



THE JOHNS HOPKINS UNIVERSITY

BALTIMORE, MARYLAND 21218

DEPARTMENT OF  
SOCIAL RELATIONS

POPULATION

MAY 16 1972

11 May 1972

Mr. Kenneth H. Olsen, President  
Digital Equipment Corporation  
146 Main Street  
Maynard, Massachusetts 01754

Dear Ken:

Here's my initial statement on Future  
modelling. Just got yours. Thanks.

Sincerely,

James S. Coleman

JSC/vrb  
enclosure

Recently, a great deal of attention has been focussed on problems that can best be described under a single heading as those involving limitations on the Earth's ability to absorb man's presence and his activities, maintaining some kind of ecological balance. The problems arise from two facts: unprecedented and increasing levels of world population, and unprecedented and increasing levels of per-capita consumption of natural resources. The concerns evoked by these problems are multiple, but interrelated. One is the general concern with "overpopulation." A second is the concern with the environment, and damages to it from pollution from land use patterns, and from ocean usage. A third is the concern about exhaustion of natural resources, such as copper and other metals, fossil fuels, and other non-renewable resources. A fourth is concern about vastly increasing levels of energy usage, and the possible problems this could create, in somewhat the same way that population increases do. A fifth is concern about renewable resources, principally food, but including as well wood.

Now is probably the first time in history that such concerns have existed on the part of large numbers of scientists and laymen alike. Man has always, in a literal sense, "lived off the land," and only recently has the necessity for examining his source of supply for its possible limitations become apparent.

The concerns about the future, in their extreme forms, have much in common with the apocalyptic views of religious sects who professed to see the

end of the world approaching. Such concerns probably derive in some part from the fascination of the very idea of an apocalypse. But the opposite bias also resides in most of us: to attend to the problems of the moment, and to discount the problems of the future. Such concerns about the Earth's limitations are a partial antidote to that source of complacency.

In our opinion, the set of interrelated problems we have described is serious enough to warrant intensive effort on the part of several groups which would allow anticipation of problems of the Earth's limitations. Such anticipation is necessary because of the lags involved in various structural relationships. As an example, there is an obvious lag between changes in the birth rate and changes in the population size. Although the U.S. population is currently just above 200 million, in some respects the effective stable population size, if the birth rate were to be just at replacement level from now on out (below its present level) is 280 million, because of the age structure of the population.

The efforts we envision would be designed to lay out known relationships between different quantities, to obtain data to estimate others, and to project forward the various quantities that may be subject to limitation. In the past, the price system has done this for certain goods and services: as those goods or services become scarce, their price rises, and a substitute crowds them out of the market. But as a device for regulating an ecological system, prices have their limitations. For example, the scarcity may occur

only just before depletion, and technological substitutes at reasonable prices may become available only after a period of time. Electrical power is a case in point. If it were not for the existing development of nuclear power, and if there were no long-range projections of power demands based on changes in population size and per capita consumption, the end of fossil fuels could approach without sufficient lead time to develop alternative sources. More fundamentally, we believe it is not merely necessary to project forward demand in sophisticated ways, but to reflect back from future projected limitations of the Earth's capacity to their implications for constraints on those phenomena that create the problems, i.e., population size and per-capita consumption of resources, and to other policies which would work toward reconstitution of the natural environment. Equally important, they provide a rational basis for national policy in pursuing particular technological developments. For it will be in large part by technology that the society will find the means to bring into balance the Earth's supply of resources and man's use of those resources.



## Letters

### World Modeling

The scathing review by Martin Shubik (3 Dec., p. 1014) of Jay W. Forrester's book *World Dynamics* is, unfortunately, more than the personal opinion of an angry man. It is the expression of the views of very influential groups of people, which threaten to discredit and suppress a method of forecasting which I consider as of the greatest importance and promise.

There can be no doubt that Forrester's world model is only a first approximation. It lumps together highly industrialized and developing countries. It makes quantitative assumptions about interrelations, and Shubik is of course right in his skeptical remark about their validation by "the acceptance of top decision makers." Such questions are not decided by authority. Forrester's assumptions are validated by their plausibility, and greatly reinforced by the *insensibility* of his results to the details of the assumptions.

It is somewhat hard to understand the violence of the reactions to Forrester's work, of which Shubik's review is only an example. The rational way of rejecting it would be to show that it is so critically dependent on the model, and on the policies which are fed into it, that its predictive value is nil or less than that of intuitive forecasts. To my knowledge this has never been attempted, by any of the critics. Instead they reject it out of hand, intuitively, with angry aspersions at the author and the Club of Rome.

The problem in question is nothing less than the future of mankind. Shall we treat it, as until now, "intuitively," which means, as Forrester rightly remarks, using primitive mental models, and contemptuously reject the help which the computer can give to our thinking? Surely, the rational and responsible way would be to improve the inputs by the collaboration of the widest possible circle of disciplined minds, not only econometricians but also politicians, psychologists, and creative tech-

nologists who can make guesses at new inventions which might radically alter the prospects. The costs would be negligible, not only in relation to the importance of the problem, but also in relation to what the United States spends every year on data acquisition.

DENNIS GABOR  
*Imperial College, London*

Shubik's review fails to enlighten the reader concerning Forrester's objectives. Forrester has chosen five quantities, namely, population, natural resources, capital investment, fraction of capital investment in agriculture, and pollution, as quantities which are of most significance in the world system. Mathematically describing interrelations between these quantities, he then programs a digital computer to operate the resulting mathematical model. The trends in our world system indicated by this computer simulation are ominous indeed. Natural resource depletion turns out to be the limiting factor on growth, and population ultimately falls, to the accompaniment of a rise in pollution and a decline in the quality of life. Furthermore, none of the conventional solutions helps matters; for example, removing the natural resource constraint leads to an even more catastrophic pollution crisis and rapid die-off of population. These conclusions parallel the thinking of others both here (1) and abroad (2) attempting to view the world environmental situation holistically.

The author anticipates criticism of his work, and has ably answered the reviewer's primary objections by pointing out that governments readily concoct legislation which is presumed to correct ills in the social systems but which is in fact based merely on mental images of the real systems, images which are far less accurate than those he has constructed for computer analysis. The reviewer has wandered further onto shaky ground by attempting to liken the author's work to the analysis of RLC circuits. Forrester cor-

rectly describes the world system as a complex, nonlinear, multi-loop feedback system, and his programming reflects this. RLC circuits, on the other hand, are not by themselves feedback systems but are simply passive, essentially linear networks of electrical quantities and are of doubtful relevance to the discussion.

Forrester's dynamic model is by his own admission crude; but even crude models often give insight into a problem and serve as stepping-off points for more sophisticated models. That Forrester's model seems to be inherently unstable is a matter for thought, concern, and further research, not ridicule or head burying.

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Engineering, U.S. Coast Guard  
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### References

1. "Man in the living environment," report of the Workshop on Global Ecological Problems (Institute of Ecology, Madison, Wis., 1971).
2. A. Lewis, *New York Times*, 14 January 1972, pp. 1 and 8.

. . . A substantial error in interpreting the book results from the reviewer's not taking note of the book's history as given in the preface. His remark "the Club of Rome, which sponsored this work . . . should provide some guidance" implies that the book is a consequence of the sponsored project. The preface clearly states: "On June 29, 1970, I attended a meeting of the Club of Rome in Bern, Switzerland . . . the group was invited to Cambridge . . . a meeting convened on July 20 for ten days of study, presentations, and discussion. The dynamic model of world interactions described in this book was devised in the early part of July to form a basis for discussion at the conference. It must be considered a preliminary effort. . . . As a result of the July meeting, the executive committee of the Club of Rome decided to establish a one-year research program at M.I.T. An international team under the leadership of Professor Dennis L. Meadows is going beyond the model described here to explore more deeply the underlying assumptions and the several major subsystems that form the sectors of the total world system." The content of the book led to the establishment of



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the project at M.I.T. and is not a report on the output of the project. The book was an unsponsored personal effort. The project sponsored by the Club of Rome and the Volkswagen Foundation has been for the purpose of extending the model, modifying and documenting the assumptions, and discussing the inputs as well as the consequences by working with scientific research groups in other institutions who have relevant information and opinions. The published results of the project will begin to appear soon.

JAY W. FORRESTER

*Alfred P. Sloan School of Management, Massachusetts Institute of Technology, Cambridge 02139*

Unlike many of my colleagues who are extremely skeptical about large-scale simulation, data banks, and the organized use of politico-socioeconomic models, I believe (and am on record as believing) that an effort of the magnitude of the United States space program should be mounted to do this work. Where Forrester and I differ is that, although we may both see the limitations of econometrics and the importance of model building in areas where measures are hard to obtain, we have different views of what is feasible and useful. In my reading of his *Industrial Dynamics* and *World Dynamics* and glancing at *Urban Dynamics*, I have not seen anything to suggest that the models presented are other than extremely simplistic, given the current state of knowledge in the social sciences. I fear that if Forrester, with his drive, energy, and intelligence, were to obtain large funding for his work at the national level, he might easily be the source of a fad for producing grossly oversimplified models, which after a few years would bring about a reaction that would seriously set back progress in simulation, data bank creation, and large-scale social-scientific investigation. . . .

In reply to the specific points in Gabor's letter, I should say first that it appears to me the burden of proof of the relative worth of Forrester's work lies somewhat with its proponents. I have not seen this proof forthcoming. No evidence is given in Forrester's books that his results are insensitive to the details of the assumptions. Furthermore, contrary to Gabor's assumption, such insensitivity is not always a merit. Those who have worked with industrial, economic, social, or psychological simulations (Orcutt, Simon, Coleman, Abelson, Adelman, Crecine, Clarkson, to

name a few) are well aware of the difficulties of obtaining a good first-approximation model. If it is too insensitive to parametric sensitivity analysis, the model is probably concentrating on the wrong variables. If it is highly sensitive, then data sufficiently accurate for the purposes at hand are probably impossible to obtain.

The application of careful dimensional analysis and the specification of good measures in the right dimensions are all difficult and critical. For instance, what is a measure of "welfare"? Even given a measure, what is its operational significance? Answers to questions such as these call for an intimate knowledge of subjects such as economics, sociology, psychology, and political science. Why are so few social scientists referred to by Forrester? Are there none whose knowledge is worth considering when building models of social, political, economic processes? In fact, there are many who have both deep substantive knowledge and the ability to use computers and who are convinced that the computer and computer models are critical for good social scientific exploration. Consider, for example, the Brookings SSRC model, Tinbergen's work on planning, Orcutt's simulation, or Klein's econometric models. Forrester in his writings does not tell us why such other workers' applications, their sensitivity analysis methods and model building, are not as good as his.

I believe that a proper scientific evaluation of the work on planning and forecasting models in the social sciences is of great importance. This, of course, should include Forrester's work. I propose to Gabor, to the Club of Rome, to the AAAS, to NSF, and others that a project be sponsored or at least a conference be held to initiate such an evaluation. It may turn out that Forrester's work is better than, as good as, or worse than that of Balderston and Hoggatt, Clarkson, Kalman Cohen, Coleman, Crecine, Cyert and March, Gordon, Klein, Leontief, Manne, Markowitz, Meyer, Naylor, or Orcutt, to name a few. An examination of Forrester's contribution to this large body of work in such a context could be of benefit to all. It might provide him with the opportunity to join with members of the growing body of social scientists working on social systems. I should be happy to supply him with a list of eminently qualified judges of work of this nature, in the fields of artificial intelligence, computer science, communications, eco-



nomics, future studies, operations research, political science, philosophy of science, psychology, statistics, and other pertinent subjects.

MARTIN SHUBIK

Department of Administrative Sciences,  
Yale University,  
New Haven, Connecticut 06520

## Test Bias

The letter (24 Dec. 1971, p. 1278) by Kenneth Clark and Lawrence Plotkin was meant to correct what they describe as "three egregious misstatements" in Stanley's article "Predicting college success of the educationally disadvantaged" (19 Feb. 1971, p. 640) where he discussed, among many other studies, one by Cleary (1). Clark and Plotkin took out of context a single sentence in the 7½-page article: "Cleary tried to replicate the findings of Clark and Plotkin [2] with a better controlled design, but failed." This conclusion referred to Stanley's prior quotation from the Clark and Plotkin study: ". . . Clark and Plotkin . . . had reported results of a study based on 'alumni' classes of the National Scholarship Service and Fund for Negro Students in which they concluded that:

. . . scholastic aptitude test scores are not clearly associated with college grades. It is suggested that college admissions officers weigh test scores less, since they do not predict the college success of Negro students in the same way they do for whites. This study indicates that motivational factors are probably more important than test scores in the demonstrated superiority of Negro students in completing college."

Stanley was not questioning their conclusion that an able, highly motivated group of black students persisted well to graduation in a variety of interracial colleges during the 1950's. (For example, see note 19 in Stanley's article.) He did, however, cite much evidence—including Cleary's study—that Scholastic Aptitude Test scores and high school records tend to predict the college grades of blacks at least as well as they do those of nonblacks. In their letter Clark and Plotkin disregard this other evidence and thereby imply that Stanley's whole case rests on the Cleary study alone, which they seem to perceive as part of an Educational Testing Service plot against them ("Accustomed as we have become for our study to be the launching pad for ETS papers. . ."). Although one need not

defend the professional integrity of researchers at ETS (3), we note that neither Stanley's article nor most of the reports he cites were done at ETS. Some of the strongest evidence came from investigations by black non-ETS researchers such as S. O. Roberts, Joseph P. McKelvin, and Charles Leo Thomas and from studies in Illinois, Maryland, Georgia, and the Seven Sisters colleges. Even a glance at the bibliography in the Stanley article would indicate the broad data on which he based his conclusions. (Indeed, only three lines of his paper were devoted to the Cleary article.)

Since Clark and Plotkin have chosen to criticize the Cleary article, let us consider the points they make. Clark and Plotkin say that their data were better than Cleary's because they "had data on over 1200 Negro subjects (with questionnaire response from over 500) drawn from all sections of the country and distributed in hundreds of diverse colleges." The quality of data is, of course, always relative to the purpose they are to serve. For the conclusion of Clark and Plotkin that an admissions officer (who necessarily works within a single institution) should weigh test scores less, distribution of the sample among "hundreds of diverse colleges" is a disadvantage rather than an advantage. For the admissions officer, Cleary's within-college analysis is clearly more relevant. Since Cleary was able to analyze data in only three colleges, she limited her conclusions: "The schools used in this study do not represent the full spectrum of colleges in the United States, so general conclusions cannot be reached." But there are many studies other than Cleary's in which the within-college analysis has been performed, and most of these were reviewed in the Stanley article. With each new analysis, the Clark and Plotkin conclusion becomes less credible.

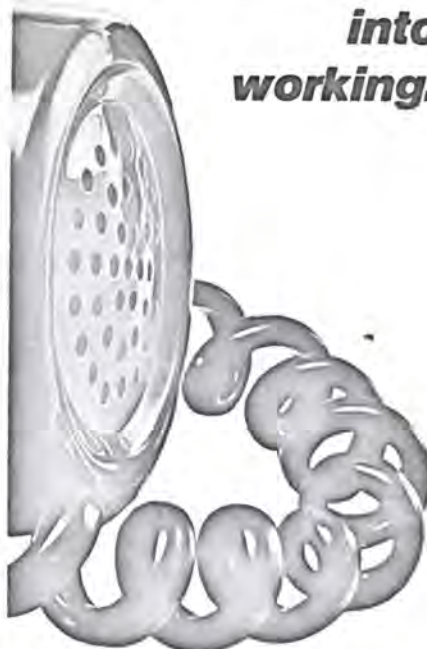
In their criticism of the Cleary article, Clark and Plotkin persist in their emphasis of correlation coefficients to the exclusion of regression lines. It is well known that the size of a correlation coefficient is a function of the variability of the group: when the range of scores is restricted, the correlations are attenuated. For this reason and others, the comparison of regression lines is a more appropriate analysis. Clark and Plotkin computed no correlation coefficients or regression equations, nor did they even work within colleges. Instead, they pooled college grades from 187 different colleges and

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THE PRESIDENT'S SCIENCE ADVISORY COMMITTEE  
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April 10, 1972

APR 12 1972

MEMORANDUM FOR

Members and Consultants-at-Large  
President's Science Advisory Committee

The attached material will be scheduled for discussion under the Chairman's item at the April PSAC meeting, together with reports being prepared on earthquake research (L. DuBridge and H. Friedman) and RECAT (G. Tape, I. Bennett and V. Fitch), as agreed at the March meeting.

  
David Z. Beckler  
Executive Officer





THE JOHNS HOPKINS UNIVERSITY · BALTIMORE, MARYLAND 21218

DEPARTMENT OF  
SOCIAL RELATIONS

3 April 1972

Dr. E. E. David, Jr.,  
President's Science Advisor  
Executive Office of the President  
Washington, D.C. 20506

Dear Ed:

I wholly agree with your statement to the President on Meadows' book. I think the only thing I might suggest in addition is that since it is clear that the problems pointed to in Meadows' book are serious ones, and of an order not before addressed by mankind, the President might consider establishing some activity (within PSAC, within OST, or with the aid of PSAC and OST) which would address the overall set of problems - taking as input some of the work on subproblems, like that of the Commission on Population Growth. I don't know what form this might take - it could take the form of giving a large contract to an organization like Rand, with that as the mission, all the way down to a Presidential Commission. I would favor the more extensive activity implied by such a contract, because it would allow detailed and diversified studies.

Sincerely,

A handwritten signature in cursive script, appearing to read "Jim".

James S. Coleman

JSC/vrb

DIGITAL EQUIPMENT CORPORATION

MAYNARD, MASSACHUSETTS

KENNETH H. OLSEN  
PRESIDENT

April 5, 1972

Dr. Edward E. David, Jr.  
Science Adviser to the President  
The White House  
Washington, D. C. 20500

Dear Ed:

In the small organization which I attempt to run, we do reasonably well in solving those problems which are serious enough to come to my attention and we do reasonably well in taking care of those areas which I always have some interest in because of my background. But too often, our people are only interested in those problems in which I am interested.

What I would like from my advisers is not only advice on problems I know about, but I would like to be advised on problems I should know about and what the alternative solutions to these problems are. At the last PSAC meeting, I felt that some of the committee members were discouraged because the President was not interested in matters of science or problems in which science could help.

Maybe the President would like from his advisers a simple list of problems with possible solutions in science and technology and maybe a list of social problems in which science can help.

If we made a list, and not a report, he might read it and ask for further work. If it was a good list, we could probably predict his reaction ahead of time and be motivated to do further work.

I would like to encourage PSAC to form such a list.

Sincerely yours,



KHO/d

D-1633

CHURCHES AT THE TRANSITION BETWEEN GROWTH AND WORLD EQUILIBRIUM

presented at the  
Division of Overseas Ministries  
of the  
National Council of Churches

November 4, 1971

by

Jay W. Forrester  
Professor of Management  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

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Jay W. Forrester

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#### NOTE TO THE READER

(This paper was originally presented at the annual meeting of the Program Board of the Division of Overseas Ministries of the National Council of Churches. It followed a discussion by Jørgen Randers showing the implications of present world trends in growth of population and industrialization, depletion of natural resources, rise in pollution, and full utilization of agricultural land. Referring to the two hours for his talk and the ensuing discussion, Randers said, "...the entire purpose is to convince you that exponential growth cannot go on forever in a world of fixed size." Randers stressed that overtaking of the natural environment is caused more by industrialization than by population. Industrial processes use natural resources and emit pollution. Capital-intensive agriculture in time decreases the productivity of land. Limiting of capital accumulation is as necessary as limiting of population. World civilization must and will move from growth to equilibrium, either by human choice or by the pressure of natural and social forces.

Many tradeoffs and choices lie before us in the approaching equilibrium. We can press forward along the historical growth curves, exceed the limits of the world environment, and endure a collapse of population and industrialization back to a level the world can support. Or we can choose a redirection of law, policies, and religions to create a smooth transition to world equilibrium. Even in choosing equilibrium, alternatives arise. The higher the population, the lower will be the achievable standard of living and quality of life. Tradeoffs will be made consciously or implicitly between advantages in the immediate future compared to advantages in the distant future. An inherent conflict exists between time horizons. Choosing to maximize the present quality of life condemns future generations to suffer for their predecessors' advantage.

The reader should, if possible, read first one of References 1, 2, 6, or 7 listed at the end of this paper before reading the following text.)

#### CHURCHES AT THE TRANSITION BETWEEN GROWTH AND WORLD EQUILIBRIUM

In recent studies of the dynamic behavior of corporations, cities, and world-wide forces, many general and fundamental characteristics of social systems have been identified. I was invited in this paper to interpret the earlier work for its meaning to the churches, now that population and industrial growth appear to be rapidly overtaking the natural capacity of the earth.<sup>1</sup>

Civilization is in a transition zone between past exponential growth and some future form of equilibrium. The nature of that future equilibrium will depend on present actions. Present actions are determined by the interplay between social forces and the value system that governs our responses. If the churches are to be influential, they will operate through the value system that conditions our responses to the rising world-wide pressures. In studies of other social systems, it has often been found that intended policies lead to unintended consequences.

- :: Are the Christian churches propagating an ethical value structure that is incompatible with a desirable future condition of the world?
- :: Are the churches today acting in a way that will improve or worsen the future of mankind?
- :: What is the primary responsibility of the church in modern society?
- :: Because the short-term and long-term objectives are usually contradictory, how is the balance to be struck?
- :: Should the church be responsive to short-term pressures, or should it be the custodian of the long-term values of a society?
- :: How is the church to resolve the conflicting goals that are always to be found in a social system?

#### BACKGROUND

During the last fifteen years new methods have become available for understanding the behavior of social systems. By "social system" we mean the interacting people, technology, laws, natural forces, and ethical values that determine the evolution of a civilization. Interactions within our social systems produce baffling results. More controversy than enlightenment often emerges from efforts to explain the course of human affairs. The confusion persists because our mental thought processes, although they have great strengths, have conspicuous weaknesses in understanding the complexities of social systems. But simulation of complex system behavior on a computer is effective in exactly the areas where the human thought processes are weak. It



is now possible to combine the power of the human mind with the power of the computer to achieve far deeper insights into the causes of social change and stress.

The new insights into social systems come from a methodology called "system dynamics." System dynamics is a body of theory and methods for clarifying and improving our mental models on which all actions are now based.<sup>2</sup> We make our decisions and operate our societies on the basis of mental images. Mental images are models that represent the real world in our thought processes. Mental models have great strength in their richness of detail. But mental models have two major weaknesses. First, the mental perceptions are not organized into the most relevant relationships. Second, the human mind is not well adapted for deducing the consequences of interactions between the known individual parts of a social system.

In system dynamics, a growing body of theory about the structure of multi-loop feedback systems guides the organization of detail into the relevant structure.<sup>3</sup> The resulting structures are too complex for the mind to manage, so computer models are used to examine the implications of the assumptions that have been taken from our mental models. By this process we begin to see the future consequences of present assumptions and actions. We also begin to see how action in one part of a social system can produce unexpected results in some very different dimension.

The concepts underlying system dynamics have evolved over the last hundred years. They apply to all systems that change through time, whether those systems are found in science, engineering, management, economics, politics, ethics, or combinations of the foregoing. Because the systems in science and technology are simpler than those in society, the methods were first developed in and applied to the technological areas. But now the power of the methods has grown to match the complexity of social systems.

The system dynamics approach starts with the perceived cause-and-effect relationships taken from our mental models. In their totality, mental models contain far richer detail than has ever been reduced to writing. In turn, the written literature is far richer in concepts than the quantitative and statistical literature. All information sources are used, in computer-model construction, to the extent that the sources contain effective inputs. But of the available inputs, the mental models held by a group of perceptive individuals are usually the most complete, diverse, and sensitive to the localized causal forces in a society. With rare and important exceptions, most of the written literature has already been filtered by an author through a non-dynamic framework of perceptions so that the essential structure of dynamic behavior has been lost.

The localized cause-and-effect relationships describing the separate parts of a social system are selected and interconnected according to the principles of structure derived from the science of feedback systems. The result is a computer model that replicates the structure and assumptions taken from the mental models now being used for running our society. In the process, the assumptions become more explicit and better organized.

The resulting computer model then shows, without doubt, the dynamic consequences through time of the assumptions stated in the model. Often the consequences are unexpected. The computer model reveals the inconsistencies and contradictions that exist within the common mental models. Computer simulation shows how the fundamental assumptions that are accepted do not lead to the consequences that people presume.

Usually the basic assumptions from existing mental models prove to be more correct than the anticipated dynamic consequences. The human mind is better at observing local reaction to social and economic forces than in grasping the implications for the larger social system. Conversely, a computer can not provide the social theory that is embodied in a model but can with certainty generate the consequences of any specified assumptions.

From this new approach has come a better understanding of the industrial corporation, the growth and decline of cities, and the interaction of major world-wide social and technological trends. Regardless of the size of a social system, certain generalizations emerge that relate policies of a society to its behavior. Some of these generalizations apply to our ethical beliefs and religious teachings, because these long-term guiding principles are part of the "policy" structure of a society. I have been asked to interpret our studies of social systems into their meaning for ethics, morality, and humanitarianism. Doing so should suggest questions and new lines of thought, not only for the overseas missions work of the National Council of Churches, but also concerning the place of the church in society.

The behavior of a social system depends on its structure and on the policies that govern decision-making. By structure we mean the interrelationships between components of the system and the channels of information available at a decision-making point. By policy we mean the criteria that determine how the available information is converted into decisions and action. Policy includes all rationale that influences how decisions are reached—experience, prejudice, folklore, ethics, religious attitudes, self-interest, generosity, integrity, and fear. Policy as used here also includes all the action-generating processes in science, biology, and nature.

System dynamics was first developed as a way to design corporate policy to improve the growth and stability of the industrial corporation.<sup>4</sup> In these corporate studies we first began to see the orderly processes by which the goals and values of an organization can influence its success. It also became clear that well-intentioned policies could often have unexpected and harmful results.

As a step to social systems beyond the corporation, system dynamics was used to examine the growth and decline of urban areas.<sup>5</sup> Again it was discovered that well-known relationships can interact to produce the observed puzzling behavior. The very actions being taken to help the cities—job training programs, providing transportation to suburban jobs, financial subsidies from the federal government, and low-cost housing programs—can range from futile to harmful.



More recently, system dynamics has been used as the organizing philosophy to interrelate major social and technological forces on a world-wide scale.<sup>6,7</sup> As in other social systems, the tradeoff compromises are acute. Alleviation of present world pressures is apt to be bought at the price of greater future distress. Treating a symptom may merely shift the pressure to some other aspect of society. Most important, the study of world interactions shows the impossibility of long-continued exponential growth in population and industrialization.

A system dynamics computer model can accept any concept that can be explicitly stated in our normal written language. Such a model unifies diverse disciplines by integrating ethical, psychological, legal, geographical, technical, sociological, and economic aspects of a social system. The procedure is no more mechanistic and impersonal than any reduction of concepts to precise description. The procedure can deal with human and moral assertions, if precisely stated, as well as with the physical aspects of our existence.

#### TRANSITION TO WORLD EQUILIBRIUM

A vast new set of ethical and moral dilemmas now faces man as humanity begins to encroach on the physical limits of the world. If exponential growth of population and industrialization were to continue at the present rate, the entire globe would be inundated in a few decades. Such growth is becoming progressively harder to sustain. Many of the political and economic stresses we are now experiencing can be traced to the clash of growth colliding with a fixed natural environment.

In all of the social systems that we have examined, from the simplest corporate subsystem to the most complex of world interactions, the great stresses and the great changes in social pressure come at the point where growth begins to slow down and equilibrium begins to be approached. It is during the transition period that turmoil is greatest. Humanity is now approaching the transition from world-wide growth to equilibrium. By equilibrium we mean a condition of constant population, constant use of resources, and constant generation of pollution, all limited so that the equilibrium condition can be sustained indefinitely into the future. Equilibrium does not preclude a shifting composition within the constant level of world industrialization; equilibrium still allows changing cultural and ethical development in all dimensions that do not overload the natural environment.

As the world moves during the next several decades from exponential growth of population and industrialization into some form of equilibrium, we can expect rapidly growing social stresses of a magnitude, a distribution, and a diversity that have never before been encountered. As all world subsystems begin to reach their collective limits, they become much more highly interdependent. Internal mechanisms that have tended to equalize and redistribute individual stresses can no longer function and all parts of the system simultaneously encounter impenetrable limits. For example, international trade has redistributed resources and products so that the excesses at one point have been used to fill shortages at another. But, as growth continues beyond the equilibrium point no excesses will remain. In retrospect, international trade will be seen as a means for continuing

a nonsustainable world growth up to a time when all countries run out of all reserves at approximately the same time. International trade will have obscured the impending end of the growth phase until everyone faces the transition simultaneously in every facet of existence. The tendency is to relieve all pressures until none can be suppressed. As a result, we will not have a long period of partial shortages to slow growth gradually. No areas of the world will encounter limits to growth ahead of other areas, so, as a result, mankind will not have the opportunity to learn on a small scale how to navigate the transition from growth to equilibrium. All will face the transition at about the same time and without benefit of a guiding precedent.

The change from the growth mode to the equilibrium mode is a major change in system behavior. During growth, pressures are relieved by expansion. The focus is on change. Problems are not solved but are overlooked in the excitement of conquest. But in equilibrium, the new no longer dominates the old. Self-renewal must occur within a fixed size. The rules-of-thumb that served as policy in the growth mode no longer apply.

Figure 1 shows a set of feedback loops that produce growth, cause growth to impinge on a fixed space limit, and then shift dominant control to an equilibrium-seeking set of relationships. The figure is simple and illustrative and does not include the multiplicity of factors in an actual social system. But the missing factors also contain equilibrium limits so that the transition out of exponential growth must always eventually occur. In the figure, the upper loops produce growth. In an area with some fertile land, the population rises, people till the land and their labor increases the agricultural capability, the food per person increases, and the rising food supply supports further increase in population. This growth in population continues until the fertile land has been fully employed and the marginal productivity of an additional agricultural worker does not produce enough food to support the worker. The food per person falls until the population is held in equilibrium and stops growing. But the falling food per person produces distress and may trigger additional investment and more technology in agriculture. The investment and technology may come from within the system or it may come in foreign aid from the outside. In either case, agricultural capability is pushed up further, food per person is again lifted above the subsistence level and population continues upward. All of this assumes that non-agricultural aspects of crowding are still well below the national population limit set by other factors that will eventually restrain population. If food production continues to support a growing population, the population approaches the national population limit, crowding rises, population occupies the best agricultural land and agricultural capability declines faster than it can be restored by investment and technology. Also at the same time, crowding leads to other forces that limit population—pollution, resource shortage, and social conflict, as well as disease and others. The upper loops have only a limited potential for generating growth. The consequence of growth is to induce ever-rising growth-restraining forces in the lower loops. In time the forces of growth and restraint come into balance and growth gives way to equilibrium. During the transition, the suppressive forces must and will rise as far as necessary to produce an ultimate equilibrium. The greater the growth forces that society sustains in the upper loops, the greater must and will become the restraining forces that develop in the lower loops.



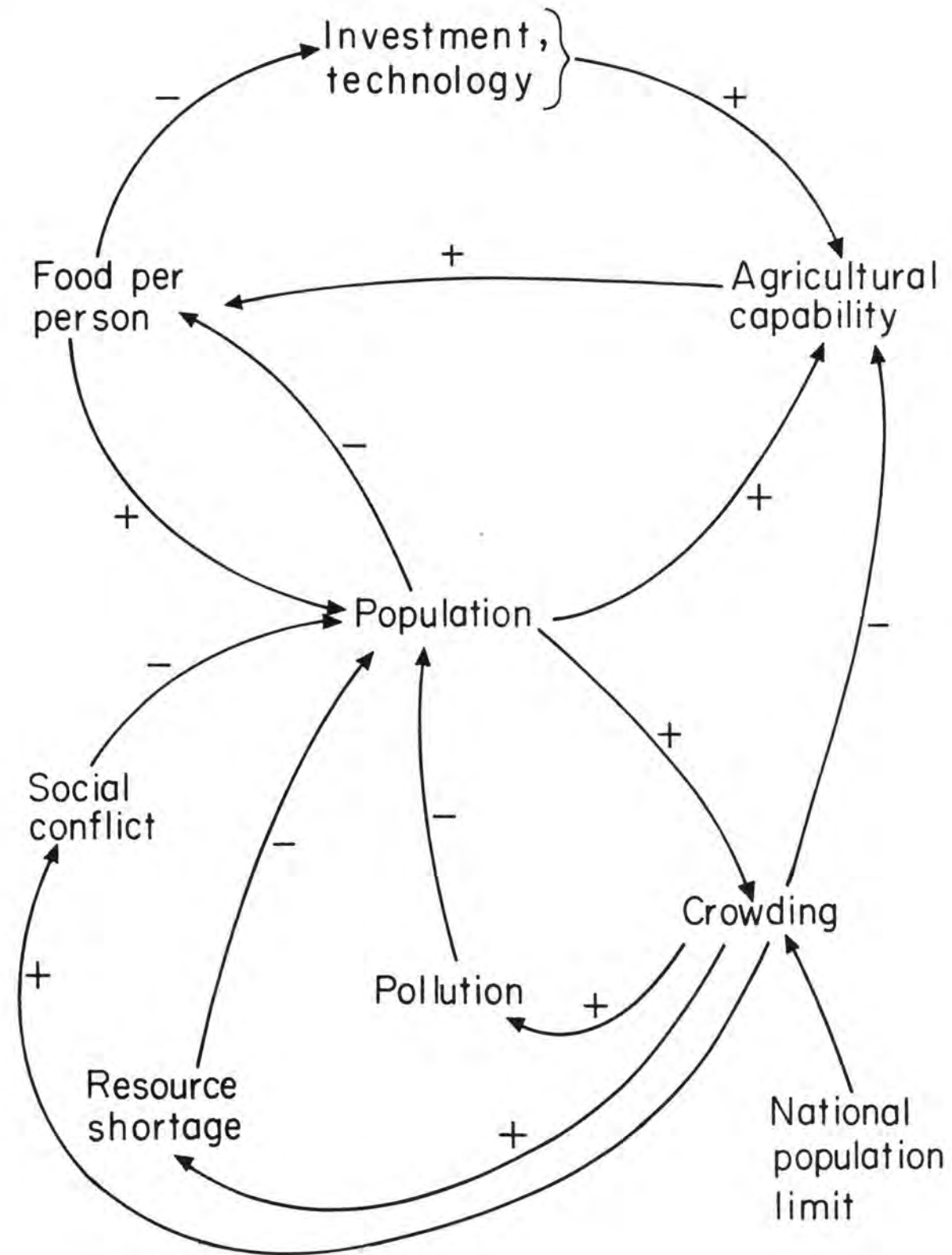


Figure 1.

Multiple pressures arise, as the world reaches the limits of resource usage, agricultural production, pollution dissipation, and living space. As we attempt to alleviate these pressures by intensifying agriculture, seeking resources on the ocean floor, constructing skyscrapers, and building pollution-control equipment, we permit growth to continue. But growth rapidly consumes the gains from our efforts; the task of outrunning growth becomes harder and harder; and eventually the social-economic structure will become unsustainable. The forces of nature will become as high as necessary to overwhelm our efforts to exceed the capacity of our environment. As long as we succeed in driving forward along the historical growth path, counterpressures will become stronger and will appear in ever-proliferating aspects of existence. By our efforts we are increasing the forces we fight.

#### CHARACTERISTICS OF SOCIAL SYSTEMS

Several generalizations from the dynamic examination of social systems will serve here as a background for discussing the church as part of the policy structure of society.

##### 1. Structure and Policies Cause the Problems

One should address problems in a social system by first identifying the fundamental causes and then moving on to design revised policies for alleviating the problems. One should never attempt merely to find a solution without first establishing the dynamic causes. Such a results-directed beginning is likely to lead to the treatment of symptoms without benefit. For example, the nation has acted on its urban crisis during the last several decades without focusing on the causes of urban stagnation and decay. Instead government has sequentially attempted to relieve symptoms as they arose. Congested traffic led to more highways, the central city became more crowded, parking garages were built, more people entered the city, buildings became taller, traffic continued to increase, and crowding and social dislocation worsened. All of these actions were taken without facing the questions of proper city size, desirable population density, and how to control both so that the other symptoms of overloading would not arise. Instead of first trying to relieve social system pressures, an analysis should begin by establishing a model of the structure and relationships that interact to produce the problems. That is, one should start by replicating the system that generates the symptoms. Only then can one be confident that he is beginning to understand the underlying causes.

Surprising as it seems, the difficulties in our social systems are caused by the interplay of elements that individually are well-known and highly visible. Our social troubles do not come from hidden causes or capricious behavior. Instead they come from evident policies that are not recognized for either their true importance or the dynamics of their interaction.



It was first in our studies of corporations that we realized how well-known policies could interact to give puzzling consequences. Time after time we had the experience of going into a corporation with conspicuous and widely reported symptoms of trouble. The symptoms might include low profitability, falling market share, or high fluctuations in employment. Such symptoms are well-known both inside the corporation and out. In searching for the relevant structure and policies, one discusses with people their actions and their responses to pressures. In general, we found that people are clear and articulate about what they are doing. Investigation usually verifies that they are doing as they say. Furthermore, the actions in general are motivated by a sincere intention to solve the organizational difficulties. Then, with due regard for the principles of feedback structure, we have assembled into a computer simulation model those relationships, policies, decision processes, and interactions that have been described by the participants. The computer simulation model usually shows that the known structure and policies interact to create the observed troubles. In other words, the very actions people know they are taking in an effort to solve major difficulties are in fact producing those difficulties. A destructive spiral can easily develop. A problem appears. The "solution" is considered obvious and action is taken. By obscure dynamics within the complex social system, the "solution" makes the problem worse. However, because the deterioration is blamed on outside influences, the "solution" is applied with ever more vigor and the situation is caused to deteriorate still further.

In urban decay the same destructive spiral is found. The poor do not have jobs and income enough to afford adequate housing. So low-cost housing is built. The housing occupies land that should have been allocated to job-creating activities and, as a consequence, jobs become more scarce. But the new housing attracts more of the poor and unskilled. The unemployed population rises, jobs decline, income per capita remains low and destitution continues.

In our study of world interactions, it appears that hunger and poverty trigger efforts toward industrial production and more efficient agriculture. But more food, better sanitation, technology, and public health measures allow population to rise. The circular process of people increasing production and production increasing population is responsible for the overwhelming rise in population that is creating a new set of global stresses.

Could it be that some of the actions being taken by our religious institutions in the belief that they will alleviate human suffering may actually be a part of the processes that produce that suffering?

## 2. Goal Conflict

A social system, if it is to fulfill human needs, must meet a multiplicity of goals. These goals can conflict with one another in several dimensions—in current tradeoffs, in time, and in hierarchy. Furthermore, the nature of the most important goal conflicts can change, depending on the mode in which the system is operating.

### a. Conflict between Co-existing Goals

Goals can conflict in current tradeoffs. That is, many goals exist simultaneously in different parts of a system. Efforts to reach one goal may mean that another is put further beyond reach. We simultaneously have goals for food, clean air, material goods, peace, sense of mission, elimination of current stresses, and confidence in the future. These objectives are coupled in various ways. Actions toward one goal may produce quite unexpected responses and deterioration in other system objectives. For example, efforts to improve the economic and technological aspects of cities attract population. Population densities rise until the economic and technological improvements are compensated by rising psychological tensions, crime, drug addiction, despair, and social disorganization. We know how to work toward economic and technical goals. But such effort shifts the system pressures into the more intangible sectors with which we cannot cope.

### b. Conflict between Present and Future

A second goal conflict exists in time—between the present and the future. Actions to enhance the present, generally deteriorate the future. Examples are all about us to illustrate how actions that favor the present can undermine the future. If one has an urgent report to finish, he can accomplish the most in the next 24 hours by working through the night, but the price is paid in lower effectiveness during the next two days. Or, if one wishes to improve his material living in the short run, he has only to borrow money, use his credit cards, and live beyond his means. But in the long run, the price must be paid. If the debts are to be met, the standard of living must fall below one's average income. Likewise, the corporation can improve short term profitability by postponing expenditures on new product research and on the repair of equipment. But in time the quality of products suffers, the efficiency of production declines, and profits drop lower than at the start. On a larger scale at the world-wide level, hunger can be reduced for a time by rapid increase in agricultural pro-



duction. But in the long run, more food permits more population. Food per capita falls back and in addition the greater population density generates new stresses and complications.

#### c. Conflict between Subgoals and System Goals

A third goal conflict exists in hierarchy—between the goals of subsystems and the goals appropriate to the total system. For example, maximum wages to individual workers is in conflict with profitability of the business. Or, the minimum cost goal of the business leads to excessive generation of pollution with the price paid by the larger public in a poorer environment.

Attempting to enhance each subgoal of a social system does not assure the best possible outcome for the system as a whole. In fact, efforts to improve each of the components of a system can lead to far less than the best possible total results.

Churches, like other institutions, can fall into the trap of believing that pursuit of subgoals is the equivalent of maximizing quality of life in the total social system. Pursuing separate subgoals in education, medicine, agriculture, and disaster relief, contributes to the population explosion, shifts people from agriculture to the cities, and sets the stage for greater social conflict.

#### d. Shifting Patterns of Goal Conflict

The most likely kind of goal conflict depends on the mode in which the social system is operating. Two behavior modes of the world social system are of immediate interest—growth and equilibrium. During growth it is easy to enhance immediate objectives by actions that defer the unpleasant consequences to the future—goal conflict is in the time dimension. On the other hand, a system in equilibrium seems more apt to shift pressures quickly between co-existing goals—the goal conflict is between current tradeoffs.

One can illustrate these shifting patterns of goal conflict by the changes that are likely to occur as growth gives way to equilibrium. For the last several hundred years the world has been in sustained growth of population, geographical occupancy, and production of food and goods. During that time, production in many areas of the globe has been able to outrun the growing population and thereby produce a rising standard of living. Likewise, public health measures, modern medicine, antibiotics, and insecticides have been able to improve the health of many populations. But all of these measures are now seen as merely postponing the day of reckoning. The very actions which gave the short-term improvements are the ones which are producing overpopulation, depletion of resources, crowding, and the reemerging threat of food shortage.

Now as the world system moves gradually toward an equilibrium state, it becomes less possible to push problems into the future. Now more often, the goal conflicts will be between co-existing goals in the present rather than between the present and the future. For example, imagine a population being held constant by two pressures. One pressure arises from a degree of malnutrition and the other pressure from a certain incidence of epidemics and poor health arising from crowding. Now suppose that the food supply is increased to remove the pressure from hunger. The population rises, the crowding becomes worse, and the pressure from disease increases. In other words, the pressure shifts relatively rapidly, within a few decades, to a new point in the system. The consequences of current actions can no longer be deferred, as was once possible, for centuries into the future.

### 3. Collapse of Goals and Values

Social systems tend to decay as a result of collapse in their long-term goal structures. As the enduring values erode, emphasis shifts to short-term objectives. As the present is emphasized over the future, the result is long-term deterioration and further emphasis on the short run. As the goals decline, the decision processes change, and a downward spiral begins to sustain itself. For example, the collapse of values is often seen in a young corporation whose founders start a business dedicated to high product quality. Under the inevitable business pressures, quality may fall short of the goal. If the leaders are not firm in their convictions about quality, they become accustomed to and accept the lower quality. Because of the lower quality, prices must be reduced. Revenues are then so low that even the existing quality cannot be sustained. The new lower quality is accepted as inevitable, and the spiral of collapse continues from the initial high standards. All of our social systems are subject to the erosion of long-term goals, unless some effective institutional mechanism exists for sustaining a vision of the future and subordinating short-term conflicting goals.

Any operating goal of a social system can be thought of as depending on three components—long-term value, the traditional past accomplishment, and the weighting influence that determines the relative force of long-term value vs. traditional accomplishment.

The long-term value component in an operating goal is an enduring standard that transcends adversity and short-term pressures. It is deeply embedded in the collective character of the system. If the long-term values are to be sustained, there must be social processes for propagating and perpetuating them.

The second component of an operating goal is the perception of actual past performance. A social system that operates on past accomplishment as its only goal is merely striving to do as well as it did in the past.



The third component of an operating goal determines where the operating goal lies between the long-term goal and the past accomplishment. If the long-term values are persuasive and if there is an institutional structure to project them into day-by-day decision-making, then the long-term values are influential. If the long-term values are weak, poorly perceived, irrelevant, inappropriate, or not sufficiently timeless in concept, then they fail to be influential and the past performance becomes the only effective goal.

If one is only striving to equal his past accomplishment, adversity will probably cause him to fall somewhat short of that goal. As time progresses, the new lower performance becomes the historical tradition and performance continues to decline. It is the role of the enduring long-term components of the goal structure to prevent this downward spiral. In the corporation, the long-term enduring goals are usually set and perpetuated by the founder-manager type of strong leader. In nations, the goal structure is cast into the constitutions and the laws. But where is the even longer-term goal structure for a society to be found that can guide people in setting national goals?

There is no custodian of the long-term goals unless it be the religious institutions. On religion rests the responsibility for maintaining long-term values and preventing collapse of operating goals. But a religion and its teaching cannot make its long-term values influential if those values are contradictory, self-defeating, inapplicable, or inappropriate to a new dynamic mode into which the social system may have moved.

#### THE CHURCH IN THE DYNAMICS OF SOCIAL VALUES

The "policies" of a social system describe the manner in which decisions are made. A policy states the process by which the existing circumstances are interpreted into a course of action. In the broadest sense, policies include folklore, emotional reactions, self-interest, humanitarianism, and all of the influences that govern action. Ethical structure is part of the governing policies of a society. To the extent that religious teachings have influence and carry weight in social decision-making, those religious beliefs must be included in a model that explains the dynamics of a society. Religious beliefs interact with other decision-making influences in a social system and are a part of the total policy structure that may produce either good or evil. Ethical principles interact with the principles of economics, technology, sociology, agriculture, and medicine to create today's pressures and social stresses.

From a system dynamics viewpoint, religious teachings are a part of the policy structure of a society. The religious attitudes, traditions, and morality influence day-by-day decisions. Historically, religious values have probably developed in response to long-term social needs. To survive, a society must have a long-term value structure to counteract the short-term pressures. Without the long-term values, "living for the present," if carried to an extreme, makes the future impossible. The societies that have

grown and prevailed are those with a viable concept of the future. Without such an enduring value set, the society fails to develop, decays from the inside, or is replaced by a more future-oriented social system.

As enduring values are gradually perceived by a society, those values are cast into religious codes. The religious codes serve to freeze and to propagate the long-term values. The enduring values take the form of religious documents, rituals, taboos, and doctrine. Added force and influence are often imparted by the belief that the values have been handed down from a deity above and outside the human system.

But the long-term value structure of a society can be too permanently frozen. The value structures of our great religions were developed at a time when social systems were beginning to evolve. The values were suitable to the conditions of the times and to the particular mode in which the social system was then functioning. But the values were products of the early times. Values were developed by trial and error. Societies with value structures that served poorly did not survive. The values that survived were suitable to the conditions under which they evolved. But if the fundamental dynamic mode of a social system changes, there is little reason to believe that the earlier long-term values will have been so timeless that they will still apply equally well to the new mode.

Christianity developed in the context of one particular dynamic mode of our social system. It developed when man was sparsely settled on the earth, when geographical expansion was still possible, when man was puny compared to the forces of nature, and when science was yet to be exploited. The Christian values were effective for social survival and expansion. In fact they are a value code that enhances growth. It is a code that gives man the obligation to develop missionary zeal. It gives man the right to mastery over nature. The values were interpreted as imposing a duty to extend God's chosen people and religion across the face of the earth. Christianity has made its believers responsible for the welfare of others, and that becomes an obligation to protect others from themselves, from the restrictions of more equilibrium-oriented religions, and from the vicissitudes of man's interaction with nature. In short Christianity is a religion of exponential growth.

But exponential growth cannot continue forever. Tremendous internal pressures must be generated to suppress growth. During growth, the new shifts attention from the failures of the old. During growth, the onward-and-outward orientation diverts a society from introspection and self-doubt. But as growth becomes less possible, long-term values directed at growth become less useful. Then the very institutions and psychological processes that perpetuated the old values become a liability. Those institutions, processes, folklore, and tradition were designed to keep the old values from being diluted and changed. But if the values are not sufficiently fundamental to span both the old and the new dynamic modes of the system—here in our discussion if they are not sufficiently timeless to serve equally in growth and in equilibrium—then the institutions that once were the necessary protectors of effective values become instead the perpetrators of obsolete values.



Because the fundamental modes of social systems can and do change, the long-term values must either be so basic that they span all modes, or the long-term values must themselves be subject to gradual change. If they can be changed too rapidly, they fail to serve their purpose in protecting the system against short-term expediency. But if they are too inflexible, they are unresponsive to essential change.

The importance of having a correct blend of ease and difficulty in changing a set of social values is illustrated by the United States Constitution. Perhaps the great strength of that document lies in its mechanisms for amendment. The means for change seem to be neither too rapid nor too slow. Change is sufficiently difficult that the Constitution cannot be altered in response to fleeting pressures that lack enduring value. On the other hand the Constitution is not so inflexible and frozen that people despair of change and therefore react by abandoning its guiding values.

But is there the correct degree of responsiveness for modifying and interpreting Christian principles? Is there a suitable way to redefine and extend religious principles in response to pressures that arise when the principles are no longer suitable? Is there any procedure for anticipating social changes so that modification can begin before the discrepancies between old values and new reality have become so great that society rejects the principles? Unlike the national Constitution, the Bible contains no explicit process for revision and updating. There is no way to introduce new insights that recognize newly emerging modes of behavior in our social systems. Without a means of revision, the escape from discrepancy between old doctrine and modern conditions has first been by reinterpreting the meaning of the old principles. By reinterpretation, society moves away from the literal words to figurative symbolism. Symbolism is more flexible and is subject to wider interpretation. But, in the face of discrepancy between the stated long-term values and the actual social necessities, the reinterpretation is apt to allow the long-term principles to drift into short-term expediencies. Secular forces supercede the long-term values and the goal structure of the society is swayed by immediate pressures.

Much of the "credibility gap" being experienced by organized religion arises from the dynamic failures to fulfill the goal-setting need of society. Long-term values that served well during the centuries of growth are found wanting as the world is faced with the pressures of moving into equilibrium. Processes do not exist for revising those long-term values that should be more fundamental and enduring than even national constitutions. Without change, the discrepancies between the values and social relevance widens. To some extent the old values are rejected. But partly they are reinterpreted and are alleged to coincide with the short-term expediencies. Without an appropriate long-term value structure, the society begins to falter.

## PREDICAMENT OF THE CHURCH

The changes in our social systems have shifted the ground on which religious principles have been established. The new system modes are dynamically quite different from those that prevailed when the principles evolved. The church, being without adequate processes for changing the value structure it propagates, is now in several predicaments.

### 1. Shortened Time Horizon

The church should be custodian of the longest-term values in a society. Those values should look beyond civilian laws and national constitutions. As custodian of the future, the church should understand that long-term values will conflict with the short-term values and goals of man and society. The church must have effective ways to project long-term goals into the current processes of everyday decision-making.

But what does the church today say about the ethical questions that arise in transition from growth to equilibrium? What does the church say about individual and national responsibility for the future? Is not the church a partner with secular society in maximizing present human welfare at the expense of future people? Is not the church an active force dedicated to social changes that can be realized only if growth were to be sustained beyond the likely limits?

The church will not be effective if it has lost its distant time horizon. If its values are the same as those of the secular society, the church need not exist. If church values are inappropriate to a newly emerging mode in the surrounding social system, the values will not be persuasive and cannot be projected.

But many of the old values of humanitarianism and the unique rights of man in preference to other living things have contributed to an exponential growth in human population and man's technology that brings man face to face with the ultimate global limit. What was once a long-term ethical structure that succeeded by deferring difficulties into the distant future has become a set of reactions that shifts stresses quickly from point to point. The value structure of the church is caught in the fundamental dynamic changes that occur when growth comes under pressure and the transition to the equilibrium mode begins.

### 2. Obsolescence of the Growth Ethic

Now that growth in population and growth in the conquest of geography and nature can no longer serve as a unifying focus for the future, the church must seek a new set of values to hold before mankind. A new ethical structure with long-term values suitable for a future of world equilibrium is needed.



How is responsibility for the future to be imposed? How will the economic and psychological costs of the transition to equilibrium be assessed? What degree of coercion and restriction on individual freedom is necessary? What is the ethical foundation for penalties against the transgressors who overemphasize the present at the expense of the future?

### 3. Compartmentalism

Religion, like other aspects of living, has established itself in a compartment that is nearly cut off from other aspects of human existence. It shares this fault with most other human activity. Science, law, economics, and psychology are also in compartments as if each could exist in its own subworld. But our studies of systems show that the important modes of behavior and the serious troubles arise because of interaction between the subsystems. Human existence will not be understood or safely managed if each compartment is treated separately.

But who will assume responsibility for understanding the interactions? Corporations are compartmentalized into production, sales, research, and other functions; but the intuitive processes of management give no adequate capability for understanding the interactions of those functions. Medicine studies organs and diseases, but has no specialty that deals with the dynamics of medical systems. Nations have departments of state, agriculture, defense, commerce, and health, but have little capability for understanding the interactions of the many national efforts. A governmental research program would not address itself to social values of the time horizon that should interest the church because such would clearly lie outside the responsibility, wisdom, or political feasibility of any government agency.

The institution with the longest time horizon is in the best tactical position to lead in exploring the nature of the social system; the church should establish that distant horizon. Long-term values are closely tied to what society is to be 100 or 200 or 1000 years hence. If not the church, who is to look that far ahead? But the church is in the predicament of undergoing a shortening time horizon when it should be leaving the near-term to other institutions and should be turning its attention to a horizon beyond that of any other unit in the society.

### 4. Egocentricity

Man through his religious concepts has established for himself, in his own mind, a unique position at the center of the universe. At one time this meant literally the physical center with the sun and stars revolving around the earth. Far more recently it has meant man as a uniquely chosen creature in nature with special rights and privileges over the natural surroundings. But that egocentric view of man at the center, with nature at his disposal, is becoming as untenable as the

geocentric theory of the world at the center of the universe. When man made graven images to worship, those images were usually in the form of man. As religion became more spiritual, physical images were discarded but the mental images of God remained in the pattern of man both in form and in emotion.

Man's view of his world and his place in it has gradually broadened. The change is illustrated by the expanding concept of selfishness. When man was being admonished to be literally his brother's keeper, selfishness was an act against one's family; but generosity was not expected to extend to other family tribes who were one's enemies. Later, the boundary expanded within which generosity was expected. First, the city became each person's responsibility; then nations became the boundary of one's obligations. Much more recently has grown the contention that all of humanity falls within the boundary; but it has remained permissible to be selfish toward anything outside of mankind, that is, toward the natural surroundings. This latest view drives churches to help men everywhere, but with what consequence? By helping the human population to grow, and by protecting man from the retaliation of nature, mankind is showing the height of social selfishness toward the environment. One must ask when is generosity a virtue and when is it a sin against the world? When is generosity a duty and when is it only a means of self-satisfaction? Is selfishness any less sinful when exercised in favor of mankind as a whole than when for oneself? Such questions must be explored anew now that the alleviation of one world pressure can actively increase some other pressure in the present or the near future. What are the proper tradeoffs? Our ethical and religious beliefs are in disarray because they contain contradictions and conflicting goals.

### 5. Fallacy of Human Equality

The collapse of the religious time horizon has had a curious effect on our attitudes toward human equality and responsibility. If the focus of attention is on only the immediate present, then responsibility for one's actions is irrelevant because responsibility implies consequences in the future and there is no attention on that future. All people can then be considered equal at any moment in time and should be treated alike because they bear no responsibility for their past or toward their future. But consider what this viewpoint does for the goals of a civilization confined in a fixed environment.

Imagine two countries side by side, each with a population and an industrial capability that can sustain them indefinitely at a high standard of living. Assume that Country L has a long time horizon, realizes that it cannot allow population and industry to grow without exceeding the natural capacity and thereby lowering the standard of living, and accepts the self-restraints and the short-term penalties necessary to come into equilibrium with nature at a high quality of life. On the other hand, assume that Country S



has a short time horizon, lives for the present only, does not plan for the future, avoids traumatic self-discipline, allows population and industry to grow, exhausts the capability of the environment, and after 50 years falls to a miserable human condition. After the 50 years, what is to be the responsibility of Country L toward Country S? If Country L must in the future share with Country S, then Country L suffers in both the short run and the long run. Country L accepted the strain of establishing a national equilibrium at an early date and then is to be denied the fruits of that action by also suffering the misery that must come from sharing equally with Country S when S has over-committed its resources. If the ethical principles teach that Country L and Country S are to share equally in the future, there are no incentives for anyone to manage for the future.

If all men are not to be equal at every point in time, then there is some boundary to be established around the concept that one is to be his brother's keeper. Furthermore, with the very long time delays that are inherent in our social systems, responsibility to the future must extend well beyond a person's own lifetime. In Country S, the penalties of living for the present will not mature until two more human generations have moved onto the scene.

If one has a responsibility for the future, an inescapable symmetry commits him to a legacy from the past. There is no basis for world equilibrium unless the sins of the fathers are to be visited on the sons. One can have no right to equality in the present but only to an accumulated equality that reflects the actions of his heritage and the long-term goals of his ancestors. The ethical and religious issues need to be re-examined and made consistent with the dynamic realities of our social systems.

#### 6. Potential Evil in Humanitarianism

Humanitarian concern means help for one's less fortunate fellow man. At times such action is based on a much too simplistic view of the situation. Such help is usually aimed at immediate goals. Long-term and short-term goals may be in conflict. When does help in the present lead to increased distress in the future? What concepts of right should govern?

Consider a country that is overpopulated. Its standard of living is low, food is insufficient, health is poor, and misery abounds. Such a country is especially vulnerable to any natural adversity. There are no reserves of food. Medical facilities are always overloaded. There is no reserve to cope with any kind of misfortune. Floods make many homeless; but is that because of the flood or because overpopulation forced people to live in the flood region? Droughts bring starvation; but is that due to weather or to the overpopulation that made food reserves impossible? The country is operating in the overextended mode where all adversities are resolved by a rise in the death rate. The process is part of a natural mechanism for limiting further growth in population. But suppose that humanitarian impulses lead to massive relief efforts

from the outside for each natural disaster. What is the long-term result? The people who are saved raise the population still higher. With more population, vulnerability of the country is increased. Epidemics become more likely, and internal social strife more probable. A smaller adverse event can now trigger a crisis. Disasters occur oftener and relief is required more frequently. But relief leads to a net increase in the population, to more people in crisis, to still greater need for relief, and eventually to a situation that even relief cannot handle.

A point is reached where humanitarian action generates the demand for still more humanitarian intervention until the entire socio-economic system falters. The church should begin to examine the limits and consequences of humanitarianism. The church should bring humanitarian concepts into a consistent relationship with the pressures accompanying the transition to global equilibrium.

#### 7. "Right" is Not Absolute

Our concepts of "right" are system policies. The concept of right is a guide to action. But do we mean the action that is right for the immediate future or for the distant future?

In the teaching of the church is often the implication that right is absolute, that it knows no compromise, that it is independent of the future time toward which one looks. These are fallacies. Generally a system policy that is desirable in the short run is detrimental in the long run and vice versa. The action that is right in the short run may be wrong in its long-run effects. The church has taken an overly simplistic view of right and ethics. As a consequence it contributes to the goal conflicts between present and future.

The church should take the leadership in re-examining right and wrong in the context of the time horizon. The time conflict should be recognized. The church, if it is to be the custodian of long-term values, must define right in terms of the enduring and future welfare of mankind. Other institutions will adequately defend the short-run.

#### ACTION

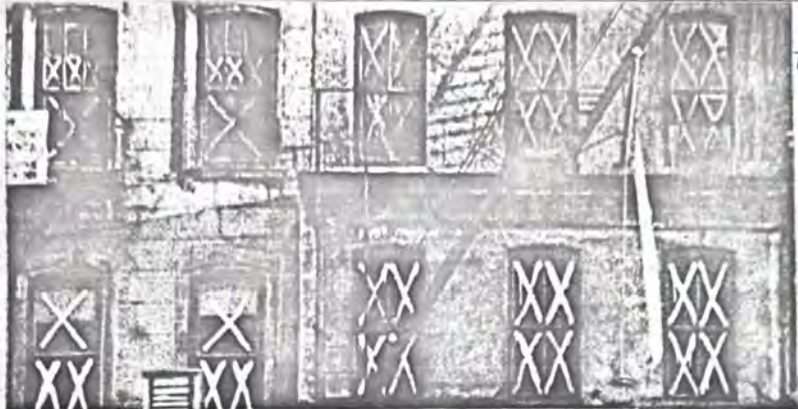
This paper has described part of the predicament of the church as seen from a system dynamics viewpoint. I have not attempted to answer the questions that have been raised. Generating answers is a major task for the future.

The issues raised here are amenable to treatment by a properly planned research program. The process calls for integrating the long-term dynamics of the ethical value structure into the socio-economic-technical models that are coming into existence. Some of the best minds from theology, law, philosophy, economics, and science should convene, along with professionals in system dynamics. The various social subsystems should be interrelated, including the dynamics of goal and value creation. By using dynamic system models to organize thought and to determine the consequences of assumptions, there should emerge a sharper image of the future role of the church in society's impending transition from growth to world equilibrium.



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## Systems analysis as a tool for urban planning

*With the use of a computer model to simulate the growth, decline, and stagnation of a city, we can see how system structures and policies interact to create the urban ills surrounding us*

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Ways for analyzing social systems result in new policies for improving the behavior of systems in which we live. Such policies can change urban slums into areas designed for self-renewal. Already, studies into the relationships between monetary policy, interest rates, and foreign exchange have thrown new light on the processes of corporate growth, product stagnation, and loss of market share, and on the growth and decline of cities. At one time the engineer's task was simply to balance financial cost against the economic performance of his technology. Now, psychological stress, ugliness, and crowding have become part of the cost. Engineers who fail to realize this broadened role will be vilified by a society that views them as insensitive to the needs of the times.

Most of the traditional steps taken to alleviate the conditions of our cities may actually be making matters worse. This is one of the conclusions of my book, *Urban Dynamics*,<sup>1</sup> which shows the city as an interacting system of industry, housing, and people. By presenting a computer model that interrelates these components of the city, the book shows how interacting processes produce urban growth, then cause growth to give way to stagnation. Job training programs, job creation by bussing to suburban industries or by the government as an employer of last resort, financial subsidies to the city, and low-cost-housing programs—these presently popular proposals are tested and shown to lie between neutral and detrimental in their effect on a depressed urban area.

The evolution of an urban area from growth into stag-

nation creates a condition of excess housing compared with the population and the availability of income-earning opportunities. Reducing the inherent excess housing of depressed areas and converting part of the land to industrial use appear necessary to reestablish a healthy economic balance and a continuous process of urban renewal. Such actions can produce a large enough wage and salary stream from the outside economy to make the area self-sustaining.

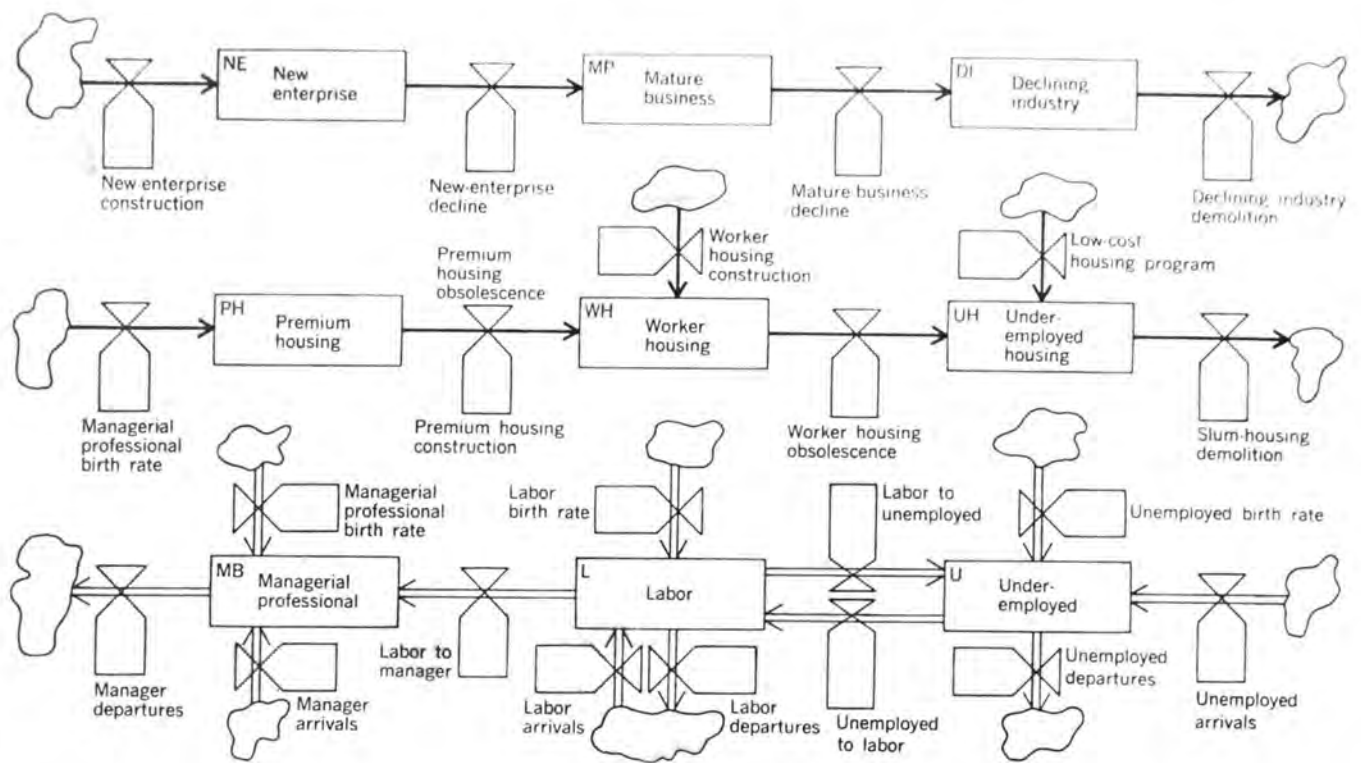
These results are controversial but, if right, they mean that many policies for remedying urban troubles may be turning growth into decline. Although I present here some results from the book, my principal emphasis is on the importance of systems analysis as a bridge between engineering and the social sciences.

### Industrial dynamics

Over a decade ago at M.I.T. we began to examine the dynamic characteristics of managerial systems. The field known as *industrial dynamics* resulted.<sup>2</sup> Industrial dynamics belongs to the same general subject area as feedback systems, servomechanisms theory, and cybernetics. Industrial dynamics is the study of how the feedback loop structure of a system produces the dynamic behavior of that system. In managerial terms industrial dynamics makes possible the structuring of the components and policies of a system to show how the resulting dynamic behavior is produced. In terms of social systems it deals

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**FIGURE 1.** In this simplified urban system, nine levels are grouped into three subsystems. Across the top the industrial sector contains commercial buildings in three categories distinguished primarily by age. Across the center are residential buildings in three categories, also distinguished by age and condition. Across the bottom are three economic categories of population. Because of their complexity, the information linkages connecting the systems levels to the system rates are not shown. In this figure, the levels (rectangles), and rates (valves), along with the information linkages, represent the system components within the dynamic boundary. The "cloud" symbols are the sources or destinations of flows going from or to the outside environment. The flows from or to the outside are controlled only by conditions within the system.

with the forces that arise within a system to cause changes through time.

A design study of a social system seeks changes in structure and policies that will improve the behavior of the system. Some people recoil at the thought of designing social systems. They feel that designing a society is immoral. But we have no choice about living in a system that has been designed. The laws, tax policies, and traditions of a society constitute the design of a social system. Our only available choice is between different designs. If we lament the functioning of our cities or the persistence of inflation or the changes in our environment, we mean that we prefer a social system of a different design.

The six steps in the design process are: (1) observe the behavior modes of a system to identify the symptoms of trouble; (2) search for the feedback structures that might produce the observed behavior; (3) identify the level and rate variables making up that structure and explicitly describe them in the equations of a computer simulation model; (4) using the computer model, simulate in the laboratory the dynamic behavior implicit in the identified structure; (5) modify the structure until components and the resulting behavior agree with the observed conditions in the actual system; (6) introduce modified policies into the simulation model to find usable and acceptable policies that give improved behavior.

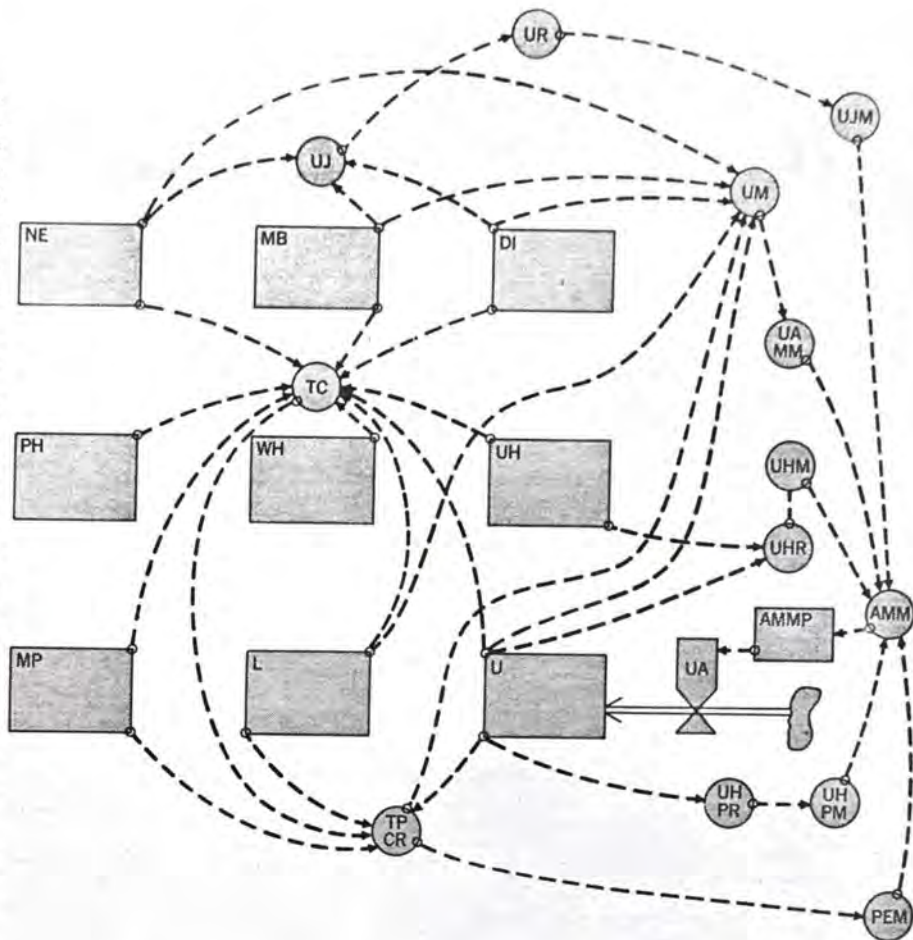
Surprising discoveries come from this combination of theory and laboratory experimentation: relatively simple structures produce much of the complex behavior of real-life systems, and people's skills in perception appear very different from those commonly supposed. It is often asserted in the social sciences that people are unreliable in analyzing their own actions, yet we find time and again that the policies and practices that people know they are following are the ones that interact to produce the most troublesome consequences. Conversely the vaunted powers of judgment and intuition usually deceive the person who tries to guess the time-varying consequences that follow

even from a completely known system structure. We find that the modes of behavior that are most conspicuous in managerial, urban, and economic systems are produced by nonlinearities within those systems. The linearized models that have been used in much of engineering and the social sciences cannot even approximate the important modes of manifestations of nonlinear interactions. Including the so-called intangible factors relating to psychological variables, attitudes, and human reactions is relatively straightforward. Again, if the influences can be discussed and described, they can be inserted in the policy structure of a model. Any person who discusses why people act the way they do, or explains a past decision, or anticipates a future action is relating the surrounding circumstances to the corresponding human response. Any such discussion is a description of decision-making policy. Any such policy statement can be put into a system model.

#### Urban systems

A body of dynamic theory and principles of structure is emerging that allows us to organize and understand

FIGURE 2. Information links to the underemployed-arrival rate. Five components of attractiveness are shown here. In the upper right corner UJM (underemployed/job multiplier) relates the population to available jobs and represents the income earning attractiveness of the area. The circle UAMM generates the attractiveness created by upward economic mobility. In other words, an area with high upward economic mobility is more attractive than one offering no hope of advancement. The circle UHM relates the underemployed population to the available housing. The area becomes more attractive as housing becomes more available. UHPM represents the attractiveness of a low-cost-housing program, if such exists. In the lower right corner PEM is the influence on attractiveness of the public expenditure per capita. As per-capita expenditure rises, it means better public services, better schools, and higher welfare budgets.



complex systems.<sup>3</sup> For example, the feedback loop becomes the basic building block of systems. Within the feedback loop there are two, and only two, kinds of variables. One is the *level variable* produced by integration; the other is the policy statement or *rate variable* that governs the changes in a system. The level variables are changed only by the rates of flow. The rate variables depend only on the levels. Any path through a system network encounters alternating level and rate variables. These and many other principles of structure are universal in the entire sweep of systems that change through time. Furthermore, the structure of a system determines its possible modes of behavior. Identical structures recur as one moves between apparently dissimilar fields. These identical structures behave in identical ways wherever they are found.

The same principles of structure and the same relationships between structure and behavior apply to a simple swinging pendulum, a chemical plant, the processes of management, internal medicine, economics, power politics, and psychiatry. A universal approach to time-varying systems that seems capable of dealing with systems of any complexity is emerging. Students, as they master the principles and practice of dynamic analysis, develop a remarkable mobility between fields of endeavor. The same person can clarify the dynamics of how a transistor functions, organize the processes of a public health epidemic, design new management policies to avoid stagnation in product growth, discover the sensitive factors in ecological change, and show how government policies affect the growth and decline of a city.

Figure 1 shows the central structure of an urban area.

The nine rectangles represent the selected level variables. The twenty-two valve symbols represent the rates of flow that cause the nine system levels to change. Engineers often refer to these level variables as the state variables of a system. The distinction between level and rate variables is also familiar to anyone who examines financial statements. Balance sheet variables are always separated from variables on the profit-and-loss statement. They are separate because they are conceptually quite different. The balance sheet variables are system levels. They are created by accumulating financial flows. The profit-and-loss variables are system rates. This sharp distinction is found in all systems.

In Fig. 1 one can begin to detect the reasons for urban decline. The age of a building tends to determine the character of its occupants. A new commercial building is occupied by a healthy, successful commercial organization that uses relatively more managers and skilled workers than those who are unskilled. As the building ages, it tends to house a progressively less successful enterprise with lower employment skills. In addition to the changing employment mix as the industrial building ages, there is a tendency for total employment per unit of floor space to decline. On the other hand, as residential buildings age there is a tendency for occupancy to increase as well as to shift to a lower economic category of population. One perceives then a condition where the aging of buildings in an urban area simultaneously reduces the opportunities for employment and increases the population. The average income and standard of living decline.

Figure 2 shows the same nine system levels and one of



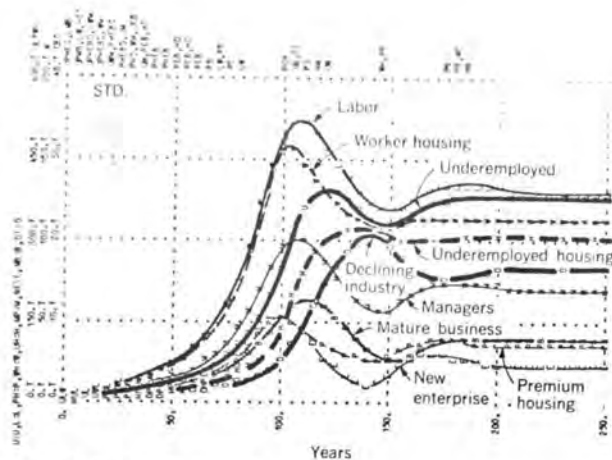


FIGURE 3. Growth and stagnation.

FIGURE 4. Changes in housing and employment.

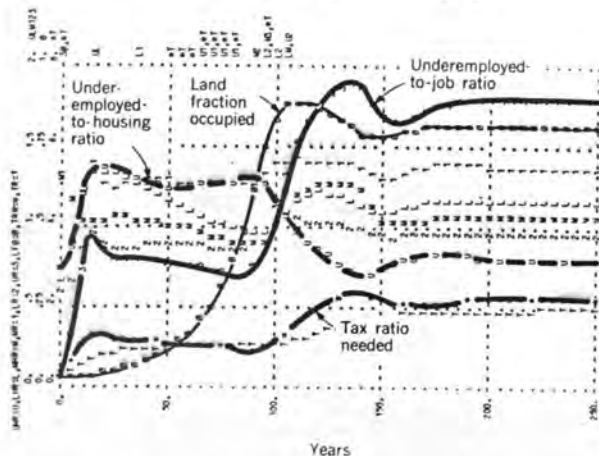
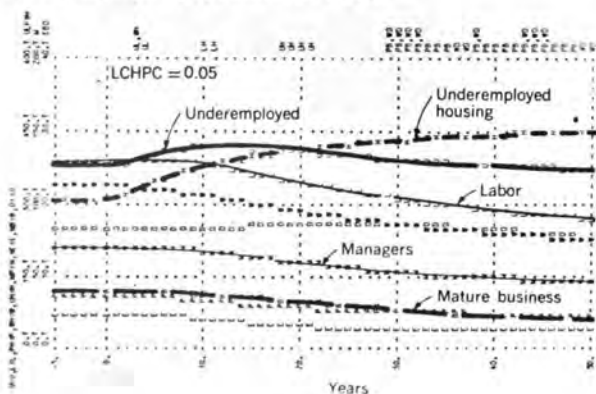


FIGURE 5. Decline of urban area caused by low-cost-housing construction each year for 2.5 percent of the underemployed population of a city.



the twenty-two flow rates. The dotted lines are the information linkages from the system levels to control the one flow rate—here the arrival of underemployed population into the urban area. The various levels of the system combine to create a composite attractiveness, which determines the inflow rate to the area. If the area is more attractive than those from which people might come, a net inward population flow occurs. If the area is less attractive, an outward flow dominates.

The concept of attractiveness is fundamental to the population flows. All of the characteristics of an area that make it attractive, these five and many more, combine to influence migration. An attractive area draws people. But almost every component of attractiveness is driven down by an increase in population. If there is an excess of housing, the area is attractive but a rising population crowds the housing. If there is an excess of jobs the area is attractive but the incoming flow of people fills these jobs. In other words, migration continues until the attractiveness of the area falls and becomes equal to any other places people might come from.

An important idea follows from examining these components of attractiveness. In a condition of population equilibrium, all areas must be equally attractive to any given population class, otherwise net migration would occur. If one component of attractiveness is increased in an area, other components must necessarily fall to establish a new equilibrium. Compensating changes in the components of attractiveness explain many past failures in our cities wherein we attempt to improve one aspect of the city only to discover that other aspects have become worse.

In making a laboratory model of a social system one should not attempt straightaway to solve a problem. Instead one should generate a model that will create the trouble symptoms. Only if one fully understands the processes whereby difficulties are created can he hope to correct the causes. This means that we want a model of an urban area that can start with empty land, grow a city, and show the processes whereby economic health falters into stagnation and decay.

As another guide to modeling, one should start, not by building a model of a particular situation, but instead by modeling the general class of systems under study. This may seem surprising, but the general model is simpler and initially is more informative than a model of a special case. Here we wish to model the general process of urban growth and stagnation. It should be a model that, with proper changes in parameters, is good for New York, Calcutta, a gold rush camp, or West Berlin. These all seem to have very different characteristics but they have certain elements in common that describe their urban processes. There are fewer concepts common to all than are to be found in any one. The general model can strip away the multitude of detail that confuses any one special situation. The general model identifies the central processes and is a statement of the theory for the entire class of systems.

Figure 3 shows the behavior of the laboratory model of an urban area. It presents the nine system level variables over 250 years. The first 100 years is a period of exponential growth, but then the land area becomes filled, growth ceases, and the aging process begins. At year 100 near the end of the growth phase the labor population is almost double the underemployed population. But by year 150, the labor population has fallen and the underemployed population has risen until these two groups are almost equal. Business activity has declined and the area has taken on the characteristics of a depressed city. This has occurred because of the way that the industry, housing, and populations in Fig. 1 have interacted with each other.

Figure 4 shows other variables during the same 250 years. Notice especially the underemployed/job ratio and the underemployed/housing ratio. During most of the first 100 years of growth these two ratios were almost constant. The underemployed/housing ratio was high



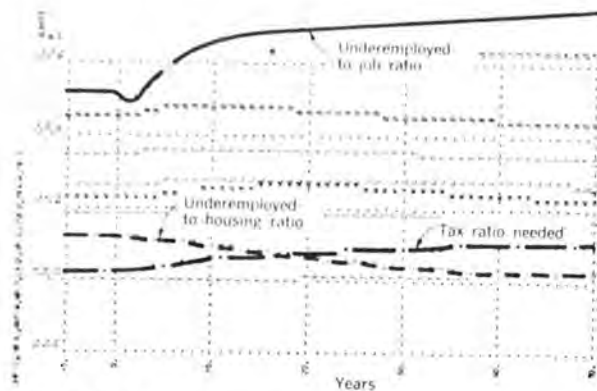
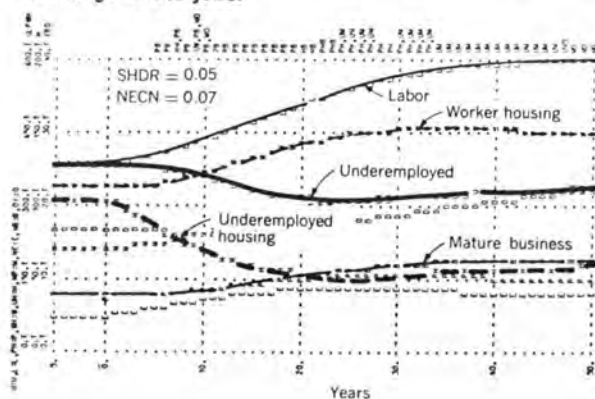


FIGURE 6. Rising unemployment and falling occupancy.

FIGURE 7. Revival caused by removing 5 percent of underemployed each year and encouraging business construction to generate jobs.



(above the center of the figure), meaning that the population is large compared with the housing. In other words, during the first 100 years there was a housing shortage for the underemployed population. On the other hand, the underemployed/job ratio was low, meaning that the population was below the job opportunities, jobs were readily available, economic opportunity was good, and upward economic mobility was high. During this early period of growth and high economic activity, the underemployed population was being effectively adjusted in relation to other activity by balancing good economic opportunity against a housing shortage.

But between 90 and 140 years, notice the sharp reversal of the curves for underemployed/job ratio and underemployed/housing ratio. Within this fifty-year span, the underemployed have increased while available jobs decreased; the result is a precipitous rise in unemployment. But in this same period, the housing that is aging and becoming available to the underemployed is rising even more rapidly than the underemployed population. Jobs have become scarce while housing has become surplus. The model is behaving the way our cities do.

Many people do not seem to realize that the depressed areas of our cities are areas of excess housing. The economy of the area is not able to maintain all of the available housing. Because of low incomes, people crowd into some dwelling units while other buildings are abandoned, stand idle, and decay.

Recall the earlier comments about compensating move-

ments in the components of attractiveness. Here, as housing becomes more available, jobs become more scarce. The stagnating urban area has become a social trap. Excess housing beckons people and causes inward migration until the rising population drives down the standard of living far enough to stop the population inflow. Anything that tends to raise the standard of living is defeated by a rise of population into the empty housing.

Figure 5 shows fifty years beginning with the conditions found at the end of Fig. 3. At time zero, a low-cost-housing program is introduced which each year builds low-cost housing for two and one half percent of the underemployed population. Observe what happens. Underemployed housing, which is being actively constructed, rises forty-five percent, but premium housing falls thirty-five percent, and worker housing falls thirty percent. New enterprise declines fifty percent and mature business declines forty-five percent, all in the fifty-year period. Economic conditions become sufficiently worse so that even the underemployed population, although it rises initially, eventually falls to slightly less than its beginning value. *These changes are a result of the low-cost housing program.*

In Fig. 6, the corresponding underemployed/job ratio has risen thirty percent, indicating substantially higher unemployment, while the underemployed/housing ratio has fallen thirty percent, indicating a still higher excess of housing. Again, the two components of attractiveness compensate for one another with better housing and a falling standard of living. In the long run, the low-cost-housing program has not served the interests of the low-income residents. Instead, it has intensified the social trapping characteristic of the area. Over the period, the tax levies rise thirty-five percent. The area has become worse from almost all viewpoints.

In this same manner job training programs, job creation programs, and financial subsidies were examined. All lie between ineffective and harmful. The low-cost-housing program was the most powerful in depressing the condition of a stagnant urban area.

The depressed areas of our cities seem to be characterized by excess housing compared with jobs and by excessive concentration of low-income population. These conditions, created by aging industrial and dwelling buildings, interact to drive out the upper-income population and business activity, and to reduce the tax base. Once the decline starts, it tends to accelerate. Unless one can devise urban management policies that produce continuous renewal, difficulties are inherent.

Figure 7 shows an urban condition that begins with stagnation and then changes toward revival. Here five percent of the slum housing is removed each year and the incentives for new enterprise construction are increased somewhat. The result is a cascading of mutual interactions that raise the economic activity of the area, increase upward economic mobility for the underemployed population, and shift the population internally from the underemployed to the labor class. This is done without driving the existing low-income population out of the area. Underemployed housing is reduced. Initially this reduction comes largely from the empty housing. The resulting housing shortage restrains the population inflow that would otherwise defeat the revival of the area.

Figure 8 shows the same fifty-year span as in the preceding figure. Here again, employment and housing move in opposite directions. The underemployed/job ratio falls, which means more jobs and lower unemploy-



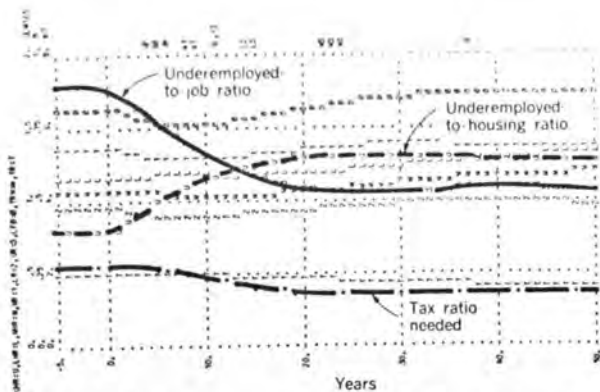


FIGURE 8. Falling unemployment and rise in housing occupancy for the same 50 years of Fig. 7.

ment. On the other hand, the underemployed/housing ratio rises, which means a tighter housing situation. If the economic circumstances are to be improved, we must accept some compensating change in other components of attractiveness. Here it is the increased tightness of housing that allows job opportunities to increase faster than population until a good economic balance is reached. I stress economic revival as the first stage of rebuilding a depressed area because it appears that an economic base must precede social and cultural development.

It is simply not possible to increase all of the attractiveness components of an area simultaneously. Attractiveness is here defined in a very broad sense. For example, legal restrictions like an immigration barrier into a country can produce enough "unattractiveness" to inward migration so that components might be maintained at a high level. But wherever one component of attractiveness is high others will be found low. Engineers, especially, should consider the compensating changes that will occur in the attractiveness components of an area because engineers tend to deal with economic considerations and technology. Economic and technical factors are more concrete than the intangible *quality of life* variables. The economic and technical aspects of a city are the ones we most easily see how to improve. Our technological society tends, therefore, to observe, react to, and improve the economic and technical aspects of a city. Such improvements increase the technical and economic components of urban attractiveness. But as a result, population density rises until the urban area once again reaches attractiveness equilibrium with its environment. The burden of forced reduction in other components of attractiveness falls on the quality of life variables—crowding, pollution, and psychological stress. These less tangible variables have been weak and hard to measure, and have been defenseless against the persuasiveness and the certainty of improvement shown by the technical and economic considerations. But we are entering a time when a reversal will occur between the formerly weak and strong variables. For a substantial fraction of our population, the standard of living is already high enough so that more gain in the economic and technical areas will come at too high a price in the quality-of-life components of our environment. The engineer, if he continues to serve society, must balance a greater number of social needs against one another. At one time his task was simply to balance financial cost

against economic performance of his technology. Now the product and also the medium of payment are both expanding. Social value and quality of life become part of the product. Psychological stress, ugliness, and crowding become part of the cost. Engineers who fail to recognize this broadened role will be vilified and castigated by a society that perceives them as narrow and insensitive to the demands of the times.

When a system misbehaves, we should ask ourselves what policies within that system cause the undesirable characteristics. If we examine the laws under which a city operates, we see a structure of regulations that could hardly be designed better to create stagnation and decline. The aging and decay of buildings is central to the urban decline process, yet we see throughout our tax laws and regulations numerous incentives to keep old buildings in place. As the value of a building decreases, so do the assessed taxes. The reduced expense makes it possible to retain the old building longer. Under some circumstances the value of a building can be depreciated several times for income tax purposes. This produces incentives to keep an old building in place. This is not the place for detail, but it seems clear that a different set of tax laws and city regulations could be devised to produce the individual incentives necessary for continuous renewal. As an example, I recently saw a suggestion that each building have a mandatory trust fund into which the owner must pay a levy each year. At any time, whoever owns the building can draw out the money if he demolishes the building and clears the land. This, you see, would create an earlier incentive for replacement. Property tax levies and income tax accounting could both be changed to produce pressures in the same direction.

These studies of managerial, urban, and other social systems have uncovered complex systems characteristics that serve to identify potential detrimental modes of behavior. First, complex systems are counterintuitive. They behave in ways that are opposite to what most people expect. They are counterintuitive because our experience and intuition have been developed almost entirely from contact with simple systems. But in many ways, simple systems behave exactly the opposite from complex systems. Therefore, our experience misleads us into drawing the wrong conclusions about complex social systems.

Second, complex systems are strongly resistant to most policy changes. A new policy tends to warp the system so that slightly changed levels present new information to the policy points in the system. The new information, as processed through the new policies, tends to give the old results. There are inherent reasons within complex systems why so many of our attempts at correcting a city, a company, or an economy are destined to fail.

But third, the converse is also true. There are points in systems from which favorable influence will radiate. Often these points are difficult to perceive, and the required action is the opposite of what is expected. But when these points are found, they tend to radiate new information streams in such a way that the new circumstances, when processed through the old attitudes and policies, produce a new result.

Fourth, complex systems tend to counteract most active programs aimed at alleviating symptoms. For example, Chapter 4 in *Urban Dynamics* shows how a job training program can increase the number of underemployed in a city. When outside action tries to alter the condition of a system, the system relaxes its own internal processes aimed at the same result and throws the burden ever more onto



the outside force that is attempting to produce a correction. The internal need for action is reduced and the external supplier of action must work ever harder.

Fifth, in complex systems the short-term response to a policy change is apt to be in the opposite direction from the long-term effect. This is especially treacherous. A policy change that improves matters in the short run lays a foundation for degradation in the long run. The short tenure of men in political office favors decisions that produce results quickly. These are often the very actions that eventually drive the system to ever-worsening performance. Short-run versus long-run reversal processes are all around us. If an agricultural country is to industrialize, it must accumulate railroads, factories, and steel mills. This capital accumulation can only be done by foregoing consumption and reducing the standard of living first in order that the standard of living may rise at a later time. If a company faces declining earnings because its products are obsolete, it must invest more heavily in product research and incur even deeper short-term losses if it is to recover in the more distant future to a profitable product stream. A student forgoes short-term earning opportunities by attending college to increase his longer-term earning capability. This reversal between the short run and the long run occurs repeatedly.

Sixth, a system contains internal dynamic mechanisms that produce the observed undesirable behavior. If we ignore the fundamental causes and simply try to overwhelm the symptoms, we pit two great sets of forces against one another. In general, our social systems have evolved to a very stable configuration. If the system is troublesome, we should expect that the causes of the trouble are deeply embedded. The causes will outlast our persistence in overwhelming the symptoms. Furthermore, the internal pressures usually rise to counteract a corrective force from the outside. We can expend all our energy to no avail in trying to compensate for the troubles unless we discover the basic causes and redesign the system so that it spontaneously moves to a new mode of behavior.

As the last of these characteristics of complex systems, we must recognize that a certain ensemble of conditions goes with each possible mode of a system. More specifically, each mode of a system is accompanied by a set of pressures characteristic of that mode. We cannot sustain a particular mode unless we are willing to accept the corresponding pressures. For example, contrast the depressed mode of a city in Figs. 5 and 6 with the revived mode in Figs. 7 and 8. The depressed mode is one characterized by the pressures that come from decaying buildings, low incomes, and social disorientation. But the revived mode also contains pressures. The revived mode is sustained by the housing shortage and the legal and tax pressures that generate a steady demolition and replacement of old buildings. But everyone in the system will want to alleviate the pressures. Active industry will want more employees; residents will want more floor space; and outsiders will want housing so they can move to the attractive job opportunities. Rents will be high. These pressures are easy to relieve by increasing the fraction of the land area permissible for housing, by keeping old buildings in place longer, and by allowing taller apartment buildings. But such moves will start the area back toward the depressed mode. We must decide the kind of system we want with knowledge of and acceptance of the accompanying pressures. Instead, much of our social legislation of the last several decades has consisted of trying to

relieve one set of pressures, after another. The result is a system mode characterized by inflexibility, conformity, crowding, frustration, supremacy of the organization over the individual, and a choking of the environment. And the resulting pressures, acting through the counterintuitive and short versus long-term reversal characteristics of complex systems, may well move us further in the same direction.

I am suggesting that the time is approaching when we can design social systems to obtain far better behavior. Different policies could change our urban areas from ones that are designed to deteriorate into ones that are designed for self-renewal. One can foresee a time when we will understand far better the relationships between monetary policy, interest rates, unemployment, and foreign exchange. Already such studies have thrown new light on the processes of corporate growth, on the reasons for product stagnation and loss of market share, and on the growth and decline of cities.

To design new policies for social systems requires a level of skill that is rare. The kind of system modeling and policy design I have been describing requires a professional training at least as extensive as that in any of the established professions. The proper training requires theory, laboratory, case studies, apprenticeship, and practicing experience.

This article is based on a paper that originally appeared in *The Engineer and the City*, proceedings of a symposium sponsored by the National Academy of Engineering, October 22-23, 1969. Proceedings are available from the Academy, 2101 Constitution Avenue, Washington, D.C. 20418.

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3. Forrester, J. W., *Principles of Systems*. Cambridge, Mass.: Wright-Allen Press, Inc., preliminary printing of first ten chapters.

**Jay W. Forrester (F)** is professor of management at the Massachusetts Institute of Technology, where he directs research and teaching in the field of industrial dynamics. Dr. Forrester was graduated from the University of Nebraska with high distinction in 1939. That same year he joined M.I.T. as a research assistant in electrical engineering. Two years later he became a member of M.I.T.'s newly formed Servomechanisms Laboratory. Prior to his present position, which he assumed in 1956, Dr. Forrester was head of the Digital Computer Division of M.I.T.'s Lincoln Laboratory. In this capacity he guided the military operational planning and technical design of the Air Force SAGE system for continental air defense. He holds the basic patent for "random-access, coincident-current magnetic storage," which is now the standard memory device for digital computers.

In 1967 Dr. Forrester was elected to the National Academy of Engineering. He is a Fellow of both the American Academy of Arts and Sciences and the Academy of Management. In 1969 he received the honorary doctor of science degree from Boston University in recognition of contributions to computer technology, air defense, and urban dynamics. Also in 1969, the Danish Academy of Technical Sciences awarded him the Valdemar Poulsen Gold Medal. Dr. Forrester is a director of the ALZA Corporation. He is also a member of the American Physical Society, the American Economic Association, and ACM.





JAN 10 1972

# population growth & america's future

an interim report  
prepared by the commission  
on population growth  
and the american future





*One of the most serious challenges to human destiny in the last third of this century will be the growth of the population. Whether man's response to that challenge will be a cause for pride or for despair in the year 2000 will depend very much on what we do today. If we now begin our work in an appropriate manner, and if we continue to devote a considerable amount of attention and energy to this problem, then mankind will be able to surmount this challenge as it has surmounted so many during the long march of civilization.*

Richard Nixon  
July 18, 1969



an interim report to  
the president and the  
congress from the  
commission on population growth and the american future.



COMMISSION ON POPULATION GROWTH AND THE AMERICAN FUTURE

726 JACKSON PLACE, N. W.  
WASHINGTON, D. C. 20506

March 16, 1971

To the President and Congress of the United States:

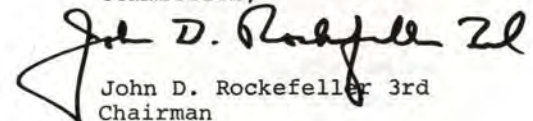
I have the honor to transmit for your consideration this Interim Report of the Commission on Population Growth and the American Future, pursuant to Sec. 8, PL 91-213.

In this report, we discuss the population situation in the United States, and outline the questions we are raising about the probable impact of future growth.

During the coming year, the Commission will continue to gather and assess information on a wide range of population-related issues. The Commission's program of research and public hearings will examine the relationship between population growth and the quality of life in the United States, and the issues that would be involved if the Nation were to develop an explicit policy on population.

We shall present our findings and recommendations in our Final Report a year from now.

Respectfully submitted for the  
Commission,



John D. Rockefeller 3rd  
Chairman

The President  
The President of the Senate  
The Speaker of the House of Representatives



**The Commission on Population Growth and the  
American Future**

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## population in perspective

# 1

The time has come to ask what level of population growth is good for the United States. There was a period when rapid growth made better sense as we sought to settle a continent and build a modern industrial Nation. And there was a period, in the 1930's, when a low birth rate was cause for concern. But these are new times and we have to question old assumptions and make new choices based on what population growth means for the Nation today. Despite the pervasive impact of population growth on every facet of American life, the United States has never developed a deliberate policy on the subject. There is a need today for the Nation to consider population growth explicitly and to formulate policy for the future.

Our population reached 100 million in 1915; it now numbers something over 200 million; the Nation had better get ready for 300 million; it may soon have to decide whether it wants 400 million. Should we look forward to celebrating the arrival of the third and fourth hundred million as we did the second hundred million? Whether or when we reach these totals will depend on what American couples do in the decades just ahead.



Such large differences in population size result from small differences in family size. For example, if families in the United States have only two children on the average and immigration continues at current levels, our population would still grow to 266 million by the end of the century; if they have three children, the population would reach 321 million by then. One hundred years from now the two-child family would result in a population of 340 million persons; the three-child average would produce nearly a billion.

The difference is important not simply because of the numbers but because it bears vitally upon a fundamental question about the Nation's future: Do we wish to continue to invest even more of our resources and those of much of the rest of the world in meeting demands for more services, more classrooms, more hospitals, and more housing as population continues to grow? Or should we concentrate our energies and resources on improving the quality of existing services and extending them to large numbers of our people for whom the "quality of life" still means just getting a square meal?

### ... a difference of one ...

Small differences in family size will make big differences in the demands placed on our society. That difference of only one child per family over just the next thirty years will have important consequences for the educational system.

If families average three children, in the year 2000 elementary school enrollment will be 50 percent above what it would be if families average only two children. Similarly, secondary school enrollment will be 43 percent higher and college enrollment 34 percent higher. In dollar terms, the three-child family implies that total annual costs of education will be nearly \$40 billion more (in 1969 dollars) in the year 2000 than for a population resulting from a two-child family. This would mean a 30

**HOW MANY CHILDREN WOULD BE STARTING SCHOOL?  
EFFECT OF 3-CHILD FAMILY vs. 2-CHILD FAMILY.**

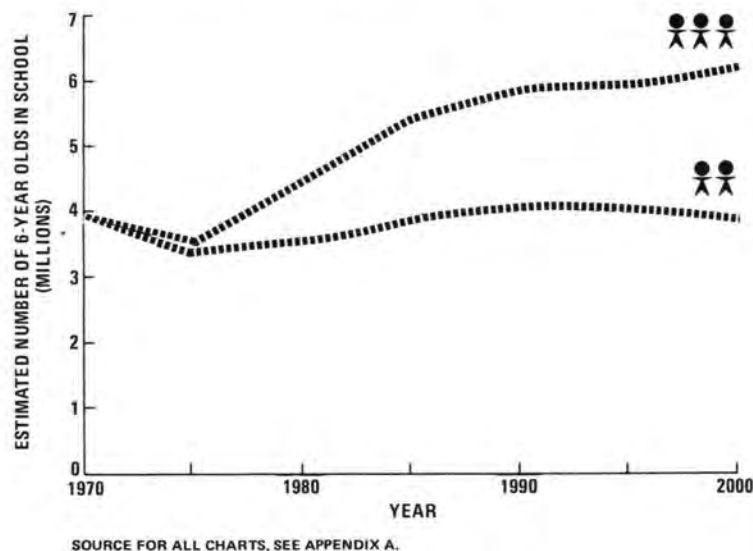


Figure 1

percent higher level of educational expenditures per working member of society. An average of three rather than two children will require more than one million extra teachers just to maintain present student-teacher ratios.

In the health field, the three-child family implies an annual cost of \$14 billion more in the year 2000 than the two-child family just to maintain present standards. If health costs continue to rise as they have in the past, the difference would exceed \$30 billion. If the three-child family is the norm in the year 2000, the economy will have to produce 20 percent more than would be necessary to provide the two-child family with the same standard of living. This could mean a higher level of resource use and environmental pollution.



The importance of these differences in costs is not that the Nation would be unable to meet the demands of a larger population, but simply that a lower rate of population growth provides more options for the use of our resources.

**. . . addressing the issue . . .**

We have all heard about a population problem in the developing nations of Asia, Africa and Latin America, where death rates have dropped rapidly and populations have exploded. Only recently have we recognized that the United States may have population problems of its own.

There are differing views. Some say that it is a problem of crisis proportions—that the growth of population is responsible for pollution of our air and water, depletion of our natural resources, and a broad array of social ills. Others point to recent declines in the birth rate and assert that the problem is disappearing. Still others claim that our problems are caused by the way our population is concentrated in metropolitan areas, by the amounts an affluent people consume and discard, by new products and technologies, or by inequities in access to the better things of life.

Our view, at this stage of our inquiry, is that population growth of the magnitude we have had since World War II has aggravated many of the Nation's problems and made their solution more difficult. The point was stated by President Nixon in his Population Message of July 18, 1969, when he said:

"I believe that many of our present social problems may be related to the fact that we have had only fifty years in which to accommodate the second hundred million Americans."

And, the longer we delay addressing the issue, the more costly and arduous the task becomes because the popula-

tion—and the number of potential future parents—will have grown that much more in the intervening years. The cumulative nature of population growth requires us to take the long view. The children born in this decade will be parents of most of the children born in the year 2000. What we do now will have real impact then. It is a challenge that Americans have rarely been called upon to face.

We are not saying that population growth continued at current rates portends an immediate crisis for the country. There is little question that the United States has the resources, if it chooses to use them, to meet the demands of a population growing at the current rate as well as to correct various social and economic inequities, as the President's National Goals Research Staff recently indicated. And it is equally true that our social and economic problems would not be solved by the stabilization of population alone. We are simply saying that population growth is important. It makes a difference.

The tension between population and the economy, population and the environment, population and government services, is with us at all times in different forms and degrees. Whether we wish to alter it or to live with it, we cannot afford to ignore it. It is time that population issues were given deliberate, impartial consideration.

This is necessary whether the birth rate is going up or down. Some Japanese leaders are publicly worrying about the low birth rate in their nation. Similar concerns have been voiced by responsible leaders of several eastern European countries. Indeed, if birth rates in the United States were to resume their recent decline, in future years we might be worrying about the same thing.

**. . . to confront the problems . . .**

In his Population Message to Congress, President Nixon urged the Nation to confront the problems posed by national population growth and to develop means of coping with them. At the President's request, Congress estab-



lished the Commission on Population Growth and the American Future—the first such body ever appointed in the United States—to examine the probable course of population growth and internal migration in the United States between now and the year 2000; to assess the problems this will pose for our government, our economy, and our resources and environment; and to make recommendations on how the Nation can best resolve these problems. (See Appendix C)

A year hence, in our final report, we will present our findings and recommendations. Between now and then, the Commission will be gathering the facts on population and its probable future change, examining how and to what extent this change is likely to affect the quality of life in the United States, conducting public hearings, reviewing the policy alternatives open to us, and deciding which courses to recommend.

It is our purpose in this Interim Report to encourage a rational discourse on population matters among the American people. In the remainder of the report, we outline the population situation in the United States and the issues it poses, the questions we are raising about the probable impact of future population growth and distribution, and how we are going about finding answers to these questions. Finally, the report reviews some of the issues which would be involved if the Nation were to develop an explicit national population policy.

## the prospects for population change

# 2

Every day in the United States an average of almost 10,000 babies are born, about 5,000 persons die, and over 1,000 more persons enter the country than leave. This adds up to a net increase in total population of about 6,000 a day or over two million persons a year.

These population numbers reflect life and death and new opportunity for the individual. For society, the balance of births and deaths and migration is profoundly important; the effects are long range and the consequences of great significance.

Recent Census Bureau figures indicate that if families average three children over the next few decades and immigration continues at present levels, our population will reach 300 million in 1996, only a quarter-century from now. If we average two children, that day will be postponed another 25 years to the year 2021. We are currently reproducing at a rate roughly midway between two and three children, which would bring us to 300 million around the year 2008.

The Census Bureau figures are not intended to be forecasts. The birth rate changed so rapidly in the past few years that last year the Census Bureau had to revise down-



ward the projections it had issued only three years before. So, it would be possible for the Nation to reach 300 million after these dates, or conceivably before. But it appears highly likely that we **will** reach that figure.

It may seem odd, when we have only recently passed the 200 million mark, to be saying that we are fairly well assured of reaching 300 million. Population growth tends to develop its own momentum which makes it difficult to stop, no matter how hard the brakes are applied. Even if immigration from abroad ceased and families had only two children on the average—just enough to replace themselves—our population would continue to grow until the year 2037, when it would be a third larger than it is now.

This momentum is the legacy of past population growth. Thirty years ago, in 1940, we had a population of 132 million people. After all the births, deaths and new immigrants over the following 30 years were balanced out, by 1970 we had a population of 204 million and a net gain of 72 million. Because of the baby boom, the number of persons now moving into the childbearing ages is much larger than previous generations of parents. In 1975 there will be 5½ million more people in the prime childbearing ages of 20 to 29 than there were last year. By 1985, the figure will have jumped still another 5½ million. This will exert strong pressure toward increasing the number of births.

Right now about 80 percent of our annual population growth results from natural increase—the amount by which births exceed deaths. About 20 percent of our current growth is due to net immigration; the number has been averaging about 400,000 annually. Historically speaking, that is not many. In the years just before World War I, the figures ran to twice that, at a time when the United States had less than half the number of people it has now.

Even so, the long-term effects of immigration are large. This is partly because most immigrants enter the country

in young adulthood, at an age when their childbearing is at its peak. If the average family (including immigrants) had two children, and immigration continued at 400,000 per year, the survivors and descendants of immigrants in the next 30 years would number 16 million in the year 2000, and would have accounted for one-fourth of the total population increase during that period. Over the next 100 years immigrants and their descendants would account for nearly half of the increase in population from 204 to 340 million.

... **a fourth hundred million?** ...

If it seems odd to be thinking now about our third hundred million, it may seem absurd to raise the question of a fourth hundred million. However, whether we add that fourth hundred million may be determined by what Americans do about family size and population in the next couple of decades.

The children born in this decade will be parents in the year 2000, and they will contribute most of the births occurring in that year. So the number of births thirty years hence depends heavily on the number of children born in the 1970's and the reproductive patterns they follow when they come of age.

An average of three children per family in the future, as unlikely as that appears at the moment, would give us a population of 400 million in the year 2014, less than a half-century away. With an average of two children, we could forget about the fourth hundred million if immigration were not a factor.

When we speak of two or three-child families we are talking about averages which can be made up by many possible combinations of families of different sizes, ranging from childless couples to those with many children.

A vocal group of concerned citizens is calling for population growth to stop immediately. While there are a variety of paths to ultimate zero growth, none of the feasible



**WILL THE U.S. ADD A FOURTH 100 MILLION TO ITS POPULATION?  
EFFECT OF 3-CHILD FAMILY vs. 2-CHILD FAMILY.**

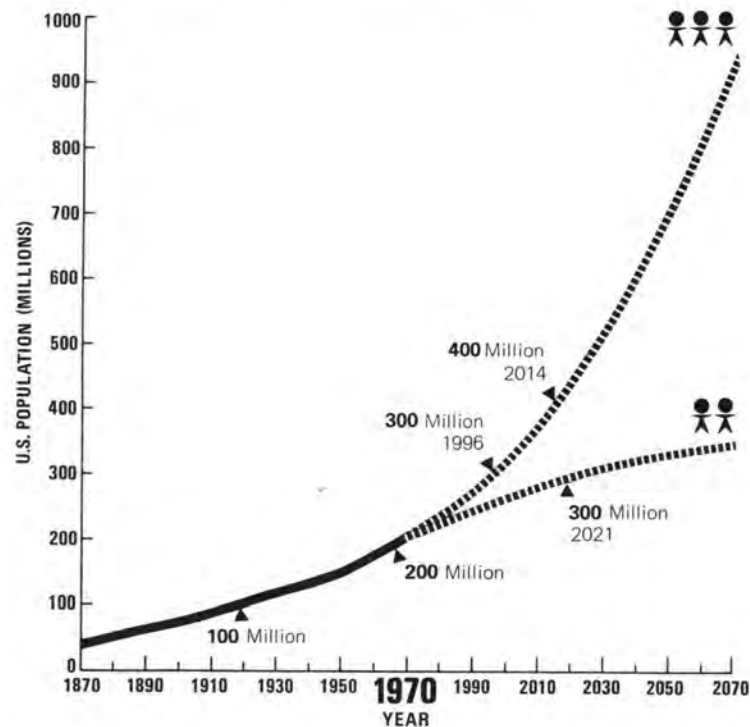


Figure 2

paths would achieve it immediately. Our past rapid growth has given us so many young couples that they would have to limit their childbearing to an average of only about one child to produce the number of births consistent with immediate zero growth. Ten years from now, the population under 10 years old would be only 43 percent of what it now is, with disruptive effects on the school system and ultimately on the number of persons

entering the labor force. Thereafter, a constant total population could be maintained only if this small generation in turn had two children and their grandchildren had nearly three children on the average. And then the process would again have to reverse, so that the overall effect for many years would be that of an accordion-like mechanism requiring continuous expansion and contraction.

We doubt that such consequences are intended by the advocates of immediate zero population growth.

... two-thirds of our people ...

The growth of population in the United States has been interwoven with the movement of our people across the face of the land.

In 1790, the four million people of the United States occupied a narrow coastal area along the Atlantic. Today, one-third of our people live west of the Mississippi, and our most populous State is on the Pacific coast.

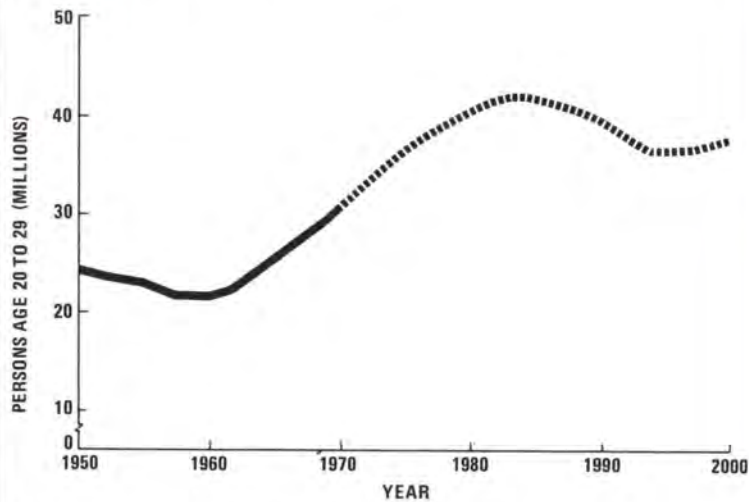
When the United States was formed, 95 percent of our people were rural, living on farms and in towns and villages. Today, over two-thirds of our people live in metropolitan areas and many more live in cities and towns outside metropolitan areas.

In the 1960's more than three-fourths of our Nation's growth occurred in metropolitan areas, with the suburbs absorbing most of it. Suburbanites now outnumber those living in central cities. The farm population dropped from 15 to 10 million, and about one-half of the Nation's three thousand counties lost population. Another one-fourth of the counties had slow growth rates because more people moved out than moved in. Migration patterns continued from mid-country out to coastal areas.

In contemporary discussion of population growth and its effects, we hear the view that the population problems of our society are caused more by the concentration of population in large urban areas than by the size and growth of the total population; that, therefore, we should



AN AVERAGE OF 2 CHILDREN PER FAMILY WOULD SLOW POPULATION GROWTH, BUT WOULD NOT STOP IT SOON BECAUSE THE NUMBER OF PEOPLE OF CHILDBEARING AGE IS INCREASING...



...SO EVEN IF FAMILY SIZE DROPS TO A 2-CHILD AVERAGE...

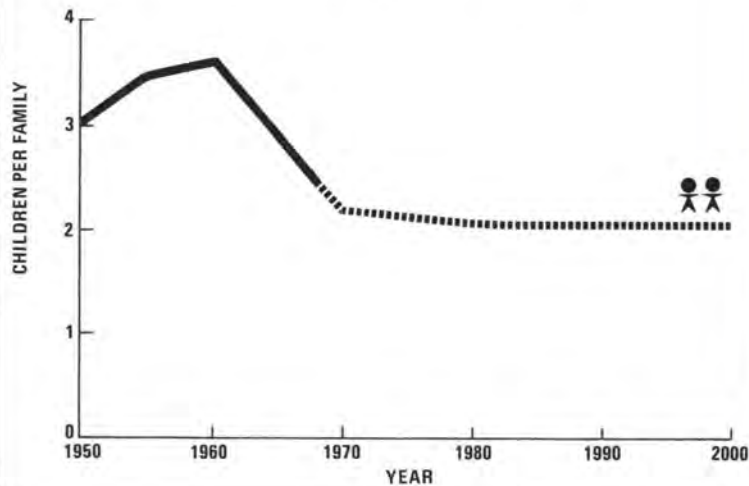
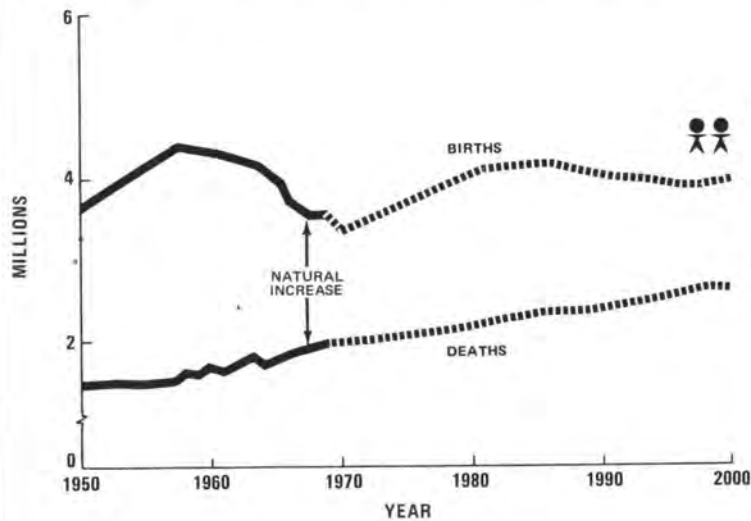


Figure 3

...THE RESULTING BIRTHS WILL CONTINUE TO EXCEED DEATHS FOR THE REST OF THIS CENTURY...



...SO THE POPULATION WILL STILL BE GROWING IN THE YEAR 2000, BUT AT A DECREASING RATE.

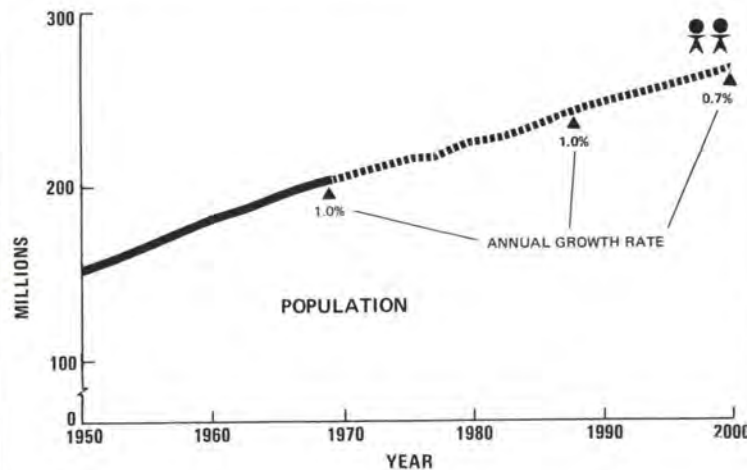


Figure 3 continued



be worried less about the number of people in the United States than about the way they are distributed geographically; and that government efforts should be devoted to achieving greater geographical dispersion of growth.

The issue is not that simple. Many of our largest cities have actually lost population. It is their suburbs and metropolitan areas of intermediate size that have grown rapidly in the past decade. Furthermore, we already are a metropolitan people. Two of every three Americans now live in metropolitan areas and this trend is continuing. This means that the size of the total population and the size of the metropolitan population are becoming increasingly synonymous and that metropolitan population growth will increasingly reflect changes in national birth rates. Over the past decade alone, 70 percent of the growth of metropolitan population occurred as a result of natural increase. If there had been no net migration at all to metropolitan areas, these areas would have experienced most of their growth anyway.

The decline of many rural counties is often cited as cause for concern and indeed it does create many problems. But the numerical impact of this process should not be overestimated. If the 1,100 rural counties that declined in population since 1960 had actually kept pace with the national rate of growth, their population in 1970 would have been only two million greater than it was, and they would have absorbed only nine percent of the Nation's growth for the decade.

The point is that national population growth and geographical distribution cannot be treated as an either-or affair. The distribution of population is problematic in many ways. But the choice among ways to redirect growth does not eliminate the necessity of making a choice about when the Nation could best accommodate 300 million people or whether it should accommodate 400 million.

. . . to know where we are going . . .

Since knowing where we are and have been helps us to know where we are going, the Commission is using the results of the 1970 Census and earlier censuses to gain an understanding of the growth, transformation and redistribution of the population of the United States in this century.

The Commission's research on prospects for population growth includes projections of population and population characteristics and studies of the importance of unwanted childbearing, the demographic impact of immigration, abortion, voluntary sterilization and family planning programs, the future of contraceptive technology, and the level of popular education about population.

With regard to the distribution of population, the Commission is preparing projections of regional and metropolitan growth, examining the implications of economic changes for redistribution of population, studying the ways in which distribution patterns compound national problems, and investigating the factors which influence individual decisions to move.

Appendix B lists the Commission's research projects.



## population and the quality of life

# 3

Given a likely population of 300 million sooner or later, the questions before us are: Is it in the national interest to reach that level later rather than sooner? What demands are implied by the growth that is to be expected? And, what difference will it make whether we grow to 400 million after that?

Much discussion these days implies that population growth is bad, just as not very long ago one heard, from a different point of view, that it was good. No such simple judgments can be made. To consider population growth or concentration as the root cause of our Nation's social and environmental ills is clearly simplistic. Such an interpretation confuses how things are done with how many people are doing them. For example, rapidly rising levels of per capita consumption, and technological mismanagement, appear to contribute more to environmental pollution than does a gradual rise in total population.

More importantly, population growth matters not in its own right but because of its potential impact on many values that Americans hold about our environment and resources, our economy, our government and our social order. The question is: What does population growth have to do with such values and with the systems necessary for their achievement?



### ... resources and the environment ...

There is little reason to believe that population growth will cause food shortages in the United States, but serious questions have been raised about the effects of continued population growth on our own and the world's resources, and on the pollution of our land, air and water. Even though population growth is not the primary cause of environmental deterioration, it may well magnify problems arising from the way we use our resources and technology.

At our present level of consumption, a continually growing population makes demands upon many resources, some of which are in scarce supply. There is a question whether continued growth will cause us to exhaust some important resources, or whether the market system, with a dynamic economy, can develop substitutes for resources in short supply. For some resources, such as wilderness, there are no substitutes. Economists and ecologists have been enlisted by the Commission to determine the effects on the environment of population growth, of technological change and of changes in demand resulting from greater affluence.

To the extent that environmental problems are aggravated by population growth, it is important to determine the environmental implications of the way in which our population is distributed—the effects of local population concentration as well as national growth.

Some contend that the country could easily accommodate more people if our population were spread more evenly. It is not how many people we have, they say, but how they are distributed across the Nation. This is only a partial answer. Clearly, some of our urban problems are due to high concentrations and poor planning. On the other hand, people consume resources wherever they live. Whether in New York City or a small town in the midwest, they still drive an automobile fabricated of steel produced in Pittsburgh using coal mined in West Virginia. In the

process, the air of Pittsburgh is polluted by smoke and the scenery of West Virginia by strip mining. Wherever Americans live, they make huge demands on the Nation's and the world's resources and ecological systems.

People in small towns can despoil their rivers and air just as people in New York have done. A large city might actually be better able to afford ecologically sound solutions to many environmental problems. So simply redistributing the population might not solve many of the population-related problems we face.

Moreover a large population such as ours might not be able to live at its present standard of consumption without high concentrations of people and economic activity. We could not drastically alter distribution patterns without radically altering our way of life. Even so, it may be desirable to slow or stop the growth of very large metropolitan areas. And as we have said, it would be very difficult to do this without slowing the growth of the total population.

### ... the economy ...

There are several points of view on how different rates of population growth might affect the economy of this country. In the past, some predicted that declining population growth would cause economic stagnation, unemployment, and a lower standard of living. Some contemporary observers maintain that a slower rate of population growth would increase the Nation's prosperity while reducing the costs associated with growth. Still others note that our economy is flexible and has shown many times that it can adjust to changes in demand. They suggest that with proper economic policies the rate of population growth is largely irrelevant to national economic prosperity.

Regardless of the effects of population change on the total economy, it is clear that some industries and businesses will gain and others will suffer as a result of chang-



ing growth rates and shifts in age composition. Various adjustments within the economy will be necessary, as is always the situation with changes in population growth, and we need to know what adjustments are likely to be required.

In addition to affecting the demands for different products, population growth also affects production in other ways. Most importantly, the number of births ultimately affects the size of the labor force and its age composition.

The effect of population growth on various private and public sectors of the economy is being investigated. Some industries with important components in the public sector such as education, health, housing and transportation, are strongly affected by population growth and redistribution. The public expenditures that will be required to accommodate expected growth in the next 30 years are being assessed. Changes in population growth rates can seriously affect certain private sectors of the economy whose markets are geared to particular age groups. Some industries, such as those in children's markets, would be affected very quickly by reduced rates of growth; others would be affected more slowly.

Continued population increase has implications for the delivery of certain social services beyond simply their pocketbook costs. In some fields, further growth may require considerable changes in methods of delivery just to maintain adequate service levels.

For example, even if money were no problem, various constraints affect health care. It is difficult to increase the rate at which doctors are produced. The training is long, difficult, and expensive. Good medical schools require costly equipment and highly skilled faculties commanding top salaries. Because of long training and internship requirements, decisions that will affect the future supply of physicians must be made years in advance. It may also be difficult to expand adequately the supply of nurses and trained technicians. Higher rates of popula-

tion growth magnify burdens on personnel in short supply, which could lead to further depersonalization of medical care. If health care has deteriorated because of inadequate facilities and overworked personnel, higher rates of population growth can make these problems more difficult to solve. In addition to growth, the increasing concentration of people and medical facilities in metropolitan areas has resulted in some serious imbalances of population and medical services.

### . . . government . . .

What are the governmental and political implications of population growth, over and above the costs of public services? Our analysis is concentrated on the possible impact of population growth on the quality of government in the United States in the coming decades, and upon the individual's participation as a citizen.

At the local level, the influence of population growth upon the quality of government seems clear. The quality of metropolitan government is likely to depend on the rapidity of population growth and on the number of different governments attempting to meet public service needs. For example, where court dockets are heavily crowded, justice is not likely to flow in the same fashion as where they are not.

Much of our research effort on the implications of population growth for local government concerns metropolitan areas, where most of our people now live. We are considering the increasing complexity and layering of local government generally found in such areas, the differences between cities and suburbs with regard to public service needs and the resources to meet them, and the problems of governmental response to future expansion of metropolitan areas.

In studying the effects of population growth on Federal and State government there is less to rely on than at the local level. We hope to open several new areas of



inquiry, such as the effects of growth on the role of legislators, on the output of State legislatures, and on the ability of the Nation to unite around a national issue.

There is also a range of questions about the effects of population growth and movement on how individuals participate as citizens. The political attitudes of those who migrate from areas of rural poverty to urban ghettos are not likely to remain the same, nor are their expectations of governmental services. The same is likely to be true of those who move to the suburbs. Place of residence—and hence the relative growth of different areas—may make a profound difference in political attitudes and behavior.

For centuries the size of population and national security have been connected in the popular mind. What is the relationship between population and national security in the modern, technological society? How is this relationship affected by the geographical distribution of the population?

#### . . . society . . .

The Commission is examining the future of the family in the United States as reproduction comes increasingly under voluntary control. In what ways will the family of the future differ from the family of today? What are the implications for the health and development of children if family size diminishes?

Changes in family size will have far-reaching significance for a variety of social processes, not the least of which is the role of women in our society. Reductions in family size imply that women will spend less time in childbearing and child rearing activities and thus have more time available for work on other interests. Basically, the effect of such a change would be to increase the options available to women; one such option would be to devote more time to fewer children, perhaps improving the quality of parenthood. We are examining the effects of changing birth rates on the size of the female labor

force, opportunities for women to have careers, and greater equality and participation of women in the affairs of the society. And, we are looking at the other side of the coin, the extent to which current levels of childbearing—wanted as well as unwanted births—result from the relatively limited range of roles many women occupy.

Some of the implications of the cessation of population growth for society are being explored. A few other nations that have come close to stabilizing population might serve as models of the future, although cultural differences make such inferences precarious. Certainly one demographic consequence of the decline of the birth rate is the aging of the population. In a population where births equal deaths, at the low levels of mortality prevailing in the United States, the proportion of people over 60 would be the same as that under 15 and the average age of the population would be 37 rather than 28 as at present. The implications of such a difference for rates of social change and opportunities for advancement must be examined.

At local levels such situations can be seen in places that have lost population. The emptying out of rural areas has meant a loss of young adults and a decline in the kinds and quality of services available. The impact of rural-urban migration on those who stay behind and on the communities in which they live is being examined. We are also evaluating the advantages and disadvantages to those who migrate to urban centers and the extent to which rural migrants contribute to the problems of urban areas.

In sum, what are commonly referred to as population problems can be viewed more profitably as environmental, economic, political and social problems that are aggravated by population growth and density. The closest thing to a "population problem" in the pure sense is the speculation that increases in the sheer density of numbers have undesirable effects on social behavior. We regard



population growth, however, as an intensifier or multiplier of many problems impairing the quality of life in the United States.

## policy issues 4

The Commission is devoting its second year to a detailed examination of the probable course of population growth and distribution and their environmental, economic, political and social implications. The aim is to determine what population prospects inevitably must be accommodated in the short run, and what kind of national population policy is desirable now for the long run. The concerns of overriding importance are whether population stabilization and redistribution of the population are desirable.

The Commission views population policy not as an end in itself but as a means to facilitate the achievement of other social goals desirable in their own right. Such goals would include improvements in the status of women, in the socioeconomic conditions of disadvantaged minorities, and in the health and opportunities of children born because they were wanted, as well as the easing of pressures on our resources and physical environment, health and educational facilities, and the problems of our cities.

The content of a population policy would not be immutable, but would need to be adjusted over time in the light of emerging developments, increased knowledge, and



changing attitudes of both policymakers and the general public. Thus, the Commission sees national population policy as an evolving rather than a static instrumentality.

... freely to choose ...

A key consideration for population policy is the current level of unwanted childbearing. This information is necessary to determine how much movement toward the cessation of population growth might ultimately result simply from preventing unwanted births. The sum of individuals' real preferences may in fact coincide with the welfare of society as a whole. There is some evidence (from the 1965 National Fertility Study) that the elimination of unwanted births would result in fertility levels ultimately commensurate with near-zero growth. If this conclusion is valid for 1970 (the 1970 National Fertility Study now underway will provide the basis for such a judgment), the policy implications can hardly be overestimated because the national objective could be attained by enabling individuals to achieve their own preferences.

Estimates made in 1965, based on married women's own reports about their childbearing experience, indicated that one-third of the married couples who did not intend to have any more children already had at least one unwanted child. In the period 1960-65 nearly 20 percent of all live births were reported as unwanted by their parents. Only one-fourth of all parents claimed to have been completely successful in preventing both unwanted and unplanned pregnancies.

The 20 percent of births reported as unwanted by their parents represent nearly five million children born between 1960 and 1965 who theoretically would never have been born if their parents' desires had prevailed. Fortunately many of these unwanted pregnancies and births become wanted children. But many do not.

Over and above the demographic significance of current levels of unwanted births, are the serious costs for

**HOW MANY BIRTHS ARE UNWANTED?  
ONE FIFTH OF ALL U.S. BIRTHS, 1960-65, WERE UNWANTED.**

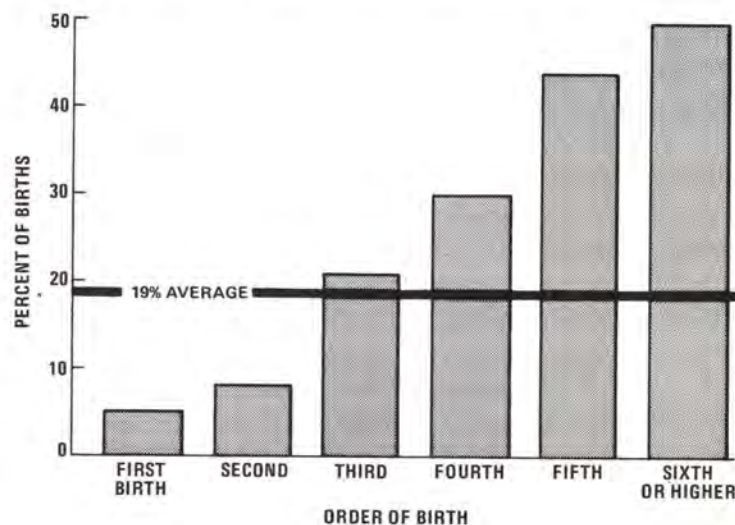


Figure 4

both individuals and society. For many, it means poor prospects for employment and limited opportunities for themselves and their children. For others, the costs are measured in increased family stress and unhappiness, altered life plans, and less time and attention for each child. Unwanted pregnancy sets off a chain of events which acutely forecloses the life-chances of some young people; it leads to dropping out of school, precipitous marriage or an out-of-wedlock birth. Unwanted childbearing is associated with serious health consequences such as increased incidence of prematurity, mental retardation, infant and maternal mortality, and physical and emotional neglect and abuse.

While the incidence—and the consequences—of unwanted births are especially acute among low-income



couples, it would be erroneous to regard the problem as one associated only with poverty. Couples in all socio-economic groups have unwanted pregnancies and experience its costs.

Fortunately, unwanted childbearing is a problem we can do something about. Voluntary family planning has become a prevailing pattern in American life, practiced in some fashion at some time by almost all couples, regardless of income, class, religion, or color. Whether Americans are able freely to choose if and when to have children depends largely on the priority which we as a society are willing to devote to policies, and research and educational programs, to reduce unwanted pregnancy.

In 1970, the Congress, by overwhelming majorities of both House and Senate, adopted the Family Planning Services and Population Research Act of 1970 (P.L. 91-572), a measure signed into law by President Nixon this past December. The Act encourages the birth of wanted children and assists couples in preventing unwanted conception. The Commission endorses this significant advance toward the reduction of unwanted childbearing, and believes that this policy should be implemented promptly.

We shall return to this question in our final report, to estimate the level of governmental and private resources—financial, manpower and institutional—which would be necessary for a comprehensive national effort. We are also examining State laws still in force which impede the dissemination of family planning services to certain classes of individuals, and the impact of other policies and programs on the opportunity for couples to secure modern family planning services.

**. . . not an easy task . . .**

If it turns out that the prevention of unwanted births should be the main target of a growth policy, the goal would be to maximize popular information and under-

standing about how to control fertility, and to accelerate the development of more effective techniques and facilities for limiting childbearing. This will involve the Commission in further considerations of family planning services and education, contraceptive technology, adoption and abortion. These all pose moral and ethical complexities which the Commission is considering.

On the other hand, if population stabilization is desirable and its achievement would require more than eliminating unwanted childbearing, then additional measures can be considered, such as changes in tax laws, the elimination of pro-natalist laws and programs, and educational programs. Some of the policy issues that would then be involved are much more difficult and potentially more controversial than those related to the prevention of unwanted childbearing. It would not be an easy task to develop acceptable measures that would lead to a slowing and eventual end of population growth. The best kind of national population policy would be one that serves the general welfare by promoting informed individual choice.

One obvious and fundamental change desirable in its own right, quite aside from its demographic impact, is to increase the opportunities for women to pursue activities other than exclusively domestic and childbearing roles. As the experience of other countries indicates, when women are able to work, birth rates decline.

As we have seen, population growth is also affected significantly by immigration. Should the volume of immigration be reduced? The historical role played by immigration in the growth of this country and our tradition as an open society make this question especially disturbing.

The issues with regard to the distribution of the population arise from the transition of the United States from an agrarian to an industrial and service economy and from a rural to a metropolitan way of life. The Commission seeks to identify the major stress points in this transition—



stresses generated in the process of regional redistribution, metropolitan growth, the rapid expansion of suburbs and the depopulation of large areas of the country.

If it appears desirable to redirect growth, it will be important to know how this might be done. The Commission is studying internal migration and the characteristics of migrants, to find out at what stages in their career and life-cycle people might be responsive to incentives to move or stay.

A principal question is the role that Federal and State governments play in population affairs. Although the Federal government does not have an explicit, comprehensive population distribution policy, many of its policies, programs and statutes seem to have an impact on population distribution incidental to their main objectives. This inadvertent impact may be seen, for example, not only in the Federal Interstate Highway System, but also in the Federal Housing Administration program and federal procurement policies. Others, such as the Economic Development Administration, the New Communities Act and the urban renewal program, are designed in part to redirect growth.

We also have many laws directly or indirectly affecting the growth of population, such as those governing immigration, marriage, divorce, contraception and abortion, which require examination.

Basic to all population policy questions are the underlying legal, ethical and political issues. Constitutionality does not guarantee ethical acceptability, and Americans support a broad variety of ethical views that must be taken into account in any formulation of policy.

This, then, is the way the Commission views its task. We do not take future population trends as inevitable. We believe that there are short-run population trends already in process that simply must be accommodated, but that the longer-run future hangs in the balance. And it is not simply population growth itself that is the issue, but rather

the quality of life that can be influenced so fundamentally by population. We have the challenge, and indeed the responsibility, to prepare for the future of coming generations of Americans.



## appendix a

### sources of data

The figures on future population in this report are based on the Census Bureau's *Current Population Reports*, Series P-25, No. 448, "Projections of the Population of the United States, by Age and Sex (Interim Revisions): 1970 to 2020," and unpublished extensions of these projections.

The Census Series B projection is used here to show how the population would grow if families had an average of 3 children. The Census Series E projection is used to show population growth if the average were 2 children per family.

Both Census series assume that net immigration to the United States will continue at recent levels of about 400,000 per year. Both assume a slight increase of about 1½ years in the average expectation of life between now and the year 2000. They differ in what they assume about the rate of childbearing.

Series B assumes that in the future women will be giving birth at an "ultimate" rate which works out to an average of 3.1 children per woman over her lifetime. The transition from the 1968 rate of 2.5 to the "ultimate" future rate is not instantaneous in the projections, but most of the transition is assumed to occur by 1980.



The 3.1 figure is an average for all women, regardless of marital status. In the present-day United States almost all women (95%) marry at some time in their lives, and many of those who do not are exposed to the possibility of childbearing. So the Series B rate of childbearing represents a reasonable approximation to an average family size of 3 children.

Census Series E assumes an ultimate rate of childbearing that works out to an average of 2.1 children per woman over a lifetime. This is the rate at which the parental generation would exactly replace itself. The extra .1 allows for mortality between birth and the average age of mothers at childbearing, and for the fact that boy babies slightly outnumber girl babies.

Different generations born in the twentieth century have reproduced at widely varying average levels, some exceeding three children (as did the women born in 1930-1935) and some approaching two (as did women who were born in 1905-1910). The fact that major groups in our modern history have reproduced at each of these levels lends credibility to projections based on either of these averages.

The sources of data for charts in this report are as follows:

#### Figure 1

Data are unpublished Census Bureau projections of the number of 6-year-olds enrolled in school each fall. The enrollment rate, or proportion of the 6-year-olds enrolled in school, is assumed to increase from 98.5 percent in 1970 to 99.6 percent in 2000. This assumption is compatible with the trends evident in the enrollment rates since 1950.

The projected numbers of 6-year-olds to which the enrollment rates are applied are consistent with Series B and E as published in the U. S. Bureau of the Census, *Current Population Reports*, Series P-25, No. 448.

#### Figure 2

Estimates of the total population, 1870 to 1900, are from U. S. Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957*. Estimates of the total population, 1900 to 1959, are from the U. S. Bureau of the Census, *Current Population Reports*, Series P-25, No. 311.

Estimates and projections of the total population, 1960 to 2020, are from the U. S. Bureau of the Census, *Current Population Reports*, Series P-25, No. 448. Projections of the total population beyond 2020 are unpublished extensions of these projections.

#### Figure 3

Estimates of the population 20 to 29 years of age, 1950 to 1967, are from U. S. Bureau of the Census, *Current Population Reports*, Series P-25, No. 311, No. 321, and No. 385.

Estimates of births, deaths, and total population from 1950 to 1960 are from the U. S. Bureau of the Census, *Current Population Reports*, Series P-25, No. 442.

*Current Population Reports*, Series P-25, No. 448 is the source of estimates and projections of the population 20 to 29 years of age from 1969 to 2000, the total fertility rate (termed "average number of children per family" in this report) from 1950 to 2000, births and deaths from 1961 to 1991, and total population from 1960 to 2000. Data on births and deaths beyond 1991 are from unpublished Census Bureau projections.

#### Figure 4

Data on unwanted childbearing are from L. Bumpass and C. F. Westoff, "The 'Perfect Contraceptive' Population," *Science*, 169: 1177-1182, September 1970.



## **appendix b**

### **research projects and papers of the commission**

The Commission plans to publish the results of its research in 1972.

#### **projections of population growth, characteristics, and distribution**

Projections to the year 2000 of the:

- Population of the United States
- Nonwhite population
- Number of persons enrolled in school
- Number of households
- Income distribution of families
- Population of each State
- Components of metropolitan/nonmetropolitan population growth.

Bureau of the Census, Department of Commerce

**Projected labor force: 1970 to 2000.**

Denis F. Johnston, Bureau of Labor Statistics in cooperation with Bureau of the Census, Department of Commerce

**Future expansion of metropolitan areas, and their projected population: 1970 to 2000.**

Jerome Pickard, Appalachian Regional Commission and Urban Land Institute



**analysis of births, deaths, immigration and internal migration**

**Growth, transformation, and redistribution of United States population in the 20th century.**

Irene B. Taeuber, Princeton University and Conrad Taeuber, Bureau of the Census, Department of Commerce  
**Demographic significance of unwanted fertility in the United States: 1970.**

Charles F. Westoff, and Norman B. Ryder, Princeton University

**Illegitimacy in the United States.**

Phillips Cutright, Massachusetts Institute of Technology

**Teen-age contraceptive practice and pregnancy in the United States.**

John Kantner and Melvin Zelnik, The Johns Hopkins University

**Demographic significance of the legalization of abortion.**

**Attitudes in the United States toward abortion.**

Christopher Tietze, M.D., The Population Council

**Demographic significance of adoption.**

Staff

**Future course of fertility in the United States.**

Norman B. Ryder, Princeton University

**Foreign experience with replacement levels of fertility.**

Michael S. Teitelbaum, Princeton University

**Demographic paths to population stabilization.**

Ansley J. Coale, Princeton University

**Demographic significance of immigration.**

Richard Irwin, Bureau of the Census, Department of Commerce

**Migration studies, incorporating:**

- Dimensions of the population problem in the United States
- The migration process
- Disparities between individual and collective consequences of population movement
- Impact of immigration on the spatial distribution of population in the United States.

Peter Morrison, RAND Corporation

**Growth of the rural population.**

Calvin Beale, U. S. Department of Agriculture

**Issues in population redistribution.**

Everett S. Lee, University of Georgia

**economic research**

**Impact of future population growth and internal migration on demands for health, education, transportation and welfare services.**

RAND Corporation

**Impact of future population growth and internal migration on demands for housing.**

Staff

**The effects of alternative patterns of future population growth for the national economy: four views.**

Allen C. Kelley, University of Wisconsin

Harvey Leibenstein, Harvard University

Edmund S. Phelps, University of Pennsylvania

Joseph J. Spengler, Duke University

**Critiques of the four views.**

Richard A. Easterlin, University of Pennsylvania

Steven Enke, G.E. TEMPO Corporation

Robert Dorfman, Harvard University

Warren C. Robinson, Pennsylvania State University

**Equity and welfare consideration in population policy.**

Paul Demeny, East-West Center, University of Hawaii

**Pro-natalist influences in federal government fiscal policies.**

Elliott R. Morss, Private Consultant

**Costs of children.**

Staff

**Projections of gross national product and related variables for different population projections.**

Office of Business Economics, Department of Commerce



In addition to the projects listed above, the Commission hopes to develop research on the effects of population growth on specific industries, and the changing functions of cities and the implications for population redistribution.

#### **environmental research**

**Effects of changes in population growth and distribution on resource adequacy and on the quality of the environment.** Among the specific areas to be covered are the effects of population growth and redistribution on:

- **The adequacy of major resource supplies**
- **The adequacy of recreation facilities**
- **Environmental pollution**
- **The ecological consequences of resource use and pollution.**

Resources for the Future, Inc.

#### **Population, resources and environment.**

Paul R. Ehrlich, Stanford University

#### **Population, consumption, technology, and the environment.**

Barry Commoner, Washington University at St. Louis  
**Earth's carrying capacity for people and how this constrains our choices.**

Preston Cloud, University of California, Santa Barbara

#### **political & governmental research**

**The impact of population changes upon the representational and policy-making roles of congressmen and senators.**

Robert L. Chartrand, Library of Congress

#### **Population futures in legislative apportionment.**

Richard Lehne, Rutgers University

**Population and the international system: some implications for United States policy and planning.**

Robert C. North, Stanford University

#### **Population changes and state government.**

John G. Grumm, Wesleyan University

#### **Metropolitan growth and governmental fragmentation.**

Allen D. Manvel

#### **The reciprocal impacts of population distribution and metropolitan government.**

Michael N. Danielson, Princeton University

#### **Adjustment of local government service levels to population change.**

Robert F. Drury

In addition to the projects listed above, the Commission hopes to develop research on several additional topics. These include the impact of population changes upon the administration of justice, national security, and the future of the federal system.

#### **social research**

#### **Socio-economic differences in mortality.**

Evelyn Kitagawa, University of Chicago

#### **Pro-natalist pressures in the United States.**

Judith Blake Davis, University of California, Berkeley

#### **Occupational costs and benefits of immigration.**

Judith Fortney, Duke University

#### **The social aspects of a stationary population.**

Lincoln H. Day, United Nations

#### **Changing status of American women.**

Suzanne Keller, Princeton University

#### **The family and population policy, with special reference to the United States.**

Kingsley Davis, University of California, Berkeley

#### **Social-psychological implications of population density.**

Jonathan Freedman, Columbia University

#### **Economic and social impact of rural depopulation: A case study.**

W. LaMar Bollinger, College of Idaho



In addition to the projects listed above, the Commission hopes to develop research on fertility and women in the labor force.

#### **research on education and information programs**

##### **Population education in the United States.**

Stephen Viederman, The Population Council

##### **Family planning education.**

Sol Gordon, Syracuse University

##### **Citizen attitudes toward population growth, distribution and policy.**

Staff

##### **Supply and demand for family planning services in the United States.**

Frederick S. Jaffe, Planned Parenthood-World Population

##### **Directions of contraceptive research.**

Sheldon J. Segal, The Population Council

##### **American population, family size, community preferences as idealized by American television.**

Richard Heffner Associates, Inc.

#### **policy research**

##### **Congressional-executive relations in the formation of explicit population policy.**

Phyllis T. Piotrow, The Johns Hopkins University

##### **Historical development of values in the American political-legal tradition bearing on population growth and distribution.**

Peter Brown and Institute of Society, Ethics and the Life Sciences

##### **Present and future American ethical norms as limits upon possible population policies.**

Institute of Society, Ethics, and the Life Sciences

##### **Population policy-making and the constitution.**

Arthur S. Miller, National Law Center, The George Washington University

#### **Guarding against unintended consequences of possible population policies.**

Theodore J. Lowi, University of Chicago

In addition to the projects listed above, the Commission hopes to develop research on existing laws on contraception, sterilization and abortion; population distribution effects resulting from federal policies; foreign experience in population redistribution policies; and citizen attitudes on population issues.

appendix c

Public Law 91-213  
91st Congress, S. 2701  
March 16, 1970

**AN ACT**

To establish a Commission on Population Growth and the American Future.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Commission on Population Growth and the American Future is hereby established to conduct and sponsor such studies and research and make such recommendations as may be necessary to provide information and education to all levels of government in the United States, and to our people, regarding a broad range of problems associated with population growth and their implications for America's future.

Commission on  
Population Growth  
and the American  
Future.  
Establishment.



## MEMBERSHIP OF COMMISSION

Sec. 2. (a) The Commission on Population Growth and the American Future (hereinafter referred to as the "Commission") shall be composed of—

(1) two Members of the Senate who shall be members of different political parties and who shall be appointed by the President of the Senate;

(2) two Members of the House of Representatives who shall be members of different political parties and who shall be appointed by the Speaker of the House of Representatives; and

84 STAT. 67

(3) not to exceed twenty members appointed by the President.

84 STAT. 68

(b) The President shall designate one of the members to serve as Chairman and one to serve as Vice Chairman of the Commission.

(c) The majority of the members of the Commission shall constitute a quorum, but a lesser number may conduct hearings.

## COMPENSATION OF MEMBERS OF THE COMMISSION

Sec. 3. (a) Members of the Commission who are officers or full-time employees of the United States shall serve without compensation in addition to that received for their services as officers or employees of the United States.

(b) Members of the Commission who are not officers or full-time employees of the United States shall each receive \$100 per diem when engaged in the actual performance of duties vested in the Commission.

(c) All members of the Commission shall be allowed travel expenses, including per diem in lieu of subsistence, as authorized by section 5703 of title 5 of the United States Code for persons in the Government service employed intermittently.

80 Stat. 499;

83 Stat. 190.

## DUTIES OF THE COMMISSION

Sec. 4. The Commission shall conduct an inquiry into the following aspects of population growth in the United States and its foreseeable social consequences:

(1) the probable course of population growth, internal migration, and related demographic developments between now and the year 2000;

(2) the resources in the public sector of the economy that will be required to deal with the anticipated growth in population;

(3) the ways in which population growth may affect the activities of Federal, State, and local government;

(4) the impact of population growth on environmental pollution and on the depletion of natural resources; and

(5) the various means appropriate to the ethical values and principles of this society by which our Nation can achieve a population level properly suited for its environmental, natural resources, and other needs.

## STAFF OF THE COMMISSION

Sec. 5. (a) The Commission shall appoint an Executive Director and such other

personnel as the Commission deems necessary without regard to the provisions of title 5 of the United States Code governing appointments in the competitive service and shall fix the compensation of such personnel without regard to the provisions of chapter 51 and subtitle II of chapter 53 of such title relating to classification and General Schedule pay rates: *Provided*, That no personnel so appointed shall receive compensation in excess of the rate authorized for GS-18 by section 5332 of such title.

80 Stat. 378,  
5 USC 101 et  
seq.

80 Stat. 443,  
459.

(b) The Executive Director, with the approval of the Commission, is authorized to obtain services in accordance with the provisions of section 3109 of title 5 of the United States Code, but at rates, for individuals not to exceed the per diem equivalent of the rate authorized for GS-18 by section 5332 of such title.

34 F. R. 9605,  
5 USC 5332 note.

80 Stat. 416.

(c) The Commission is authorized to enter into contracts with public agencies, private firms, institutions, and individuals for the conduct of research and surveys, the preparation of reports, and other activities necessary to the discharge of its duties.

Contract au-  
thority.

84 STAT. 68  
84 STAT. 69

## GOVERNMENT AGENCY COOPERATION

Sec. 6. The Commission is authorized to request from any Federal department or agency any information and assistance it deems necessary to carry out its functions; and each such department or agency is authorized to cooperate with the Commission and, to the extent permitted by law, to furnish such information and assistance to the Com-

mission upon request made by the Chairman or any other member when acting as Chairman.

## ADMINISTRATIVE SERVICES

Sec. 7. The General Services Administration shall provide administrative services for the Commission on a reimbursable basis.

## REPORTS OF COMMISSION: TERMINATION

Sec. 8. In order that the President and the Congress may be kept advised of the progress of its work, the Commission shall, from time to time, report to the President and the Congress such significant findings and recommendations as it deems advisable. The Commission shall submit an interim report to the President and the Congress one year after it is established and shall submit its final report two years after the enactment of this Act. The Commission shall cease to exist sixty days after the date of the submission of its final report.

## AUTHORIZATION OF APPROPRIATIONS 84 STAT. 69

Sec. 9. There are hereby authorized to be appropriated, out of any money in the Treasury not otherwise appropriated, such amounts as may be necessary to carry out the provisions of this Act.

Approved March 16, 1970.





Paper-Action

Comments on HUD Wired Cities' Program

Draft

D. A. Dunn

Oct. 14, 1971

1. Problems listed under "Urban planning: the wired community" page 6 are all directed to relations between city government and citizens. Worth stating as is, but incomplete--doesn't point up problems in educational and cultural areas or problems in information flow generally that will be greatly improved by wired city. Overlaps with education and PBS programs should be pointed out specifically.
2. Impacts and benefits listed pages 12, 13 seems to imply that the benefits of the tiny proposed HUD program will be the 40,000 jobs, \$28 billion in equipment, and associated benefits to citizens. Most of this will occur without the proposed initiative. It is better not to claim too much.
3. Budget and resource requirements pages 16 through 22 are misleading in not pointing out that the source of "resources" is the general public paying directly to cable companies for services. "Budget resource requirements" label on Table II-3 and "Program resource requirements" label on Table II-4 seem to imply that the government has some sort of control over the "programs" listed which is not true of the wired city which is the main component of these tables.
4. Wired Cities: HUD pages 55-59
  1. Experiments - Describe need for more information (in addition to information on what users want) on social impact of new services and on legal and social obstacles to provision of some services, even in the case where services are wanted and users are willing to pay. Reference "Policy" page 25.



Phase I - Disagree that "most important task will be to evaluate prototype components already developed by industry." Suggest an aggressive component research and development program which includes support for groups doing integrated hardware and software development. A federal R & D program in this area even at a modest level, say 3 million per year, could have important effects in the acceleration of the development of components especially suited to the provision of public services. Such a program should be started immediately, not after "evaluation of commercial hardware."

Phase II - Objectives ok, but the proposed concept of a pilot network as described should be regarded only as an example. The total cost and the way that costs are allocated to different elements of these pilot programs may vary widely, depending on the willingness of industry to cover the hardware and other costs. Similarly, the scope of the programs may vary widely, depending on the capabilities and interests of local groups. For example, in one case federal funds for the provision of all or part of the software and programming costs for a limited time period might be enough to cause industry to provide the innovative hardware. Similarly, federal funding of only the funds for the social experimenters in designing the experiment and in evaluating the public response might be enough to cause industry to provide all other costs. The idea of using the leverage of federal funds to get meaningful social experiments or pilot projects going is essential to this area. More programs will be possible for the same total federal funds and the transfer of knowledge to industry and local groups will occur much more readily if local industry and other local groups are the major contributors to the program in their city.

Federal leverage can be used to push programs in the direction of more and better public services and more services oriented to the disadvantaged, without paying the whole bill. It is also not necessary and probably undesirable to maintain direct federal control over all aspects of a project, because of the problems of then moving to private or local control.

The suggestion of the panel is to regard the present network description as an example only and to introduce the idea that federal support can be granted for any aspect of a pilot project. The particular approach for a given city is likely to be different from that for some other city and a proposal for any given city should be selected only after proposals are received from a number of industry and local groups in a number of cities. Imaginative approaches should be considered that use the federal funds to best advantage by combining them with industrial and other sources of funds.

The idea of educational services as a major element of the programming and software in the wired city experiments should be emphasized and the connection with the educational initiative program should be strengthened. In some cases funding of educational software and programming may be the only leverage needed to get an entire pilot project underway. The reason that we emphasize this concept of leverage is because many of these services are almost financially viable without federal funds and in many cases only a little will be needed to cause industry to commit its own funds. The existence of federal support for educational programming in a particular city could in many cases be enough to make the provision of other services immediately commercially profitable because of the number of users willing to subscribe to the overall package of services, but who



would not be willing to subscribe to only a subset of the total service package.

The probability of getting some of these programs started immediately is very high if HUD issues an RFP which calls for imaginative proposals. An increased budget for planning grants should be established for this fiscal year FY 72 (we suggest an additional 2.0 million for analysis). A substantially higher budget for FY 73 (now 7.0 million) is justifiable, because no software and programming is now included (we suggest an additional 10.0 million for software and programming and 3.0 million additional for analysis, giving 20.0 million total for FY 73). We suggest adding 5.0 million to analysis in FY 74 and 20.0 million for software for a total of 42.7 million. Same in FY 75 for total of 47.3 million, then tapering off at rate lower than shown now with higher budgets in last three years. This program could be one of the most important in the federal budget, in our view, if it is well managed. It could give a major impetus to the development of the wired nation and especially to the development of an effective public service component in the local information system of every U.S. city.

Phase III - the community information center is a good example of a specific software program that could be supported as a part of the Phase II pilot project program. Perhaps it is not best regarded as a separate "phase."

Phase IV - This phase is a logical extension of the Phase II projects, but as explained above under Phase II, Phase II may evolve quite differently from what has been projected in the present description. There may be no need for federal support of hardware for such a city-wide test. In fact, a large number of city-wide tests may be possible with the federal government

only picking up the tab for experimental design and evaluation. Especially as now viewed, the project is too little and too late. By the date suggested, a large number of all-city two-way systems will probably be built with private funds and it may not be necessary to fund the type of project suggested here. There will be a strong need for the all-city study suggested, but it will probably be possible sooner and with a large number of cities if the federal leverage approach discussed above is accepted.



# NATIONAL ACADEMY OF SCIENCES

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## COMMENTS ON DRAFT OST REPORT

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### Chapter 6 (Population)

The style of this chapter is quite acceptable. But I have several major comments.

1) The chapter gives the impression of considerable federal accomplishment, of a formidable federal organization which has been hard at work. Yet that is scarcely the case -- that organization is largely on paper and the part at HEW headquarters is still seeking policy guidance.

2) The chapter has taken as its focus "family planning" -- which simply is not population control, unless we are unbelievably lucky.

3) Perhaps I missed it, but the word "abortion" does not even occur in this chapter. Yet clearly this is the best means now available of avoiding the  $5 \times 10^5$  unwanted children born annually in the U.S.A. Public attitudes, and laws, are changing rapidly in this regard and the chapter should have something to say about it.

Nor does the chapter note the enormous social cost of the altered personality structure of these half-million unloved youngsters.

4) The chapter fails to make clear the distinction between the penalties for population growth in the LDCs and for such growth here. And these are very striking.

In fact, little is really said about the necessity for population control.

5) Perhaps I am oversensitive but I thought it understates the role of industry in providing various versions of "the pill" and fails to come to grips with the great difficulty drug houses face in developing the next generation thereof.

6) The history of the prostaglandins is a wonderful demonstration of how recondite science finds important application. Why is it not played up as it deserves?

7) Thus it is not what is said but what is unsaid that troubles me. I was left with the feeling that the federal bureaucracy has matters fairly well in hand -- and it does not.

#### Chapter 7 (Food)

A quick pass through it brought out no exceptionable items. The coverage is adequate, the proper highlights stressed.

A useful figure -- to be inserted at any one of several relevant points: during the period in which total population increased  $1 \times 10^8$  to  $2 \times 10^8$ , the farm labor force decreased from  $14 \times 10^6$  to  $4 \times 10^6$ .

Some might notice the absence of any reference to the potential of "aquiculture", a point highly stressed in the PSAC report of a few years ago.

#### Chapter 8 (International Development)

This chapter quite well summarizes the major aspects of technical aid. It might help to indicate early that there are remarkable ramifications and consequences of the fact that the LDCs, without exception,



have a non-problem-solving culture. It is for this reason that simplistic approaches to "development" all fail.

#### Chapter 17 (Social Sciences)

This is an excellent summary statement. Bert Brim is to be congratulated. The chapter may seem over-optimistic concerning both the past and early future contribution of social sciences to design, evaluation and conduct of social action programs, but it certainly states the nature and potential of the social sciences in these directions in such manner that the neophyte can readily grasp them. I am not in position to speak to serious gaps or to challenge the various assertions of the chapter -- but believe that the cognoscenti would approve. One wonders why there is no mention of the specific successes -- and failures -- of economic and monetary policies, of the specific behavior of the CEA, the Federal Reserve, OEO, etc. etc. etc. And in discussing "models", I miss concern for a really macro-model -- a la Jay Forrester -- attempting to appraise the feedbacks among gross parameters, e.g., world population, natural resources, environment, quality of life, individual welfare, etc.

#### Chapter 21 (The Formulation of Policies for Science and Technology)

I have some regrets about this chapter. The report largely avoids partisan political flavor -- and that is good. It is about the "health of science and technology", what they are doing and might do, what they have done. This chapter is a mixture of what might be called "general theory", facts of the current scene, and advocacy of Administration policy. Is the latter necessary? I do not raise this in opposition to the specific policies since I am sympathetic in large measure. Rather am I concerned with the precedent. If OST is to produce these annually, could they not be non-political objective appraisals? PSAC, certainly, should not be involved either in endorsing or

opposing Administration proposals, policy or programs except for the operation of the most technical and scientific aspects thereof.

A few more specific comments follow:

1) No one knows the qualifications of the "unemployed and underutilized scientists and engineers" (p. 21-3). How many Ph.D.s are in this category?

2) NSB very reluctantly agreed to the NSF budget for FY 1972. Neither the Board nor I relate the decrease in Federal support for graduate students to the current employment situation -- they simply have no means of over-ruling OMB.

3) The strong support for the government-wide reorganization plan (21-13 et seq) which is not yet a reality -- and which I approve -- seems out of place in this report. Whereas the statement (21-14) that each department should have an Assistant Secretary for R&D seems quite appropriate.

4) I find no sharp discussion of the "Mansfield amendment" philosophy, whether it be Defense or Civilian agencies. To what extent should "basic" research be supported by mission agencies versus NSF or its equivalent. On what grounds.

5) I find the list of "reasons" on p. 21-16-7 somewhat too harsh. All the others stem directly from the first reason. Neither branch of government clearly accepted federal responsibility in the areas cited in the paragraph above -- hence none of the rest of the group of reasons for failure could conceivably have been achieved successfully.

6) I like the ARPA-like proposal on 21-19. It is a good idea regardless of any reorganization scheme.

7) The discussion on 21-21 is only a crack in the door. There is serious need for an inventory of major government labs (let us say those that spend greater than \$1 million per year) to see how many still have a sense



of mission, whether those missions are still valid, etc. Incidentally, the Oak Ridge lab now has major contracts with both NIH and NSF as well as a tie to Interior.

8) Does PSAC really agree to the job shop description of NSF on 21-22-4?

9) Where is a description of policy for the frontiers of science? How shall the level of funding be determined? To what extent shall it be federal inhouse function? How will we assess the future research roles of universities? Are they to convert to a problem-solving mode?

10) The statements on 21-24 et seq are semi-political opinions. Some I share -- some I do not. But do they belong in the report? Are they well debated conclusions of OST/PSAC or are they a statement of Administration positions?