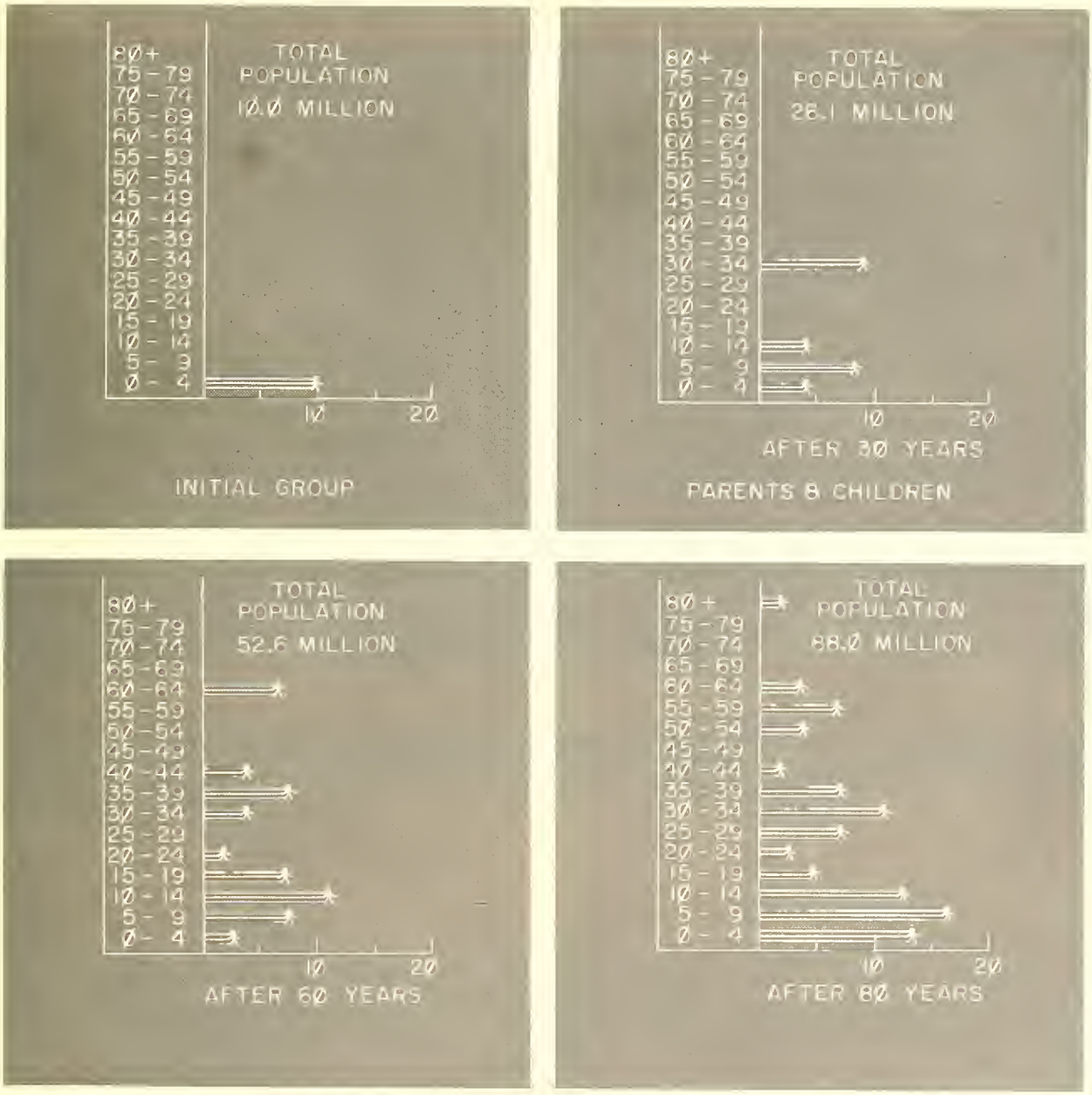
The migration model may also be used to study the proportion of urban growth due to migration from rural areas. In the study of urban-rural composition, students may contrast the total population growth in rural areas with that in urban areas, changing as they wish the proportion of urban growth due to migration from rural areas. They may also compare the age compositions of each area.

The study of the development of generations is an option that is especially useful to more experienced students of demography.

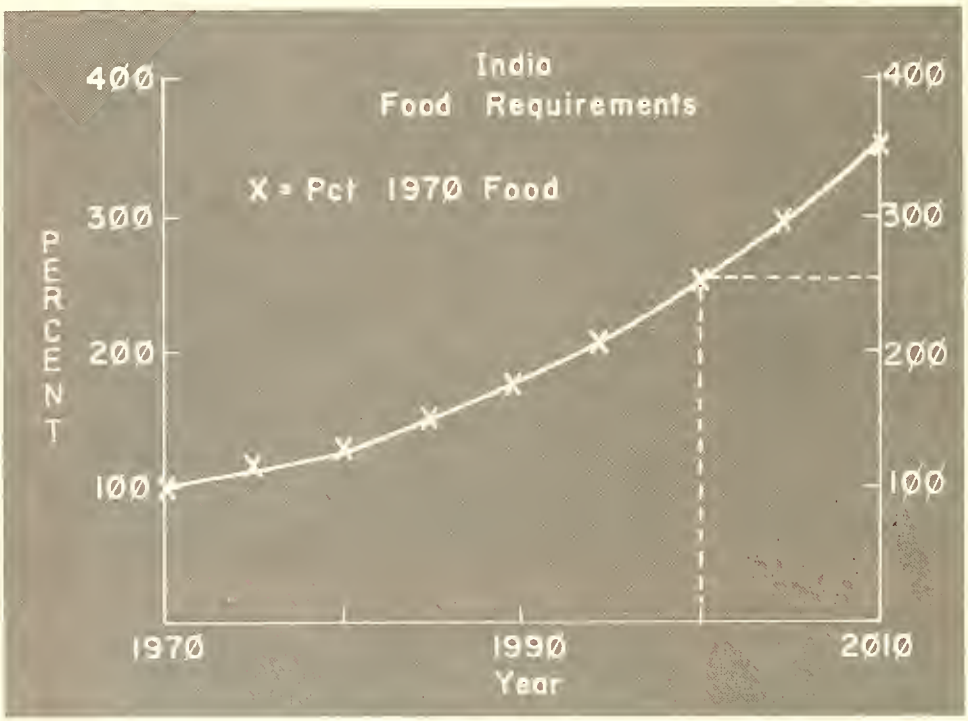
A participant may construct an initial cohort or set of cohorts and then follow the development of population from this initial group. The participant also constructs the mortality and fertility schedules that he wishes to use. This option is useful in isolating the effect of various fertility and mortality patterns as well as for studying the long term effect of immigration.

In the example on the next page, a student has constructed a hypothetical cohort of ten million children aged 0 to 4 years. He has assumed that the average woman who survives to age 45 has had 4 live births, and that child-bearing is limited to women aged 20 to 29 years. He has used the mortality rates of Mexico.

The displays on the next page show the initial cohort and then at various future times, the survivors, their children, and their descendants.

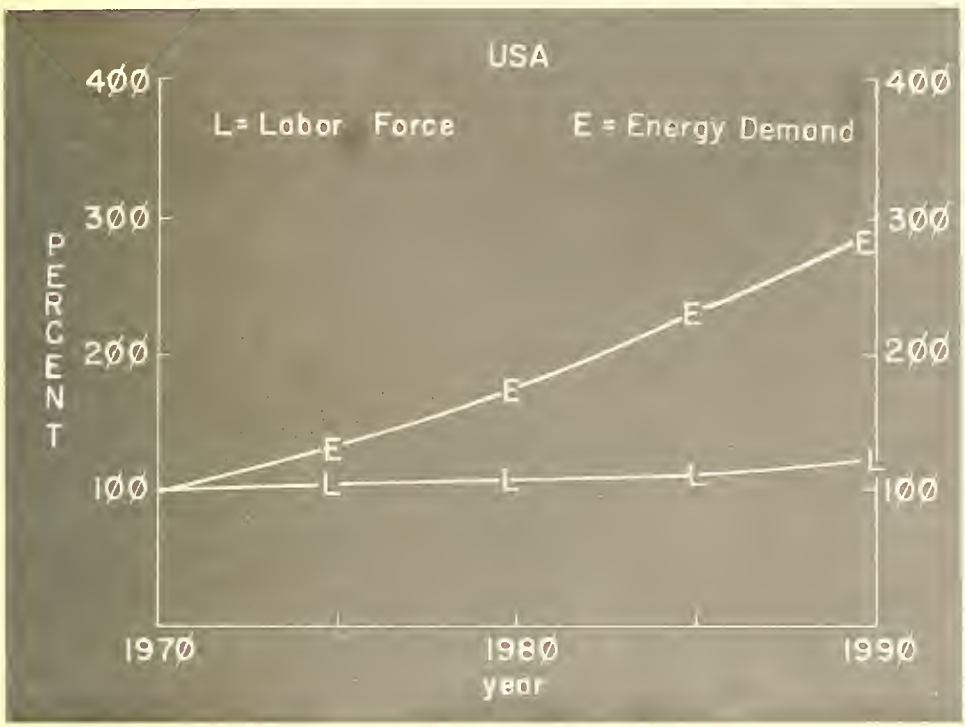



Beginning with an initial group of 10 million children aged from birth through 4 years, these graphs show the initial group and their descendants. Childbearing has been limited for this study to an average of four live births per woman, and to women aged 20 through 29 years; consequently, after 30 years the oldest children are 14 years old, and the youngest to be born to the original group are in their first year. The entire group of children numbers almost 17 million; and the whole population, parents and children, number 26.1 million. After 80 years, less than 3 million of the original group are alive, but their descendants number more than 85 million.




This display shows the long-term total food requirements of India. If no reduction in fertility occurs, India must provide 200% of her 1970 food supply by the year 2000, and still greater amounts at later dates, in order to maintain her population at the present level of nutrition. Projections with different levels of nutrition are also possible.

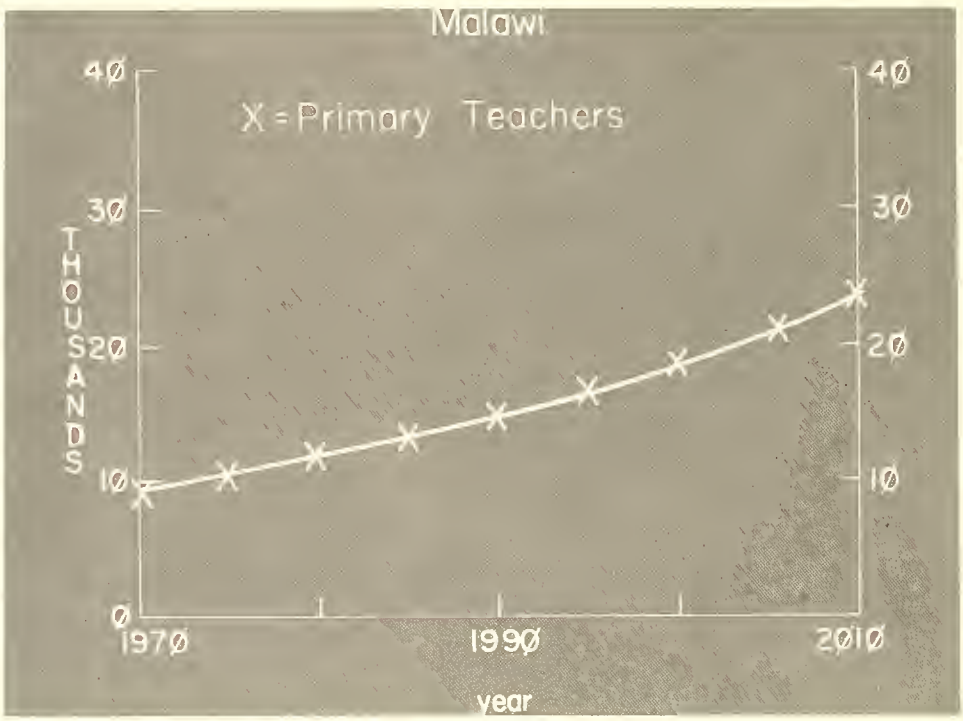
The Population Dynamics and Economic Development Program has been designed to use the Population Dynamics Model as a basis for studying supplementary programs, as shown on page 7. These supplementary programs, described in more detail in the following pages, focus on the needs and conditions of life of the projected populations. One such supplementary program estimates the food requirements of any projected population. FAO guidelines are used to make these projections.




In this projection, POPDYS compares the growth of the labor force and the increase in energy requirements in the USA for the next 20 years. To project the total energy, POPDYS converts other forms of energy, such as coal, to equivalent kilowatt-hours. This projection shows that the USA labor force will grow steadily to reach 1.23 times its 1970 size by 1990. In contrast, if the present rate of increase of energy consumption per worker is maintained, by 1990 the USA will need over 3 times its 1970 energy requirements.

**Projections of the natural resource requirements, energy consumption, arable land, and pasture land are produced by POPDYS.** Each of these projections uses the basic demographic model to estimate the future population, and then applies other variables to determine the actual projection. Students can easily change any of the variables during the course of these projections to simulate foreseeable changes.

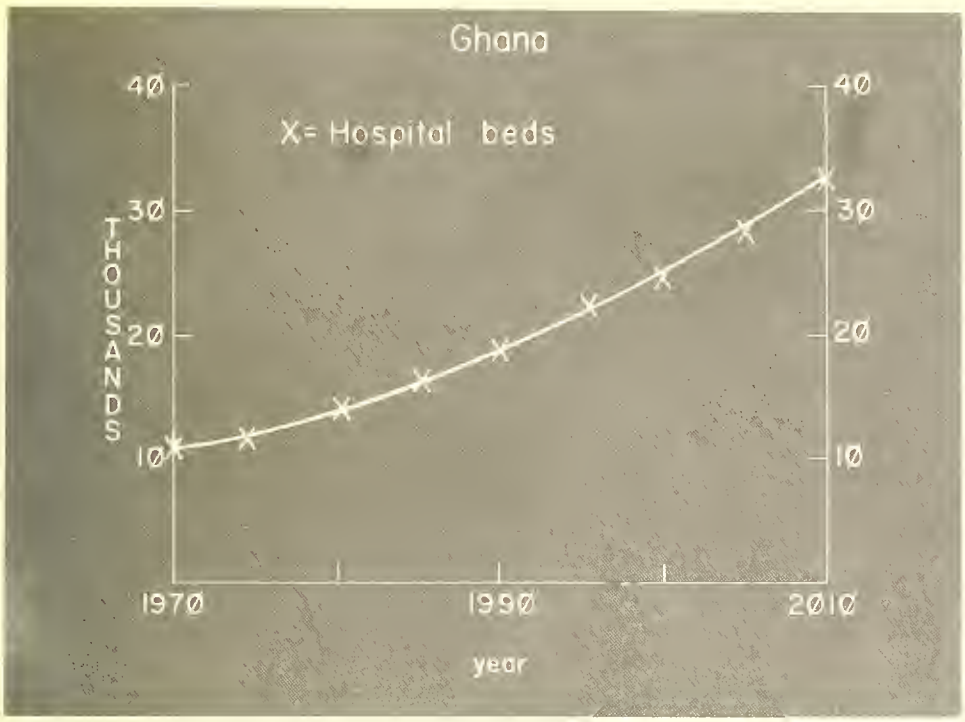
The illustration on this page shows an estimate of the energy needs of the USA. This projection is dependent on the growth of the labor force and the amount of energy presently consumed by each member of the labor force. It is also sensitive to such factors as fertility and mortality rates and labor force participation rates, which would affect the size of the projected labor force and the annual rate of increase of energy consumption per laborer. Students can instruct POPDYS to change any or all of these rates gradually during the course of the projections.




For a participant studying the future educational needs of Malawi, POPDYS produced a forty year projection of the number of teachers needed to maintain the current student-teacher ratio in the primary grades. School enrollment ratios were assumed to remain unchanged for this projection. However, participants may direct POPDYS to gradually change the ratios to reflect expected increases. These projections generally are based on current UNESCO data.

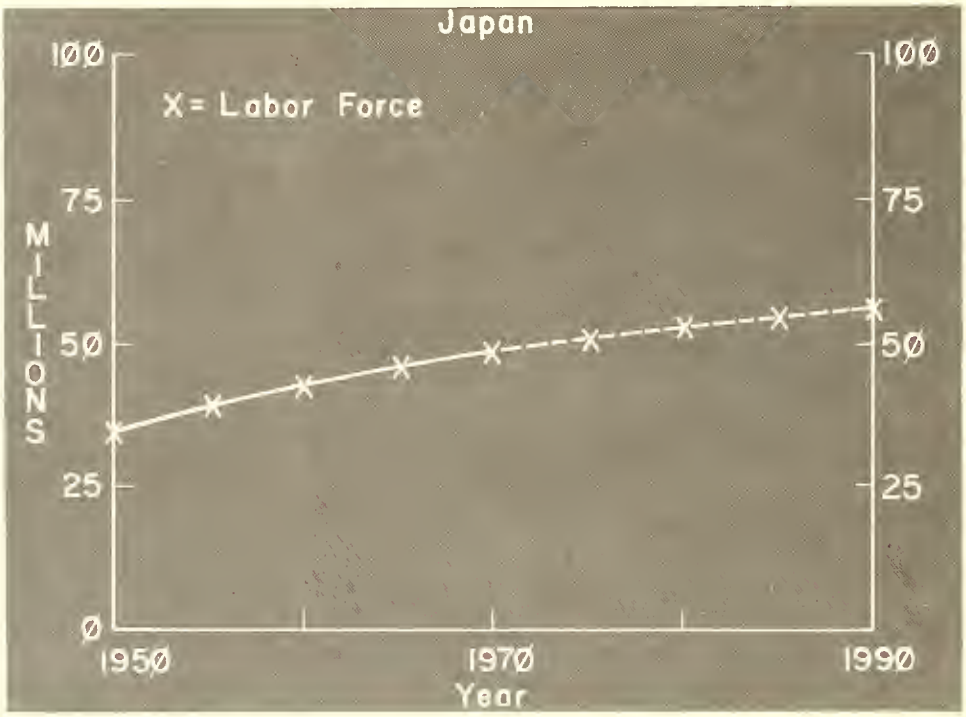
Population growth also requires increasing numbers of teachers, doctors, nurses, midwives, hospital beds and dwelling units.

The program can indicate future school personnel needs by projecting enrollment figures per educational level (primary, secondary, and higher education). Current enrollment figures are used to calculate teacher-pupil ratios, and these figures may be changed by the participant to reflect possible future changes.




Projections of medical personnel and facilities are based on the current per capita availability. This graph shows that if the per capita availability of hospital beds in Ghana is to be maintained at 1970 standards, Ghana must supply twice the 1970 number by 1995 and more than 30,000 hospital beds by 2010. No changes in the fertility or mortality rates of Ghana were considered in this projection, but projections can be made based on foreseen changes in these rates as well as in the per capita availability.

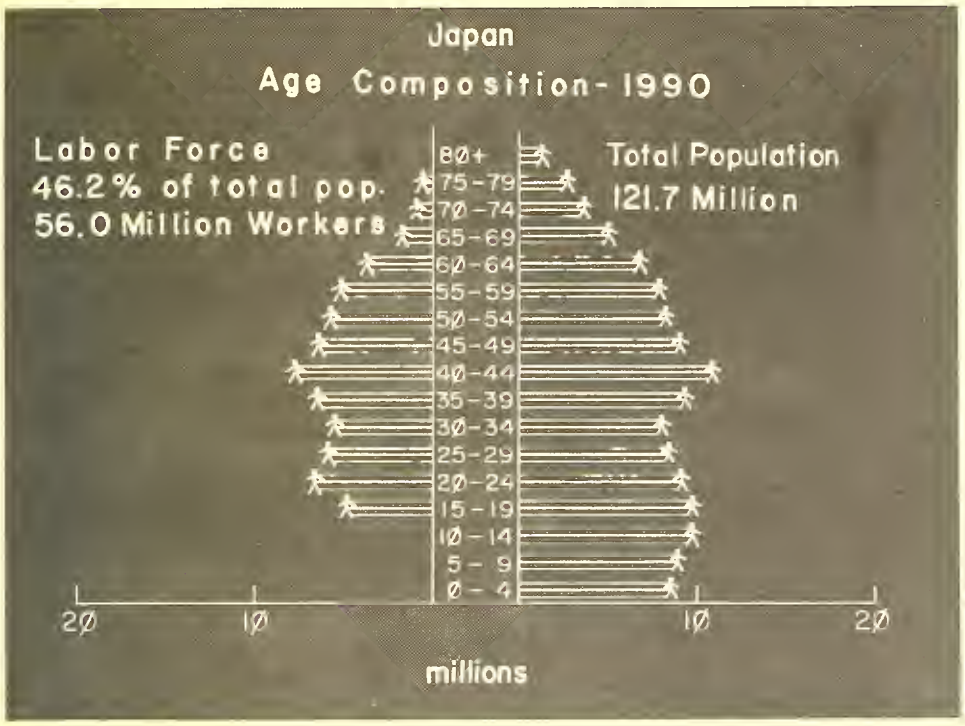
**Students can make projections of a country's future health care needs in terms of personnel and facilities.** Initially, such projections are based on current per capita availability. However, these figures, as well as demographic variables such as birth and death rates, can be changed by participants to reflect future improvements in health care services.



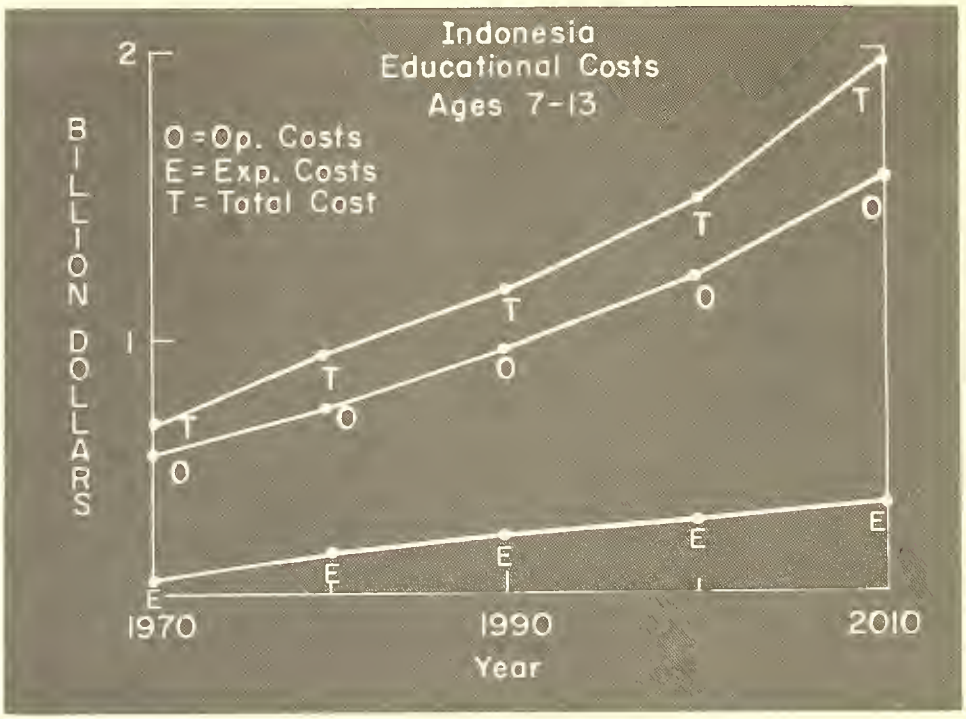

Here the growth of the labor force of Japan is shown. The actual growth from 1950 to 1970 is plotted as a solid line. The projected growth from 1970 to 1990 is shown as a dotted line. The Japanese labor force grew from 36.1 million in 1950 to 52.2 million in 1970. If the participation rates of each age group remain constant and if fertility and mortality rates do not change from their 1970 values, there will be 56 million Japanese workers by 1990.

Projections and age analyses of the labor force are also available to participants. Fertility and mortality rates of the country, as well as the age-specific and sex-specific labor force participation rates, may be changed in making these projections.

The labor force size and participation schedules used for POPDYS projections are based on the most recent International Labor Office data.

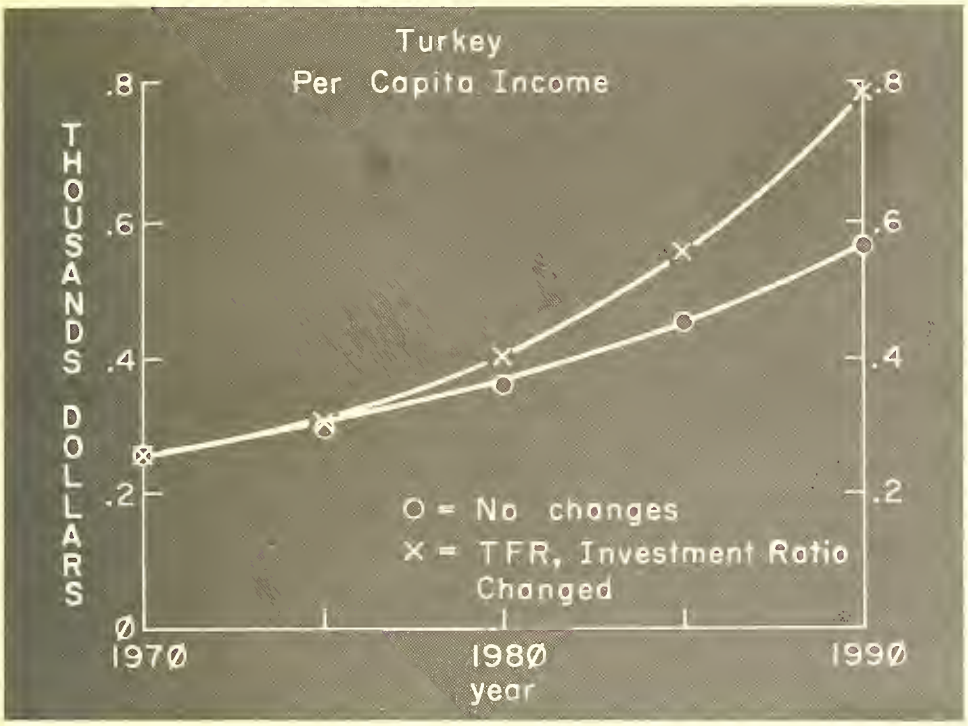



The projected age composition of the Japanese labor force of 1990 is unusual. In this display, the age composition of the projected Japanese total population appears on the right side; on the left is shown the projected age composition of the labor force. The column of numbers in the center shows the age limits of each age group. The left-hand part of the display shows that the median age of the labor force in 1990 will be approximately 40-44, or much older than it was in 1970.




The projection of educational costs for Indonesian students aged 7 through 13 years is shown above. The expansion costs (E) are incurred when an increment in the number of students that must be educated requires an expansion of facilities, purchases of additional supplies and hiring of extra teachers. Expansion costs grow because the number of additional students continues to increase each year. Operating costs (O) are costs incurred to maintain the existing number of students in any year. The total educational cost is the sum of operating costs and expansion costs. In 2010, the projected total cost is almost triple the 1970 value. The projection assumes no improvement in enrollment ratios and no changes in fertility and mortality patterns.

In the projections concerned with educational costs, actual as well as relative costs are calculated. Demographic variables and school enrollment ratios may be changed during the course of these projections to study the effect of changes that a participant may expect. Actual costs can be expressed either in constant U.S. dollars or in the currency of the country being studied.




The per capita income in Turkey is projected in this illustration. The lower line (0) shows the projected income that can be expected if current economic and demographic growth patterns remain constant. The upper line (X) shows the projected income that can be expected if the demographic and economic conditions change so that the Total Fertility Rate is reduced by half, from about 6 live births per woman to 3, by 1990 and if the annual investment rate rises a few percentage points above the 1970 rate.

Based on the demographic conditions projected by the population model, POPDYS makes projections of economic growth, which is represented by per capita income and gross national product. POPDYS also enables a participant to see the effects of different demographic conditions on the labor force and the estimated costs of social services such as education and welfare.

POPDYS uses an economic growth model to make projections of per capita income and gross national product. For these projections, the participant may change demographic variables which affect the growth of the labor force; he may also change economic variables, such as the investment rate and the rate of technological growth.

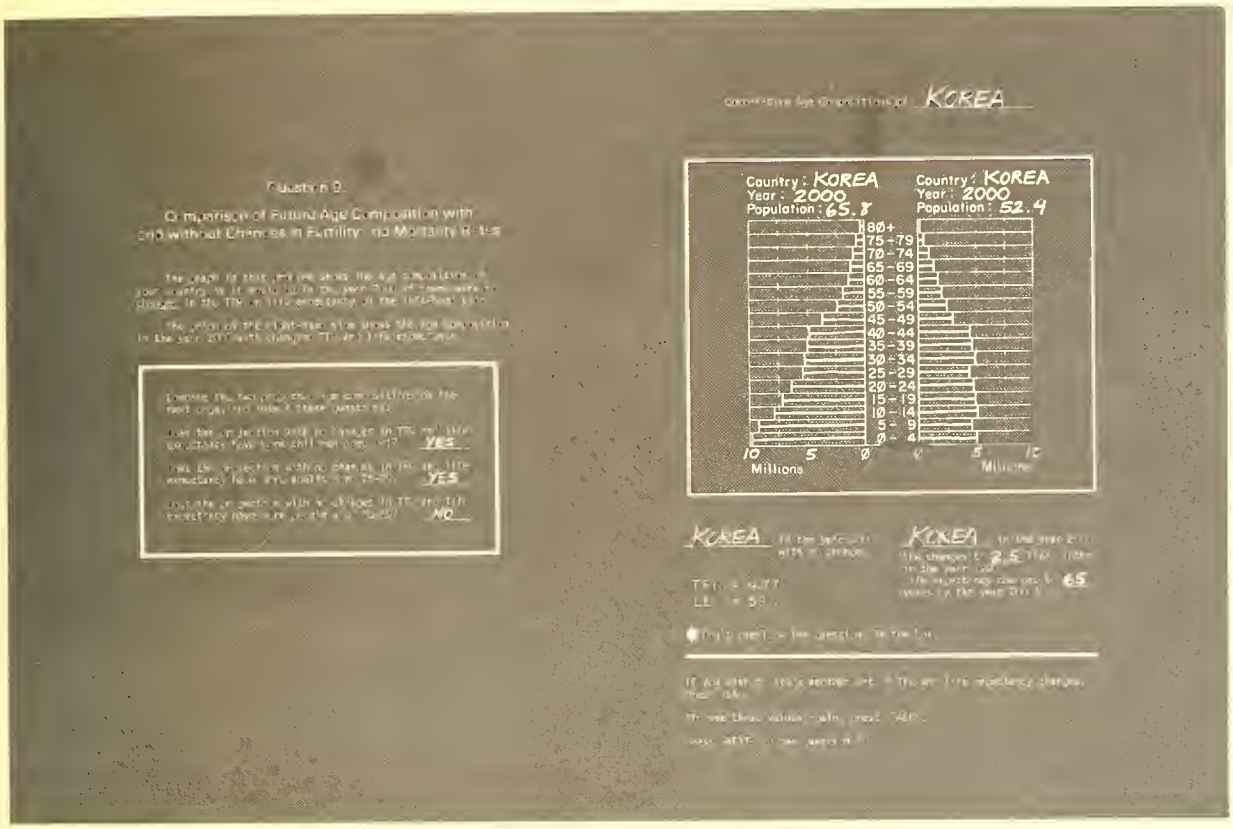
The Population Dynamics Group has written a workbook that can be used by participants in all phases of our program.

The Workbook, which is divided into sections labeled Population Dynamics, Economic Development, and Natural Resources, is designed to guide students in the individual use of the console. In each of the Workbook sections, the students are directed first to review the factors which affect growth and then to measure the past growth of their nation. After this background work has been completed, the Workbook guides students in changing specific variables in order to study their effect on future growth.

In the Population Dynamics section, for example, students first study the related concepts of annual percentage rate of growth, births and deaths per thousand population, and the doubling time of the total population. Then they use these concepts to review the past growth of their countries. Having acquired this historical perspective, the students begin a study of various future alternatives. At first, no changes in fertility or mortality levels are assumed. The Workbook asks, "What will be the doubling time for your country's population if present conditions remain unchanged?" The Workbook then directs students to study the effects of reducing the mortality rate in their country. In separate questions, students can experiment by reducing the infant and child mortality rate and raising the life expectancy at birth to any values they wish. The next questions deal with concurrently reducing mortality and fertility. POPDYS plots both the projected total population and the projected age compositions produced by these reductions. The next questions reflect the special interests of the particular participants attending the seminar; for instance, family planning and maternal health workers study projections of the number of infants and women of childbearing age who will need health services under the various fertility and mortality conditions.

After the participant has completed these exercises, he is then able and encouraged to use POPDYS to explore other topics of interest to him.

In addition to the Workbook, the Population Dynamics Group has developed a User's Manual which may be used in connection with or independently from the Workbook. The User's Manual explains how to operate POPDYS or PLATO in order to obtain the graphs, displays, and numbers shown in the preceding pages.




The illustration shows pages from a Korean participant's Workbook. In this question, he was studying the effects of reducing fertility and increasing life expectancy, both over a period of thirty years. To measure the change in the composition of the population that these variations will produce, he selected the age composition of Korea in the year 2000; the age composition on the left can be expected if there are no changes in fertility and mortality, and the age composition on the right can be expected if these variations in fertility and mortality do occur.