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Aging populations and heterogeneity

Population problems are as old as the human race. In previous ages it was the lack of people that caused concern – high death rates made it imperative to produce enough children to ensure the continuance of the family and the race. Those groups that were unable to do this simply vanished from the earth.

It would be oversimplistic to assert that nowadays the main problem is one of too many people. This is certainly the case in individual countries, mostly in the poorer parts of the world, where the issue is often basically what size of population can be supported by the food-producing resources of the country. IIASA has, in fact, carried out some initial research along these lines within the framework of its Food and Agriculture Program, and in cooperation with the Food and Agriculture Organization (FAO) in Rome.

Within the developed countries, rapid technological advance, coupled with the economic consequences of global indus-

trialization, is forcing governments to face up to the social and economic consequences of large numbers of unemployed. In this case a simplistic question that might be posed is not, as in the poorer countries, "What are they going to eat?", but rather "What are they all going to do?"

Another aspect of the matter, and one which is already changing the economic and social structure of human society, is the balance of age groups. Advances in medical research are enabling people to live longer, and a falling birth rate in the developed countries means that fewer young people will be available to provide the working population that will have to create the wealth required to support an enlarged older generation in their retirement. In all the countries of the IIASA member organizations the population is aging, a shift in age composition that will increasingly have major social, economic and health consequences.

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This overall presentation of the IIASA Population Program has been prepared by **Dr. James Wilkie**, Editorial Adviser to the magazine *Austria Today*. I hope that this new formula for *Options*, with its concentration on one aspect of IIASA's work in each issue, will be welcomed by our readers.
Thomas H. Lee

The problems

Aging populations and changing life styles

It is clear that demographic changes are going to have the gravest consequences for policymakers at governmental level, and in both the public and private sectors of the economy. What, for instance, happens to old-age pension schemes and other social arrangements as both mortality and birth rates fall and the relative number of workers declines? When people do not work their needs have to be supported by some form of social solidarity. Although pension schemes are financed differently in planned and market economies, all industrial societies are encountering difficulties because of the growing ratio of older unemployed persons to those in the labor force. Children provide many of the services, as well as material and moral support, for aged parents, but changing patterns of fertility, marriage and divorce are altering the family networks on which the older generation has traditionally relied.

Even the benefits of increasing life expectancy have been questioned. For some, gains in longevity represent only added years of chronic illness. The treatment of such diseases may be only palliative, postponing death while leaving the patient's health seriously impaired. Obviously, prevention is preferable to treatment, but this can be both expensive and complicated: preventive strategies also need to include nonmedical interventions, such as environmental control and behavioral change.

The baby-boom/baby-bust phenomenon

The rise in birth rates after World War II brought most industrial countries far above a simple replacement level, perhaps for the last time in their history. That rise was followed by a phenomenal decline in birth rates in the 1970s and 1980s. Virtually no industrial nation now has a population that is self-replacing. This dynamic behavior has attracted both popular and professional interest, and the phenomenon is now familiarly referred to as baby-boom and baby-bust.

The baby-boom created exceptional opportunities for employment and job promotion in teaching and supervisory positions for the population cohort born in the 1930s,

but such opportunities will not be experienced by the 1960s generation, at least in the early part of their careers. How this common problem is handled under different political arrangements is something that has still to be examined. A demographic phenomenon that shows up as youth unemployment in Italy and Spain may simply appear as a problem of allocation of human resources in the countries of Eastern Europe. In the USA it may show up as the

health analysts and many others study the dynamics of population change. The mathematics needed to analyze the evolving age distribution of a human population is the same as that needed to analyze the evolving age distribution of a population of trees, automobiles or capital equipment.

What are the causes of changes in fertility, migration, marriage, divorce, morbidity and mortality that are radically altering population structures in nearly all countries? And



Population aging is going to have the most far-reaching social, economic and political consequences for decision makers in the next few decades.

failure to utilize the talent of a new generation.

The industrial feedback

The demography of industrial and commercial firms and other large organizations is a virgin field of study that is ripe for the plough. The advantage that a firm has once it starts to expand is that it can hire personnel, and it usually hires young, new employees. In an industry where technology is changing rapidly – and that means most of them nowadays, especially as regards office automation – this expansion gives it an advantage over firms that are stagnant and whose workforce is aging. A positive feedback results, which can have staggering effects on wage unit costs, overall productivity, and the success or failure of the firm under tight market conditions.

The broader perspective

Population analysis is much broader than traditional demography. Reliability engineers, biostatisticians, labor economists, actuaries, population biologists, public

what are the consequences of these changes for industry, for the health and social services, for housing, for the labor market? Over the next few decades:

* The biggest changes in economic patterns will result from the changing distribution of the world's population and the changing age distribution of populations within countries. This will clearly be a vital factor in strategic industrial and commercial forward planning.

* The biggest environmental changes will result from changes in the size, the age and geographic distribution, and the health of human populations. People are a key part of the environment, and the environment is important because it affects people. But environmental changes will affect populations of animals and plants too, and the study of these changes also requires population analysis.

* The biggest social and political changes will result from the changes in the international distribution of population and changes within countries in the age distribution of the population. In IIASA member countries the rapid growth in the population of older people will fundamentally alter patterns of work, education, leisure, the nature of society, and the functions of government.

The research program

Research on the consequences of population aging began in January 1984, based on some preliminary thinking and previous research done at IIASA in 1982 and 1983, and it is expected to continue at least until 1987.

The IIASA research program concerns itself with wider issues that other professionals have neglected, and that correspond to the preoccupations of nonprofessionals concerned with population. The work combines policy relevance with analytical sophistication, because it is believed that advances in demography will come about by developing and applying more powerful methods to important policy concerns.

Some of the research is substantive, i.e. concentrating on specific problems, and some is methodological; the methodological research will develop the forecasts, models and methods required for the substantive research. As a means of illustrating the type of work being carried out under the program, one example of a study from each of these two categories is discussed on a later page, namely interfirm competition, and heterogeneity. Both of these projects have broken new ground, and both should provide a basis for much future research at IIASA and elsewhere.

The fact that these two projects have been highlighted as illustrations should not divert attention from the considerable amount of other substantial research that has been and is being undertaken at IIASA. The criteria that have been set establish high standards

for the work undertaken:

- * It should be interdisciplinary, drawing insights and methods from different disciplines, and be of interest to academics and practitioners in different disciplines.

- * It should be of international interest, involving scholars and relevant to policy-makers in the various countries of IIASA member organizations in both East and West.

- * It should be of world-class quality and, as such, publishable in the best journals.

- * It should emphasize insights and ideas, innovative approaches and fresh thinking inspired by interdisciplinary, international cross-fertilization.

The general objective is to shed light on some key issues in population aging, in part by developing some new methods of analysis and in part by targeting thinking on areas that are not only of scientific and policy significance, but that are also areas where IIASA has something new, interesting and fruitful to contribute.

It is anticipated that the results will be published in refereed articles which are viewed as a contribution to the better understanding of key issues and associated methodological tasks. It is also anticipated that models developed at IIASA will be used in practical applications in various IIASA member countries, not only by scientists, but also by policymakers and practitioners.

An oversight of the work undertaken in 1985 is given on the following pages.

Why IIASA?

The problems are known and the need for research is obvious. What, then, is the part being played by the International Institute for Applied Systems Analysis, and why is its work important? There are a number of reasons why the advantage lies with IIASA in the field of population studies:

- * The Institute's approach is interdisciplinary, with genuine East-West research cooperation and cross-fertilization, an extensive network of collaborating scholars and practitioners, and a focus on some important issues that confront all the countries of the IIASA member organizations.

- * First-rate policy-relevant, methodologically sophisticated research on populations is not easy. Demographers have tended to focus on specialized topics, related, for instance, to fertility in Third World countries. Opportunities abound for internationally-valid, policy-relevant contributions, as do opportunities for methodological advance. Populations obey certain invariances and accounting relationships that permit the development of a mathematics of population analysis more powerful than the limited techniques available in nearly all the other social sciences, and comparable to the methods of engineering and the physical sciences.

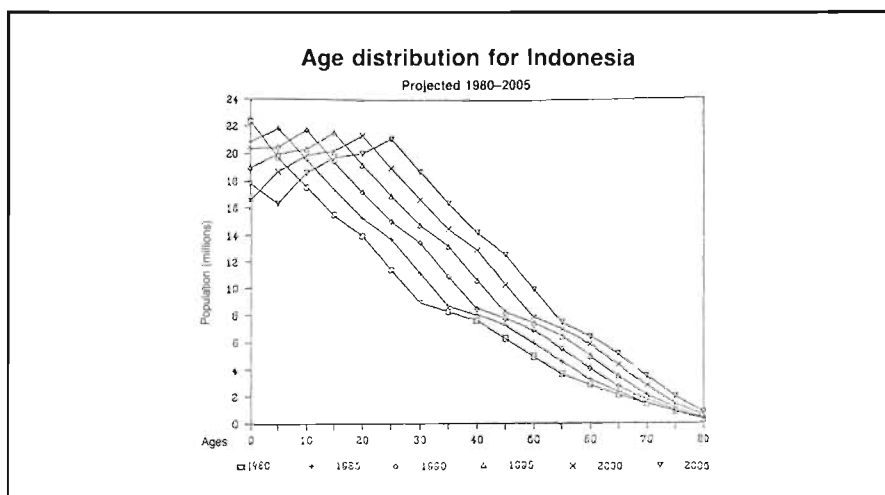
- * Population analysis is ripe for interdisciplinary research, with strong emphasis both on mathematics and on policy analysis. IIASA is well fitted for such interdisciplinary research.

- * Population analysis is relevant to other research areas at IIASA. It is important, not only for studies of the environment and of industrial change, but more generally for any study requiring medium-to-long term forecasting. Furthermore, the mathematics of population analysis is closely allied to statistical analysis and stochastic process theory, areas that will be a focus of systems and decision sciences (SDS) research in the future.

- * Population analysis is important to all the countries of IIASA member organizations, and is a broad, if disjointed, area in which each member country has talented scholars who can come to IIASA to exchange ideas and develop fresh insights.

- * Population analysis and policymaking is a field where IIASA could not only excel in internal research, but also in such outreach activities as education for doctoral and post-doctoral students, and seminars for policymakers and industrial leaders.

In sum, population analysis is a field ripe for fresh thinking based on international, interdisciplinary research, a field of great interest to industry and government, and a field where IIASA could establish itself as a preeminent center. And there is a strong and lean nucleus already in place upon which to build.



The bottom curve is the number of persons age by age in 1980, the second curve that for 1985. The striking difference between those born before 1980, on the right of the diagram, and those on the left is due to a drop in infant mortality in the 1980s and other causes. The older population is increasing slowly, the younger very rapidly. The challenge of numerous young people is felt in Indonesia, as well as elsewhere in Asia, including China, the Philippines, and Thailand.

A. Substantive research

1. Socioeconomic consequences of population aging:

* What will happen to old age pensions and other social arrangements when birth rates fall and the relative number of workers declines? The crux of the problem is expected about the year 2015.

* The baby boom, gave exceptional opportunities to those born ahead of it, in the 1930s. It will correspondingly handicap those born after it, in the 1950s and 1960s. How do policies manage to cope with this and similar demographic configurations in countries with different social systems?

* Family demography in contemporary advanced countries. Changes such as nonmarriage, high divorce rates, mothers working, etc., are associated with low birth rates, although no one knows just what is the causal structure. This has to be analyzed.

* Some work has been started on the demography of the firm, in which a first attempt is made to establish the effect of one age distribution as against another, in those industries where technical change is rapid enough for the recently trained young workers to have an advantage over those trained in an earlier time. First calculations show that, even with a small falling-off in productivity per dollar of salary, the effect is to give a further major advantage to the firm that is already expanding. This puts a positive feedback into the market, by which firms that are growing will tend to grow further.

2. Medical and public health causes and consequences of population aging:

* Policy implications of heterogeneity in morbidity and mortality. Pioneering research has been conducted at IIASA on some of the demographic consequences of heterogeneity. It is now intended to extend this research to consider the implications of heterogeneity for health policy. Individuals differ in their susceptibility and vulnerability to different diseases, which has important implications for treatment, prevention and screening.

* Dependent competing risks. Contrary to the common assumption of independence among competing causes of death, changes in the age-specific mortality rates from one cause may affect the age-specific mortality rates, and the number of deaths, from other



causes. This has important implications for understanding and forecasting mortality and morbidity trends, as well as for evaluating the desirability of various kinds of health strategies.

* Prevention versus treatment of chronic diseases. Medical, social and economic advances have shifted the spectrum of morbidity from the curable to the chronic disease. Prevention is clearly desirable, but often involves nonmedical measures such as environmental control or behavioral change. Demographic and biostatistical models of the effects of prevention versus treatment of chronic disease may shed some light here.

* Specific health interventions concerning chronic disease. Three case studies are anticipated: (a) changes in smoking behavior (in cooperation with Harvard University); (b) chronic pulmonary disease (in cooperation with the Slovakian Ministry of Health); (c) chronic rheumatological disease (in cooperation with the Hungarian Ministry of Health); (d) analysis of data from longitudinal medico-demographic studies (in cooperation with Duke University, USA, and the Institute of Control Science, Moscow).

B. Methodological research

1. Forecasting:

* Forecasting births. Births are important in determining the total population size as well as the family structure. One hitherto neglected aspect of this branch of research is the impact of early versus late motherhood, which will be analyzed.

* Forecasting deaths. Analysis of trends in mortality rates at various ages and from various causes is clearly essential in determining the age composition of a population. Such analyses may also be used to infer changing patterns of fatal illnesses and hence to shed some light on patterns of morbidity.

* Forecasting errors. Forecasts rarely include estimates of their error. Substantial attention will be devoted to uncovering practical means by which error can be calculated and shown along with forecasts. Estimates of error will be needed not only for population forecasts, but also for analyses that depend on the forecasts, e.g. of prospective financing needs of social security systems.

2. Models and methods:

* Dynamic models. It will be necessary to develop mathematical models in order to

provide the answers to such basic questions as "Is life span increasing?" and "Is productive life expectancy increasing?" Such models must account for the effects of heterogeneity and selection as well as of debilitation. Adequate models of the dynamics of mortality and morbidity will have to account for dependencies among competing risks. The mathematical formulation of such models will be based on multistate demography, event history analysis, point process theory, heterogeneity analysis and estimation, and some aspects of stochastic process theory.

* Population surfaces. Recent research has suggested the usefulness of studying surfaces that describe demographic variables over age and time. Some of the methodological research will focus on developing computer software to generate and picture such surfaces as well as on developing models for summarizing and analyzing them.

* Life expectancy. This is an important summary statistic in demography and in health analysis. Models will be developed to show how life expectancy is affected by changes in age-specific mortality rates and other demographic variables. In addition, models will be developed to gain insight into future trends in life expectancy.

What of the future?

The plan for 1986 and beyond is that IIASA will continue to investigate various aspects of population, especially those concerned with aging and heterogeneity, and it is hoped that there will be equal success in placing the results before both scholars and policy analysts in government, industry and commerce. The Population Aging Project will continue ongoing IIASA research on the socioeconomic and health consequences of changing age structures in developed countries. In 1986 a primary focus of this research will concern the industrially relevant interaction of population change, technological advance, and evolving employment patterns.

The second project, the Population Heterogeneity Project, will develop previous IIASA research on the dynamics of selection in heterogeneous populations, with applications ranging from fertility, morbidity and mortality to studies of equipment failure and the management of renewable resources. Both projects will thus build on the demonstrated research performance of the Population Program in 1984 and 1985.

The aging of populations as they mature toward stationarity exemplifies a distinction well known to systems analysis: that stability and contraction are by no means merely the reverse of expansion. Under growth the several parts of a system fit together in a way that can be disrupted by any leveling off or decline. The substantive research on the consequences of population aging will analyze the difficulties engendered by the approach to a stationary condition in which total population size is more or less constant, but the number of elderly individuals and the proportion of the population that is elderly are substantially greater than at present.

The intended research, although centered on demographic theory and method, depends on knowledge from a number of disciplines. In addition to being interdisciplinary, the planned research is international in scope, with its focus on the countries of IIASA member organizations. The effects of the population developments being studied at IIASA can be foreseen and, in most cases, the prior knowledge gained from IIASA's substantive research can suggest measures that will take advantage of the benefits and moderate the adverse impacts. For instance, although pensions are financed differently in socialist and market economies, both will be affected in the same direction by an increase in the ratio of older

people to those in the labor force. Thus, the consequences of population aging are real, in that they will be found in societies differing in institutions and ideologies, and one of the aims of the research is to study the diverse forms in which they will show themselves, and the diverse policies that will be adopted to deal with them.

Further activities would depend on additional researchers being brought in, as would an expansion of existing activities, such as the heterogeneity analysis, to encompass a greater variety of demographic areas. One way to expand the program would be to recruit two or three additional researchers for a year or more. Another would be to bring ten or fifteen researchers together for a month or six weeks, or perhaps a summer of interaction. Some of these researchers could be doctoral students: IIASA has a three-month summer program for young scientists, and a special seminar could be instituted that focused on a demographic frontier.

One or more such month-long or summer-long research seminars, involving either innovative researchers or promising students or both, could infuse new ideas and new blood into demography by bringing creative scholars together from different countries, and from fields related to demography through concern about populations. These could include, among others, reliability engineering, actuarial mathematics, biostatistics,



Old people are not just statistics. What sort of life are the elderly going to have – years of idleness, boredom and ill-health, or years of creative fulfilment? IIASA research is contributing to the formulation of strategies to deal with the problems.

tics, epidemiology, and population biology and ecology. There is relatively little discussion of this kind today; an interdisciplinary, international research seminar at IIASA could provide some cross-fertilization and produce a new hybrid vigor in demography.



Social security and doctors' waiting rooms are well-known to the elderly.



The Population Program's central research team. Left to right, James Vaupel, Susanne Stock (secretary), Anatoli Yashin and Nathan Keyfitz.

The research team

The Population Program is led by Professor Nathan Keyfitz (USA); James W. Vaupel (USA) and Anatoli Yashin (USSR) are senior researchers. Apart from this team of full-time researchers at IIASA, work on the program involves close collaboration with distinguished scholars from East and West, in the fields of demography, statistics, and health.

Collaborative research is actively under way with Professor Kenneth Manton of Duke University, Dr. Graziella Caselli of the University of Rome, Dr. Ingvar Holmberg of the University of Gothenburg, Dr. Ian Diamond of the University of South-

ampton, Dr. Martin Rusnak of the Slovakian Ministry of Health, Professor Alexander Petrovski and Dr. Anatoli Michalski of the Moscow Institute for Control Science, Dr. Istvan Korondi of the Hungarian Institute of Rheumatology and Physiotherapy, and Dr. Sergei Tscherbov of the All-Union Institute of Systems Studies in Moscow.

Professor Keyfitz will remain leader for the coming year, but James Vaupel will take up a professorship at the University of Minnesota. He will maintain a consulting relationship with IIASA, while Anatoli Yashin will become deputy leader and head of the Population Heterogeneity Project. Additional research scholars will be recruited, as well as several research assistants. Collaboration will be maintained with researchers such as James Vaupel, Kenneth Manton and Michael Stoto, who are expected to spend substantial time at IIASA as visitors.

Publications

The researchers associated with the Population Program have published several books and numerous articles in scholarly journals, such as *Demography*, *Theoretical Population Biology*, the *Journal of the American Statistical Association*, and *Probability Theory and Applications*, as well as journals read by policymakers, such as *Public Interest*, *Scientific American*, and the *Journal of Policy Analysis and Management*. They plan to continue to publish extensively. One specific planned publication is a book on the dynamics of selection in heterogeneous populations, based on some of the joint research done by James W. Vaupel and Anatoli I. Yashin. Another planned publication is a book on population forecasting by Nathan Keyfitz.

Interfirm competition – an example of substantive research done at IIASA

Demographic research is not a subject of concern to statesmen and academics alone. Industrialists and managers in other fields have an interest in how aging affects the quality and efficiency of the work of their organizations. This question has attained enhanced topical importance in recent times, due to the now breakneck speed of technological change in the shape of the microelectronic revolution. But, with or without this additional factor, the effect of aging on an organization's productivity and cost-efficiency is an area where there is a distinct lack of research material. Now, however, Nathan Keyfitz of IIASA has carried through a project which breaks new ground and may well serve as a model for specific studies elsewhere. It looks at the problem of aging from the management point of view:

A demographic source of instability in interfirm competition

A firm that is growing rapidly, like a country with a high birth rate, will in general have younger employees than one that is growing slowly. At one extreme, a firm that is unable to hire new employees, and all of whose existing employees retain their jobs, increases its average age by one year each calendar year. A firm expanding at 4 per cent annually over a long period by recruitment at the labor force entry ages will have a mean age 13 years younger than the one which is contracting at 4 per cent.

None of this makes any difference if output and salary are unrelated to age. But suppose productivity increases with age at a faster rate than does salary. In that case the stationary firm with older employees would have an advantage in the market. Its employees, being older than those of a new firm, would be more highly skilled and productive in relation to their cost; the slow growth that enabled the firm to avoid hiring new employees would give it an advantage, and this would speed its growth, requiring it to take in new recruits, which in turn would check its growth. Such negative feedback would favour stability.

Though applicable in some conditions, such a stabilizing effect of age is by no means universal under modern conditions. Two major elements have an effect here: the

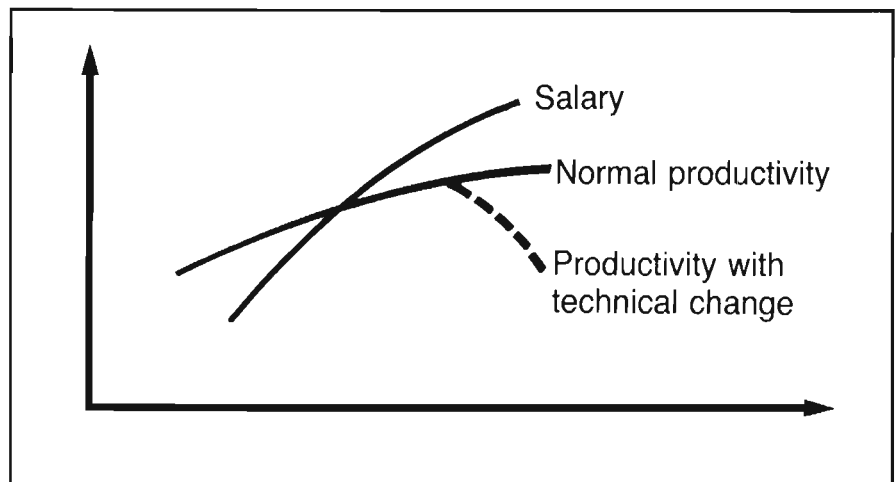
conventions of salary setting, and technical change.

In large establishments, in both the public and private sectors, people are normally paid more year by year, in addition to any increases they may receive because their individual productivity has improved. Where employees have a raise each year, apart from any raises tied to inflation or productivity, the firm whose growth slows will suffer an increase of wage costs per unit of output. Under rapid technological change it is especially likely that aging will be a handicap, so the firm that is expanding, and able to recruit new young employees, would thus have a further advantage. Instability results from this positive feedback unless some other factor counteracts it.

ty that comes with age, and is mentally less prepared to cope with the new learning.

Though a person can manage an office successfully to an older age than he can push a wheelbarrow, new techniques at the drafting board or in setting type, for example, can drastically reduce the output of the older person relative to the younger, even disregarding differences of pay. It is these latter kinds of change that apparently dominate innovation in the information economy. This effect on the age profile of labor cost is added to that of the conventions of wage setting (see diagram).

Lacking data on productivity by age under various conditions of technical change, we start with the moderate assumption that productivity per wage dollar of older people



Suggested curves of salary and productivity with age, and how the latter tends to shift with certain kinds of technical change

The instability is greater the steeper the gradient of pay with age and the less productivity increases with age. Data on salary gradients with age are plentiful, but productivity is less visible statistically, except under simple conditions of production. The essential factor is that the older worker is paid more per unit of output than the younger one. If new and radically novel working procedures are introduced, they put the older experienced person and the newcomer onto the same level; both have to learn from scratch. But the older person expects to be paid more, may have some biological rigidi-

ty is less than that of younger, and decreases by 2 per cent per year of age. The object is to assess whether the effect of aging could be numerically large enough to be a major factor in the profitability of enterprises. The study considers the difference in age distribution between a firm that is growing at 4 per cent annually, one that is stationary in that it hires at the youngest age exactly enough newcomers to offset its requirements, and one that is declining, say by 4 per cent per year. (The difference described arises only if the recruitment is at the youngest ages; if recruitment is proportion-

ate at all working ages, growth or decline will have no effect on the age distribution of employees.)

The differences in age distribution resulting from the differences in rates of growth are considerable. For example, the age distribution of males in the US labor force gives a mean age near 25. A firm with the same recruiting pattern, but contracting at 4 per cent annually, would have a mean age of 50-54 at last birthday. One growing at 4 per cent annually would have its mean at ages 20-24. Superimposed on the "normal" population, a growth rate of 4 per cent gives a mean age of 31 years; superimposing a decline of 4 per cent gives a mean age of nearly 44 years.

When the curves are combined with some (necessarily hypothetical) age gradients of productivity per dollar or other unit paid out as wages, a remarkably definite picture emerges. If we suppose that at the early working ages the employer receives equal amounts of output for the wages he pays up to a certain point, say for employees up to age 30, and after that productivity per wage unit declines by 2 per cent per year of age,

Demographic factors can have far-reaching effects on industrial and commercial performance.

then the result will be a difference of about 7 per cent in the wage cost of production between a firm contracting at 1 per cent annually and one expanding at the same rate. Whether this difference would be large enough to help or hinder a firm appreciably would depend on market conditions; if competition were at all strong it could be quite decisive. A more extreme example is that of a firm expanding at a rate of 4 per cent annually against one contracting at the same rate, with productivity per unit wage again going down by 2 per cent annually after age 30. The difference in wage unit costs would then be over 30 per cent, which would have drastic effects in any market.

The study looks at a number of other hypothetical situations. For example, it contrasts a firm that has not hired personnel for the previous 25 years, say, with one that has continued hiring and thus shows the normal age distribution. The mean age would be 50.83 years in the former and 36.77 years in the latter. The productivity difference with a gradient of 2 per cent per year of age would be over 40 per cent. The effect is naturally much higher for a firm that stops hiring than

for one that keeps hiring but slows its growth. Whatever hiring takes place attenuates the aging effect.

The several parameters that have been introduced arbitrarily into the calculations are also examined. These include the decline in productivity per wage unit with age, taken as 2 per cent per year after age 30. Suppose it was only 1 per cent, or as high as 3 per cent? The study shows that the effect, taken as the ratio of productivity of those firms with 4 per cent increase to that of firms with 4 per cent decrease is very close to linear, i.e. that one can interpolate in the table without further calculation and say, for instance, that pay rises beyond a productivity rise of 0.5 per cent annually would give a relative advantage of about 4.5 per cent.

Using a different distribution pattern to that of the US males which was the basis for the study was an obvious cross-check on the method. Taking this to an extreme with the assumption that employees are equally divided among the several age intervals increases the effect considerably. Starting the decline in productivity per unit wage earlier or later than 30 also has a considerable effect, as one might anticipate. Surprisingly, however, even 20 per cent hiring greatly diminishes, indeed reverses, the age effect, if instead of not hiring when the firm starts to decline it does a limited amount of hiring of personnel.

The conclusion is that the magnitude of the age effect is sufficient for some impact on the market, even though many other elements operate. A firm may be failing and then obtain a new management that picks it up; a firm may be succeeding and then lose its supplies and be forced out of business; a firm may be stationary and have a patent monopoly that makes it impregnable. Our question is whether, against this background noise, the effect of aging or rejuvenation is large enough to be worth considering. The conclusion is that it is certainly large enough. Much attention has been given to the vintage of capital; the calculations here suggest that the vintage of labor also needs attention.

This field of the demography of the industrial or commercial firm is one that is ripe for study. The study of the positive feedback that results from stagnation or rejuvenation, and the numerical calculations on which the conclusions are based, has been carried through with hypothetical data. We would like to make some actual observations and see how far this destabilizing positive feedback operates. It is, at any rate, a unique pioneering project, which may provide the initial basis for much detailed research and individual studies in different social and economic situations.

Heterogeneity –

One of the main tasks of methodological research is to underpin the rest of the research – i.e., as the name implies, to develop mathematical models and methods of analysis to help make population forecasts and to help analyze both socioeconomic and medical consequences of population aging. One major analytical advance by IIASA researchers James Vaupel (USA) and Anatoli Yashin (USSR) has been the development of methods for studying the effects of heterogeneity in various population phenomena:

Heterogeneity's ruses: some surprising effects of selection on population dynamics

Conventional ways of calculating life tables assume that every member of a population has the same probability of dying at a specified age. Until recently, most demographers thought this assumption made little difference; but Vaupel and Yashin have shown, on the contrary, that population heterogeneity must be taken into account in a number of areas. For example, they found that eliminating one cause of death can increase the mortality rate from another cause, even though at the individual level the two causes are independent. Moreover, individuals differ from one another in their susceptibility and vulnerability to certain diseases. This has important implications, not only for treatment, but also for prevention and screening. A situation in which all women have a 20 per cent chance of contracting breast cancer is fundamentally different from one in which 75 per cent of women are immune to this disease while the remaining 25 per cent are at great risk.

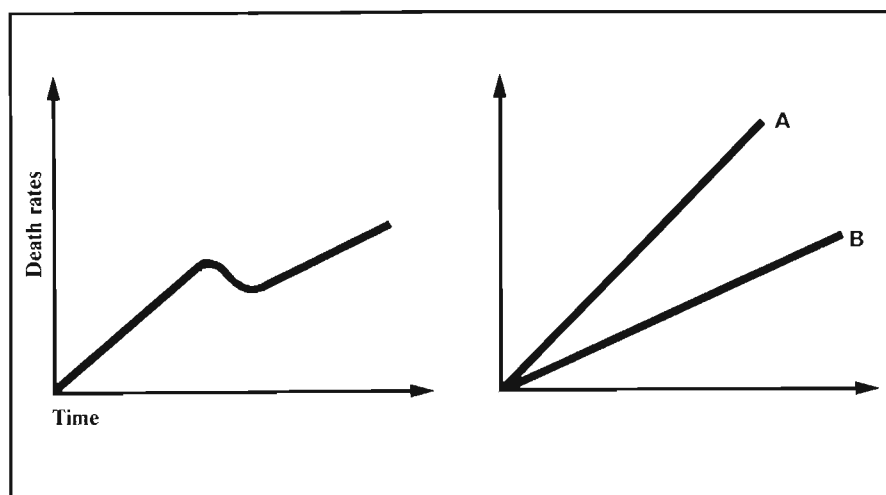
The recidivism rate for convicts released from prison declines with time since release. The recidivism rate for former smokers who are trying to stop smoking and for former alcoholics who are trying to stop drinking also declines with time. Does this imply that the hazard of recidivism for individual convicts, smokers and alcoholics declines over time? Not necessarily: there might be two groups of individuals, the reformed and the incorrigible. For individuals in each group, the hazard of recidivism might be constant. The observed decline would be an artifact of heterogeneity, a ruse.

To take an analogy, over the course of the last century it has taken more and more effort (as measured by cost or by feet drill-

a methodological breakthrough at IIASA

led) to discover a specified amount of mineral oil. Are geologists becoming more incompetent? Some insight can be gained by drawing this analogy between oil discovery rates per unit of effort and mortality rates per unit of time. It seems likely that the oil that is easiest to find and that is contained in the biggest fields tends to be found (i.e. "dies") first. Even if geologists were steadily becoming more and more expert, this selection effect could outpace their growing knowledge and make it increasingly difficult to discover oil.

Extending this to the field of human demography can best be illustrated by a double graph based on two sub-groups:



Mortality statistics provide the curve on the left, which shows that the observed hazard rate for a particular population cohort increases steadily, suddenly declines, and then starts increasing again, albeit at a slower rate. Much effort might be wasted in searching for a specific hazard-related reason for this, if the factor of heterogeneity is not brought into consideration. It transpires that this trajectory is produced by two subcohorts who suffer constantly increasing hazard rates, as shown on the right, whereby the hazard rate for the frailer subcohort A is much steeper than for the more robust subcohort B. The sudden decline in the observed hazard rate on the left is produced by the rapid extinction of the frailer subcohort. Up to the point of decline this frailer subcohort experiences death rates that are relatively low. Then, due to the exponential increase in the force of mortality, the death rates become sufficiently large that within a

few years almost all the frailer subcohort dies. The observed hazard rate then declines to the level of the hazard rate for the more robust subcohort B. Since this hazard rate is increasing, the observed hazard rate then starts to increase as well: the observed hazard rate now equals the hazard rate for the more robust subcohort because only members of this more robust subcohort are still alive.

There are innumerable variants of this discrepancy between observed phenomena and the picture which emerges when the problem is analyzed for the effect of heterogeneous factors. To remain with the pattern already used for illustration, the

observed hazard rate may decline even though the hazard rates for the two subcohorts are constant. The observed hazard rate may decline and then rise even though the hazard rate for one subcohort is rising steadily and the hazard rate for the other subcohort is constant. The observed hazard rate may increase more slowly than the hazard rates for the two subcohorts. There are also much more complex situations, for instance, when reductions in the differing mortality rates for the various subpopulations within an expanding population lead to an increase in the observed mortality rate for the entire population.

Regardless of how many attributes are considered, individuals who are grouped together will differ along various neglected dimensions. Some of these differences will almost certainly affect the individuals' chances of death, marriage, unemployment, or other transition. Because of this

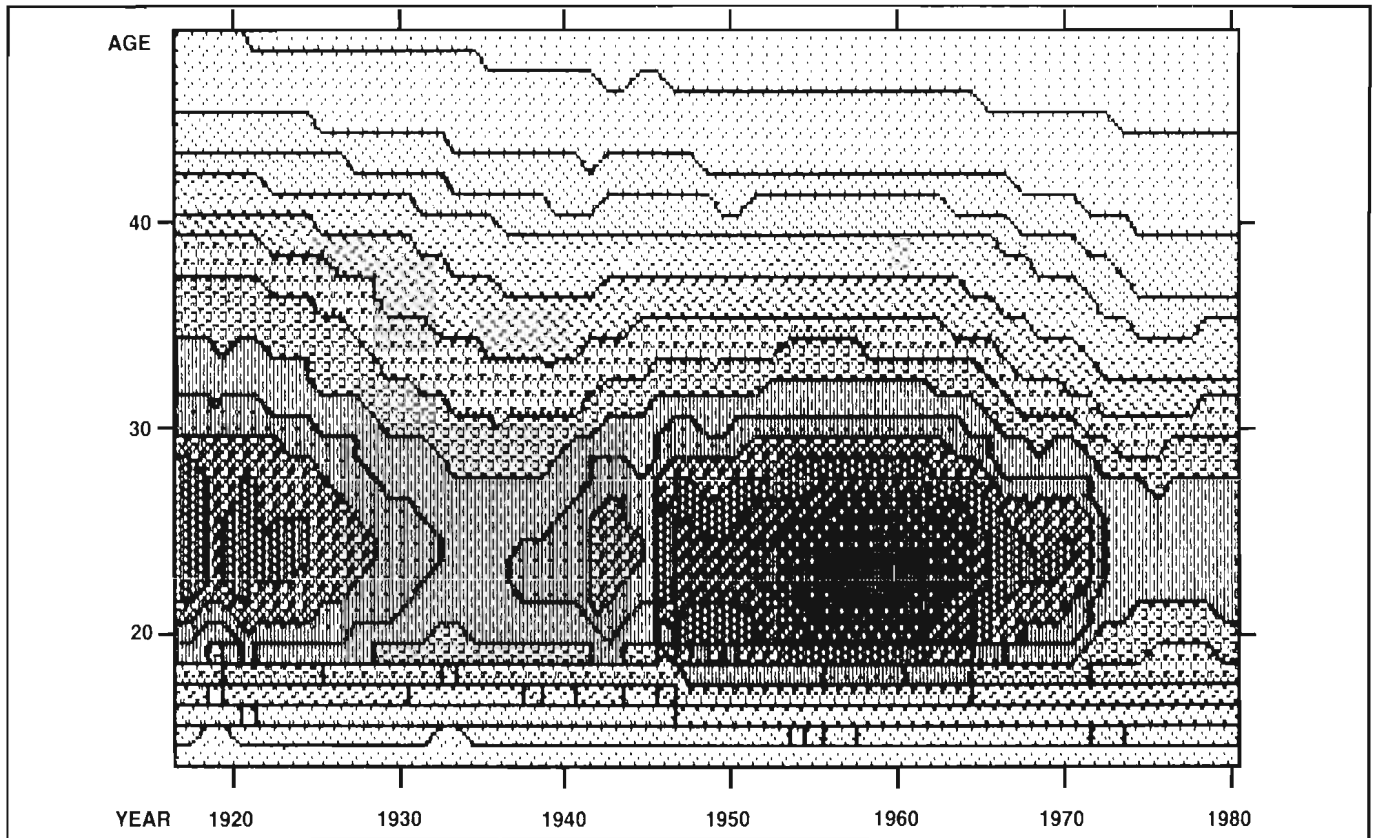
heterogeneity, selection will occur: the surviving population will differ from the original population. This, in turn, means that observations of the surviving population cannot be directly translated into conclusions about the behavior or characteristics of the individuals who made up the original population. The observed dynamics on the population level will deviate from the underlying dynamics on the individual level.

Sometimes this is not important. Perhaps the population, when classified along various observed factors, is more or less homogeneous, so that effects of unobserved heterogeneity are unsubstantial. Sometimes, however, selection is important, and when it is, the patterns observed may be surprisingly different from the underlying patterns on the individual level.

It would be difficult to overstate the importance of the methods which have been developed at IIASA for studying the effects of heterogeneity in mortality and other population phenomena. Their range of application in analysis and forward planning at governmental and other level is almost unlimited.

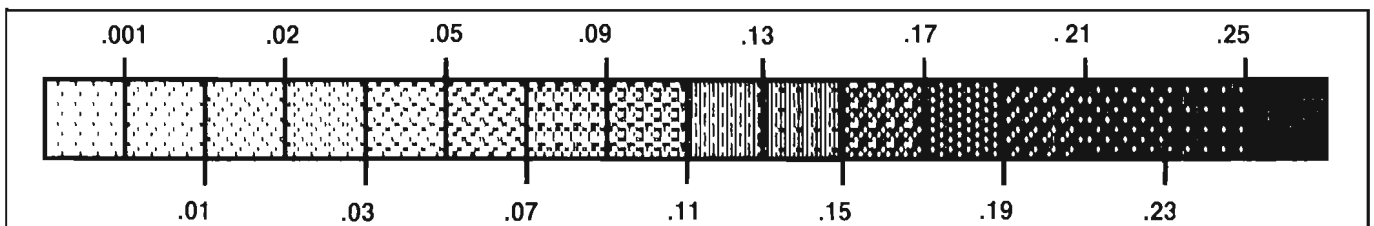
These methods have applications in all areas of demography. One is the study of the growth of the population above age 85. In most developed countries the group of people over 85 is the most rapidly growing segment of the population. This growth has implications for medical costs, the provision of health services, social security expenditures, etc. The methods of heterogeneity analysis will aid understanding of evolving mortality trends among the elderly, and hence result in better predictions of this population's growth.

A revolutionary possibility that has been largely ignored by demographers and other social scientists is that life spans will increase substantially within a few decades. Nearly all actuarial and demographic projections assume that the rate of progress in reducing mortality at various ages will taper off to zero over the next 50 years. But over the last 20 years the rate of progress in reducing mortality at nearly all ages, and especially at older ages, has accelerated, not declined. Theoretical studies undertaken at IIASA on the impact of heterogeneity on mortality chances suggest that this acceleration may continue. Simple extrapolation of recent rates of progress indicates that a newly-born child in most developed countries has a life expectancy of over 90 years. If the accelera-



US birth rates – with contour lines selectively placed from 0.001 to 0.25 From age 14 to 49 and year 1917 to 1980

Demographers now use visual devices to illustrate the meaning of their masses of data. One example of the computer graphics developed at IIASA is the age-time chart, in which the births are represented by a third dimension above the paper. The shadings represent successive levels, the darker the higher. Standing high above the plane in this diagram are the high births to women in their 20s after World War I and World War II. It shows that the baby boom consisted in higher births to women at most reproductive ages, but especially at the prime ages under 30.



Vaupel and Gambill (1985)

tion in the rate of progress against mortality continues, a life expectancy of over 100 years will prevail. If there is some major breakthrough in the biomedical sciences, life spans could jump by 10 years by the year 2000, and perhaps even double (or quadruple) within the lifetimes of children alive today. Demographers were taken by surprise by the baby boom after World War II; in order to avoid another such surprise, IIASA is working on an analysis of the new demography that would result from a significant increase in life spans, including the radical implications this would have for the size and age composition of the population.

Another planned application of the

heterogeneity analysis is an investigation of the demography of smoking behavior. Better understanding of who smokes and who gives it up, and why and when, could substantially reduce morbidity and premature mortality by providing insights about where to target efforts to reduce smoking.

Heterogeneity is also significant in fertility analysis. In the USA, to take one example, there is a division of labor, so to speak, such that less than a quarter of the women currently produce half of the children, while another quarter have no children at all. The first group, because they have several children, tend not to have finished their education or job apprenticeships (due to early

childbearing), and tend to have multiple, unstable marriages. They are an underclass that deserves attention. IIASA researchers are engaged in an analysis of the evolving demography of early versus late motherhood and childlessness.

IIASA is also working with institutions in Czechoslovakia, Hungary, Italy, Sweden, the US, the USSR and the UK to understand the health policy implications of population heterogeneity. The opportunity is being taken to explore solutions to public health problems with teams of policymakers, physicians, and other specialists drawn from the various parts of the health care profession.

News from the Institute

IIASA Scholars

Professor Robert E. (Ted) Munn, designer of the Global Environmental Monitoring System (GEMS), is the new leader of IIASA's Environment Program. Dr. Munn joins IIASA from the Institute for Environmental Studies of the University of Toronto, where he undertook research on air pollution, acid rain, and climate and environmental impact assessment. Professor Munn heads the publication program of the Scientific Committee on Problems of the Environment (SCOPE) of the International Council of Scientific Unions (ICSU) and is Editor-in-Chief of the *International Journal of Boundary-Layer Meteorology*. His own books include *Descriptive Micrometeorology*, *Biometeorological Methods*, and *The Design of Air Quality Monitoring Networks*. Professor Munn has also served as Chief Scientist of the Air Quality Research Branch of Environment Canada, and as senior consultant to the United Nations Environment Programme (UNEP), the World Meteorological Organization (WMO), and the World Health Organization (WHO). Dr. Munn was a visiting professor at the University of Stockholm in 1970-71 and Chelsea College, University of London, in 1977. In 1984 he received the Frank Chambers Research Award of the Air Pollution Control Association of America.

Scientific Meetings

Representatives of Austrian industry, trade unions and ministries met with researchers to examine measures to counter *forest die-off* and lines of research to be pursued. The meeting on January 17, 1985 was hosted by the Institute. It was organized by the Austrian Ministry of Science and Research and the Austrian Research Center, who provide financial support for research in this area at IIASA. Dr. Wolf-Dieter Grossmann has additional details.

The *United Nations Environment Programme's Scientific Advisory Committee* for the World Climate Impact Studies Programme met in Laxenburg on February 6, under the chairmanship of Professor J. Dooge of University College, Dublin, Ireland, to review the IIASA project headed by Dr. Martin L. Parry and financially supported by UNEP. (See *OPTIONS* 1984/4)

The RAINS (Regional Acidification and Informational Simulation) model developed by IIASA's *Acid Rain Project* was presented to groups of experts on lake acidification (meeting February 13-15) and the impact of air pollution on forests (meeting February 25-27). After interactive sessions with the model, discussions focused on an evaluation of the lake acidification sub-model in the first meeting and on guidelines to develop a model for direct impacts of air pollutants on forests in the latter meeting.



Professor Robert E. (Ted) Munn, the new leader of IIASA's Environment Program

Dr. Leen Hordijk can supply further information.

Mathematical Modeling in Immunology brought together medical researchers, health care personnel and modelers seeking a better understanding of the processes of the human immune system at a meeting held in Cracow, Poland, on February 18-25. It was cosponsored by IIASA and the Polish Academy of Sciences. Additional details are available from Dr. Anatoli Yashin.

World Problems and their Perceptions were analyzed at a meeting in Budapest, Hungary, from February 25 to March 1, cosponsored by IIASA, UNESCO, and the Hungarian Committee for Applied Systems Analysis. Some 25 scientists, academics, government officials and UNESCO and FAO experts, drawn from 11 countries,

examined alternative approaches to world problems within the framework of a study carried out for UNESCO by IIASA. Dr. Istvan Kiss (Hungarian Committee for Applied Systems Analysis), coordinator of the study, can provide detailed information.

Applying methods derived from *fuzzy sets* theory in order to deal better with the uncertainties relating to the analysis and modeling of resource-use problems and risk analysis was demonstrated at a meeting organized by the Institute of Cybernetics and Information Processing of the Academy of Sciences of the German Democratic Republic, and cosponsored by IIASA and the International Atomic Energy Agency (IAEA). (Wartburg, GDR, March 3-8) Dr. Serguei Orlovsky has additional information.

A symposium on the *Ecologically Sustainable Development of the Biosphere* was chaired by Academician Yuri Izrael, Chairman of the USSR State Committee for Hydrometeorology and Control of the Natural Environment and IIASA Director Thomas H. Lee in Moscow, USSR (March 14-16). The Memorandum of Understanding drafted on that occasion, determining the involvement of various Soviet research organizations in the IIASA study, was signed later by Academician Y. Izrael and Professor T.H. Lee. At its June meeting the IIASA Council formally approved this project, part of the Environment and Resources Program. More information is available from Dr. William Clark.

Professor Thomas H. Lee, Director of IIASA, welcomed the industrial executives, government officials and scientists gathered at Duke University, North Carolina, USA, for an international conference on *East-West Trade, Scientific and Technical Cooperation: New Opportunities and Perspectives* (March 21 and 22). The meeting grew out of previous IIASA work on innovation management, and was sponsored by Duke University, the American Committee on East-West Accord, the Dow Chemical Company, the Soros Foundation, and IIASA.

Industrial and government policymakers met with the North American scholars collaborating in IIASA's *Forest Sector Project* at a conference in Victoria, Canada (March 21-23), cosponsored by IIASA and the Forest Economics and Policy Analysis Project of the University of British Columbia. A special session was devoted to IIASA's Forestry Project research.

Assessment of Climate Impacts on Ag-

riculture in Semi-Arid and High Altitude Regions was the theme of a meeting convened at IIASA (April 1-5). The project, which is due to be completed this year, is supported by UNEP within the framework of the UN World Climate Impact Programme. Contact Dr. Martin L. Parry for further information.

IIASA hosted a meeting of the MIT/KFA Consortium on *Integrated Energy Systems*, which was also attended by representatives of Bulgaria, Canada, Czechoslovakia, the GDR, Sweden and the USSR (April 15-17).

Children in an Information Age: Tomorrow's Problems Today was the theme of an International Conference organized jointly by IIASA, the State Committee for Science and Technical Progress of the People's Republic of Bulgaria, UNESCO, WHO and the "Ludmilla Zhivkova" International Foundation in Varna, Bulgaria (May 6-9). The 340 participants from over 60 countries discussed the social, cultural and economic impact of computers on the education process and on children. The Bulgarian proposal to launch an international research program on these issues was welcomed by the participants. Please contact Professor Tibor Vasko for further information.

The role of the Time Factor in Strategic Regional Policy was the theme of a meeting held in Tbilisi, Georgia, USSR (May 20-24), with 21 participants from 8 countries. The meeting was organized in cooperation with the All-Union Research Institute for Systems Studies (VNISI) and the State Committee for Science and Technology of the Georgian SSR. Detailed information is available from Professor Andrei Kotchetkov.

The University of Lodz, Poland, hosted a meeting on *Identification of Structural Change* (May 23-24) within the framework of the IIASA project on *World Economic Modeling*, developed jointly with the University of Bonn, FRG, in which 20 scientists from 8 countries participated. Please contact Dr. Anatoli Smyshlyaev for further information.

Economic Strategies: Hunger, Equity and Growth was the subject of a Task Force meeting held at IIASA (June 3-5). Results obtained by IIASA's Food and Agriculture Program (FAP) on this theme were discussed by 18 participants from eight countries and three international organizations with the staff of FAP. Contact Professor Kirit Parikh for more information.

FSP Network Meeting. The annual meeting of scientists collaborating with IIASA's Forest Sector Project took place in Albena, Bulgaria (June 3-7). The purpose was to provide a forum for the exchange of ideas on the preliminary runs of IIASA's Global Forest Sector Model. Participants from North and South America, Eastern and Western Europe, Australia, New Zealand and Japan made significant revisions in scenario assumptions and data. Final runs of the model are now being made.

Long-Term Fluctuations in Economic Growth: Their Causes and Consequences was the theme of an International Task Force meeting organized jointly by IIASA and the Institute of Theory, History and Organization of Science, Academy of Sciences of the GDR, Weimar (June 10-14). The meeting brought together 52 participants from 15 countries to assess the latest developments in the understanding and interpretation of long-term economic fluctuations, and to review the methodology used and its application potential. The participants agreed that it appears both desirable and feasible not only to develop more consistent theories and approaches, but also to propose strategies for socio-economic and scientific-technological development at the regional, national and global levels for both planned and market economies and developed and developing countries. For more information please contact Professor Tibor Vasko

IIASA Meeting of the International Energy Workshop (IEW) (June 11-13). Some 130 energy experts from academia, government and industry met at IIASA to discuss projections of the future global development of crude oil prices, economic growth, primary energy consumption and production, and energy trade. The discussions, which focused on the reasons for differences in these projections, were based on a poll with some 350 responses, which were summarized and analyzed by Professor Alan Manné from Stanford University, USA (co-organizer of the IEW), and Dr. Leo Schrattenholzer of IIASA. The IEW is an ongoing worldwide activity open to anyone who supports its aims. Its annual meetings alternate between Europe (IIASA) and North America. For more information please contact Dr. Leo Schrattenholzer.

IIASA and its Hungarian National Member Organization, the Committee for Applied Systems Analysis, held a joint Task Force meeting on *Discontinuous Social Change* in Budapest, Hungary, and at IIASA (June 11-14). Participants discussed the

possible applications of methods from the natural sciences to social systems, and it was decided to seek advice from independent experts on the feasibility of the study.

An *International Gas Study Meeting* was held at IIASA (June 13-14). Participants from 16 countries discussed the early results of IIASA's study on natural gas prospects for the European continent over the next 50 years. Discussions focussed on four areas: gas production, consumption and export potentials; primary and final energy consumption dynamics; environmental aspects of fossil fuel usage and their impact on cost-price relationships; and geopolitics. For more information please contact Dr. Hans-Holger Rogner.

Under the chairmanship of Professor Boris Z. Milner (USSR), an Ad Hoc Committee Meeting on the proposed program on *Technology, Economy and Society* was held at IIASA (June 17). The members gave their general support to this program, and advised the Research Committee of the Council to recommend approval of the proposed program.

An informal planning meeting of the *IIASA Advisory Board* was hosted by Austria's largest bank, the Creditanstalt-Bankverein (June 21). The meeting, co-chaired by Dr. Hannes Androsch, Chairman of the Board of the Bank, and Academician Jermen M. Gvishiani, Chairman of the IIASA Council, was held to discuss some basic issues connected with the setting up of the Advisory Board and preparations for its first formal meeting, which will take place in early December. This new initiative, which is expected to guide the Institute in formulating and implementing new research strategies that are relevant to decision makers, was strongly supported by the 23 members of the Board who participated in the meeting. Some 53 high-level representatives of public and private sector business, industry and finance from 20 countries have so far accepted the Institute's invitation to serve on the Advisory Board.

IIASA "Life"

Guest Seminar by Professor Rudolf E. Kalman of the Technical University of Zürich, Switzerland. Professor Kalman, developer of the Kalman Filtering Theory, advocated a new approach to the problems of system identification through the testing

of data and modeling assumptions for statistical stability (January 10).

IIASA acquires on-line access to Soviet data banks. An agreement signed in January makes IIASA the first institution in the West to have on-line access to bibliographical information from the data banks of the Institute of Scientific Information on Social Sciences of the USSR Academy of Sciences (INION). Their economic, social and political science data banks were established for the International Information System on Social Sciences of the Socialist Countries (MISON). The agreement was signed on January 14, 1985 by IIASA Director Thomas H. Lee and INION Director Academician Vladimir A. Vinogradov. The computer connection is made through Radio Austria and the USSR National Center for Automated Data Exchange.

Chinese delegations at IIASA. A 16-person delegation from the Chinese National Social and Economic Information Center (NSEIC) and the Ministry of Post and Telecommunications, headed by Professor Yan Shancheng, Director of NSEIC, visited Vienna for two weeks at the invitation of the Computing Center for Economics and Social Sciences (WSR) and Radio Austria. As NSEIC is playing an important role within the Preparatory Committee of the Chinese National Committee for IIASA, set up under the State Science and Technology Commission of China, the delegation visited IIASA to become acquainted with the Institute. On this occasion Minister Ma Bin, Chairman of the Board of Directors of

NSEIC and former Deputy Minister of the State Commission for Import and Export, delivered a talk on January 25 on some aspects of the new economic policy of the People's Republic of China. A second delegation from the Academia Sinica, the Chinese Academy of Sciences, headed by Mrs. Wang Minxi, visited IIASA for ten days to discuss problems in the management of scientific research and to learn about the Institute's research activities.

World Automotive Industry. The IIASA study on world automotive industry concentrates on commercial vehicles and on the major potential new markets outside North America, Western Europe and Japan. The experience and findings of the Massachusetts Institute of Technology's Future of the Automobile Program were presented on January 16 by Professor Daniel Roos, co-director of the 4-year study combining industrial, labor and government officials with researchers in 7 countries coordinated by MIT's Center for Transportation Studies.

Swedish delegations. Twenty-four officials of Swedish universities and institutes of higher education, headed by the Swedish representative to the IIASA Council, Professor Anders Karlqvist, and IIASA alumnus Professor Folke Snickars, visited IIASA on February 4, and were briefed on various IIASA projects.

T-T Meeting. Defining a strategy for IIASA, topics and issues to be investigated, and the direction in which the Institute

should move – these were debated at a day-long "Time-to-Think" meeting on February 19 led by Dr. Gerhard Neumann, former Vice President of the General Electric Company, USA, who initiated such strategic "brainstorming" sessions at the Company. Participants who joined IIASA staff in this frank exchange of views and ideas included Academician Laszlo Kapolyi, Hungarian Minister of Industry; M. Jacques Lesourne of the French Conservatoire National des Arts et Metiers; Mr. Mans Loennroth, Special Assistant to the Swedish Prime Minister; Academician Vladimir Michalevich, Director of the V.M. Glushkov Institute of Cybernetics of the Ukrainian Academy of Sciences; Professor Rudolf Schulten of the Nuclear Research Center at Jülich, Federal Republic of Germany; Professor Alvin Weinberg, Director of the Institute for Energy Analysis, Oak Ridge, Tennessee, USA; Mr. Ralph Whitmore, Chairman, Alaska Bancorp, USA; and Professor Pieter de Wolff, former representative of the Foundation IIASA-Netherlands on the IIASA Council.

French Minister of Research and Technology visits IIASA. On the occasion of his visit to Austria, Professor Hubert Curien, French Minister of Research and Technology, visited IIASA on February 21. He confirmed to Austrian authorities the support of France for the Institute and stressed the importance of IIASA, both in applied research and as a bridge between East and West. He emphasized the need for IIASA to develop research programs with real applications and in particular welcomed the objective that 25 per cent of IIASA's activities should be funded from external sources.

MIT/IIASA Cooperation. Professor James Fay and Dr. Dan Golomb of the Massachusetts Institute of Technology, USA, discussed cooperation between MIT and the Acid Rain Project in conducting policy analysis relating to acidification in Europe during their stay at IIASA from March 6-8.

Visit of Members of the Finnish Parliament. On March 21, fourteen members of the Finnish Parliament's Committee on Technology and Trade visited IIASA. They were briefed on IIASA's research program with special emphasis on projects related to environmental issues.

US Congressmen visit IIASA. On the occasion of the Inter-American Development Bank Conference in Vienna, Representatives Douglas K. Bereuter and Stan Lundine with associates visited IIASA on March 23



From left to right, M. Jean Pierre Ayrault, Secretary, and Professor T.H. Lee, Director, with Professor Hubert Curien, French Minister of Research and Technology, during the latter's visit to IIASA.

and were briefed about current activities by the Director and senior scientists. Special emphasis was put on environmental issues. The representatives also met with Academician Jermen M. Gvishiani, the Chairman of the IIASA Council, and expressed to him their support of the Institute.

Joint Meeting of the Executive and Finance Committees of IIASA Council. The Joint Meeting was held on March 25 under the chairmanship of Academician Jermen M. Gvishiani. Although the Committees did not take any formal decision, Director Thomas H. Lee presented the preliminary general research strategy. The Committees also reviewed the progress made in establishing the IIASA Advisory Board, which aims at strengthening relations with industry. The Committees welcomed Professor Lee's report on the situation in the US and were pleased with the testimony regarding IIASA given to the Appropriations Committee of the House of Representatives by Dr. George Keyworth, President Reagan's Science Advisor.

Indian Ambassador briefed. The Indian Ambassador to Austria, H.E. Shilendra K. Singh, visited IIASA on March 27. He was briefed on an IIASA-UNIDO project on *Assessment of Industrial Development Impact on the Environment*, for which the Doon Valley of India will be one of the two regions chosen for case studies.

Guest Seminar by Professor Russell Ackoff. During a Distinguished Guest Lecture on March 29, Professor Ackoff, Anheuser-Busch Professor of Management Sciences at The Wharton School of the University of

Pennsylvania, USA, advocated the re-design of systems for better performance and survival in a changing environment, rather than dealing with decomposed elements.

Forest Policy Group. 24 professors from Austria, the Federal Republic of Germany, the Netherlands and Switzerland, attending this year's meeting of the Central European Forest Policy Group, were at IIASA on March 29 for briefings on the current research activities of the Forest Sector Project.

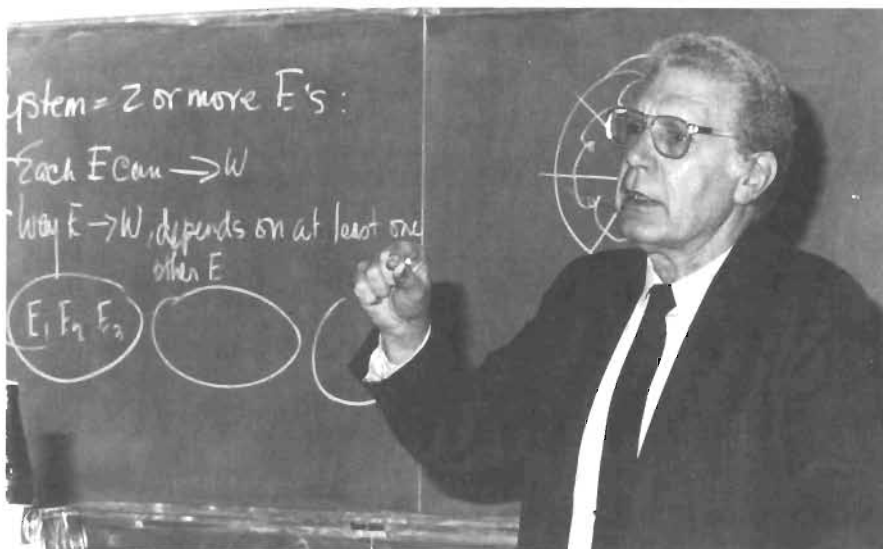
Meeting with Austrian Minister for Foreign Affairs. On April 18, IIASA's Director and Secretary, Professor Thomas H. Lee and M. Jean-Pierre Ayrault, had a meeting with the Austrian Minister for Foreign Affairs, Mr. Leopold Gratz. The Minister,

whose interest in IIASA goes back to the founding of the Institute when he was Minister of Education, was briefed on the results of the Joint Meeting of the Executive and Finance Committees of the IIASA Council. Minister Gratz expressed his satisfaction with recent developments, and reaffirmed the strong support of the Austrian authorities.

President of the Academy of Sciences of the German Democratic Republic visits IIASA. On May 24 Academician Werner Scheler, President of the Academy of Sciences of the German Democratic Republic, visited IIASA. Professor Scheler was accompanied by H.E. Dr. Horst Grunert, Ambassador of the GDR to Austria, Academician Werner Bahner, Vice President of the GDR Academy of Sciences, and



Academician Werner Scheler, President of the Academy of Sciences of the German Democratic Republic, with HE Dr. Horst Grunert, Ambassador of the GDR to Austria (left), and Professor T.H. Lee, Director of IIASA (right).



Professor Russell Ackoff, University of Pennsylvania, who gave a Guest Seminar and a Distinguished Guest Lecture at IIASA.

by Academician Wolfgang Schirmer, GDR representative to the IIASA Council. During a working session, the delegation from the GDR was briefed on IIASA's research activities with special emphasis on the environment and population programs. Professor Scheler stressed the support of the GDR Academy of Sciences for IIASA's activities.

Guest Seminar by Professor George B. Dantzig. Professor Dantzig, G.A. Griley Professor of Transportation in Operations Research and Computer Science at Stanford University, USA, and a former leader of IIASA's Methodology Project, participated in the International Energy Workshop and also visited the System and Decision Sciences Program. He gave a guest seminar on *Experiments with Alternative Methods for Solving Linear Programs* (June 10-14).

Vice Chairman of the Czechoslovak State



Mr. Eugen P. Pitovranov (second from right), President of the USSR Chamber of Commerce, and a member of IIASA's Advisory Board, with Director T.H. Lee and Deputy Director V. Kaftanov.

Commission for Science, Technology and Investment visits IIASA. On June 12, Dipl. Ing. Karel Nutil, Vice Chairman of the Czechoslovak State Commission for Science, Technology and Investment, visited the Institute and was briefed on IIASA's research activities, with special emphasis on the Environment Program.

President of the USSR Chamber of Commerce visits IIASA. Mr. Eugen P. Pitovranov, President of the USSR Chamber of Commerce, and a member of IIASA's Advisory Board, visited the Institute on June 17. He was informed about the Institute's research activities, and in particular about relations with decision and policymakers. He also met with Academician Jermen M. Gvishiani, Chairman of the IIASA Council.

Young Scientists' Summer Program (YSSP). This year IIASA accepted 57 young scientists for its Summer Program. Representatives from all 16 National Member Organization countries took part in the Program, with one participant each from the UK, the People's Republic of China, and India. A special feature of this year's Program was the organization of some of the participants into research teams. Three YSSP research teams worked on applications of heterogeneity dynamics, sustainable development of the biosphere, and acid

rain. The teams, led by IIASA research scholars, accounted for 37 of the participants, with the remaining 20 working in the Regional Water Policies Project, the System and Decision Sciences Program, the Food and Agriculture Program, and the Economic Structural Change Program.

Meeting of the IIASA Council and its Research Committee. The 24th meeting of the IIASA Council, chaired by Academician Jermen M. Gvishiani (USSR), was held on June 19 and 20. Following the recommendations of the Research Committee, which met on June 18 under the chairmanship of Professor Gerhart Bruckmann (Austria), the Council broadly supported the research strategy presented by Director Thomas H. Lee. This entails the concentration of IIASA activities into four main areas: System and Decision Sciences; Population; Environment and Resources; and Technology, Economy and Society. The Council requested the Director to prepare a detailed Research Plan based on this strategy. Resolutions passed by the Council approved guidelines for disseminating the results of IIASA's Food and Agriculture Program, and the formal launch of a project on the *Ecologically Sustainable Development of the Biosphere*. The Council also reviewed the financial situation, paying special attention to progress in external fund raising and the

use of national currency funds, and approved a preliminary budget for 1986.

Visit of Mr. Richard Green from the NSF. Mr. Richard Green, Assistant Director of Scientific, Technological and International Affairs at the National Science Foundation, Washington, DC, USA, visited IIASA to acquaint himself with the Institute and to obtain an overview of IIASA's research activities (June 24).

New Member of IIASA Council. IIASA is glad to welcome a new member to the Council: Academician Arpad Csurgai, of the Hungarian Committee for Applied Systems Analysis. He succeeds Academician Istvan Lang, who has recently been elected Secretary-General of the Hungarian Academy of Sciences. In recognition of his important contributions to IIASA, Academician Lang has been awarded the title of *IIASA Honorary Scholar*.

Office of Planning and Sponsored Research. The November 1984 meeting of the IIASA Council endorsed the Director's objective of funding 25 per cent of IIASA's activities from external sources. In order to achieve that objective, an Office of Planning and Sponsored Research has been established. On July 1st Mr. Larry Ostermann from the US took over the leadership of this Office from Dr. Jagmohan Maini, who returned to Canada.

OPTIONS

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Guest corner

Systems analysis and the crisis of the welfare state



The welfare state attempts to soften the impact of industrial society on the individual. The helpless part of the community must somehow be shielded from the hardships that face the individual as traditional family support systems weaken. Few today propose to leave that task to private charity.

In the euphoria of the years after World War II it was thought that all those not able to earn a decent living – the sick, the unemployed, and the old in particular – could be supported by the community at a trifling cost. It seemed possible to be humane without raising taxes. Proponents of the welfare state encouraged this view; they saw its humane objectives as so worthwhile that they understated costs in order to persuade public and legislators.

After a century of the welfare state in Europe and some 40 years in America, we now know a good deal about costs, and some of the innocence of those early expectations has worn off. We now know that the 2 per cent of payrolls that was the social security tax in the US at the start of the scheme was just not sustainable. People were promised pensions that were going to require two or three times this amount when the scheme matured; with the increased benefits promised since, the tax is up to 13 per cent and is still not high enough for the prospective costs in the long term.

A part of the trouble is demographic: people now live longer than they did, and this increases the number to be supported. As individuals we all want to live as long as possible, and yet each further year that life is prolonged has an effect on the community; it increases taxes. It is the business of systems analysis to illuminate this kind of contradiction between our interests as individuals and our interests as members of the taxpaying community.

The matter is made more difficult by the decline in births: in Western Europe the present birth rates lead to only 1.6 children per couple, whereas at least 2.1 are required for replacement. At present rates the populations of the Western European nations will soon start to decline, and in this they will undoubtedly be followed by other industrial countries. The decline will ultimately reduce the number of old people to support, but long before that happens it will reduce the labor force – the people available to pay social security taxes. We are at the moment temporarily favored by the entry of the baby-boom generation into the working ages, but as they move into the retirement ages there will be more and more people

drawing pensions and fewer and fewer to pay them.

These are straightforward matters, and actuarial-type calculations can tell us where we are heading and what modifications of taxes will be required to cover the higher costs.

But another difficulty is appearing that is more difficult to calculate: the very existence of social insurance changes people's economic decisions. When the age at which people could draw pensions was lowered from 65 to 62 (for example, in the US and Sweden, with somewhat reduced benefits) the cost was calculated from the people who at the time were retired at age 62. This, it may be said, is the empirical basis for estimating costs. But lowering the pension age gives a new incentive to retirement, so that many more people retire now that they have the prospect of an earlier pension. The legislation changes the basis on which retirement decisions are made and costs incurred. Thus, what looked like a straightforward actuarial problem, to be dealt with in the same way as mortality calculations for individuals, actually involves feedback and other mechanisms of systems theory.

Similarly, unemployment benefits increase the number of unemployed because they enable individuals to demand more favorable conditions before they will accept a job. In some instances the legislation permits them to disregard job offers away from home and thereby acts to preserve local pockets of unemployed, even when jobs are beckoning elsewhere. Health insurance increases the number of people who can prove that they are sick. This is no criticism of the individuals in question – in fact, it shows that they are acting rationally in their own self-interest, as we expect people to do. The trouble is that, collectively, the community rebels against the costs that its own legislation and the responses of its members have generated. This, again, means that we are faced with a system whose properties are psychological, economic, medical and demographic – in short, a problem of the total system.

This system has other requirements to reconcile. In most countries and at most times social insurance – in particular pensions for the aged – have had two objectives: permitting a dignified retirement to those who can no longer work on the one hand, and on the other hand removing from the labor force those whose presence keeps the young out of jobs. Whether pensions are primarily for those who cannot work, or for

those who can work only too well, is the kind of plural objective that presents a particular challenge to systems theory. It has to take into account the need of the old to be supported in one way or another: if they work they block the advance of the young; if they are on pension they are an expense to the young.

What is now needed is a model that will take these various feedbacks, interactions and multiple objectives into account. Instead of assuming that the sick, the unemployed and the pensioners are fixed, we must recognize the feedback, and take it into account in devising policies, and these policies must aim at more than one goal.

Is the problem confined to the market economies? I do not believe so. Aging and sickness, like the weather or earthquakes, do not distinguish between centrally planned economies and free enterprise. The aging of populations is going on equally in all advanced countries, and the response to welfare legislation is similarly rational by the individuals concerned, so that individual, rational use of social facilities can produce a collective difficulty wherever the state takes responsibility for individuals. The difficulty may show itself in different ways; what appears as unemployment in the West can show up as a problem of applying labor effectively in the East. Observing the different effects created by the same situation – in this case aging – in East and West is one of the aims of IIASA research.

Demographic aging is one of the physical circumstances that transcend systems of political and economic organization. The same questions are starting to be asked outside of Europe, America and Japan, as various new countries enter the ambit of industrialization, and sooner or later these will be global questions.

The achievements of the welfare state in both East and West are real, so the problem is to avoid going back on its noble purposes by dismantling it. Reasonable policymakers want to retain the humane legislation introduced after World War II and see to it that escalating costs do not discourage the tax-paying public. Nothing less will serve for such a problem than a model in which all the variables are treated simultaneously and provision is made for the major feedbacks that are operative in the real world. No model so ambitious has yet been produced, and we in IIASA are now working on partial models; we are being challenged to keep a very complex problem in view as we tackle its parts.

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