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THE FUTURE ENVIRONMENT
U. S. AND WORLD TRENDS

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THE FUTURE ENVIRONMENT:

U. S. AND WORLD TRENDS

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The Outlook for Space Study Group
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland

in fulfillment of
Contracts NAS5-20732 and NAS5-20734

by:

Kathryn H. Humes, Principal Investigator
Forecasting International, Ltd.

Harold S. Becker, Principal Investigator
Theodore J. Gordon
The Futures Group

William G. Stroud
National Aeronautics and Space Administration

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Dr. Marvin J. Cetron, President of Forecasting International served as Program Manager and provided unlimited technical, administrative and managerial guidance to the study team, whose members included:

<u>Forecasting International, Ltd.</u>:

Kathryn H. Humes, Principal Investigator
George Foster
Norman Nisenoff
Carol M. Burkett
Sue Ellen Gardner
Susan R. Richmond

<u>The Futures Group</u>:

Harold S. Becker, Principal Investigator
Theodore J. Gordon
Lynne Heston
Robert Richmond

Use of This Volume

Aside from the Introduction, this volume is a collection of essays on some twenty Issues that we have identified as reflecting a need for national policy-making and, a priori, having implications for spaceflight. Each essay contains a statement of the issue, a discussion of the dimensions of the problem, supporting information and data, and a list of potential policies or actions that might be taken.

These issues have then been aggregated into six topics which we have called Trends. A brief overview of each of these Trends has been included. Thus the content of the report is:

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1. Overview:

In June 1975, the Administrator of The National Aeronautics and Space Administration established a Study Group of twenty NASA scientists, engineers and managers to conduct a study of the role of civilian space flight in the U.S. in the period 1980-2000.

The study was to last one year and, although conducted by a NASA group, was expected to draw extensively on outside consultants and on expertise in disciplines not indigenous to NASA. The study was intended to be contextual; i.e., that is, the study topics were to be considered within the framework of other societal activities. This direction was set by two of the five objectives the Administrator established for the study:

1. "To identify social and economic challenges which can benefit from space."
2. "To relate goals and objectives of civilian space activities to national goals and objectives."

In recognition of its lack of expertise in economics, sociology, international affairs, and the future, the Study Group undertook a number of activities to bolster its knowledge and expand its horizons. A major effort along these lines was a contract with Forecasting International and The Futures Group which has resulted in this report to the Study Group. Included in this support to the Study Group, were extensive contacts with Working Group II (Future Environments) of the study team, with other members of the Group, and frequent participation in the Study Group discussions and deliberations on the relationships between space flight activities and the future economic, intellectual and other needs of the American Society.

Specifically, the basic contract required support, as follows:

a) Methodologies of technological forecasting

b) Lectures and seminars on contextual planning

c) Comments on the "system design" of the Outlook for Space Study

d) Literature searches and reports on the future

e) Participation in Study Group activities

and consultation on related matters as required. In addition, during the initial phases of the study, Forecasting International provided considerable support to the Technology Forecasting Task being performed by JPL for the OFS Study. Tutorial lectures on methodologies, existing technology forecasts and editorial assistance were furnished. This work is not reported here but was included, where appropriate, in the Working Group V (Technology)[1] report.

An early task of the Working Group II, and of the Study Group, was the examination of the various methodologies by which the future could be characterized and the choice of one for use as a framework for evaluating the differing contributions that various space flight activities could make in the future. Our early reports examined three approaches for consideration by the Study Group.[2,3,4] One developed several scenarios, as forecasts of

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[1] A Forecast of Space Technology, 1980-2000, Final Draft, Report for Working Group V, OFS Study Group, J. James and R. R. McDonald, JPL, Principal Authors, July 1975.

[2] Theodore J. Gordon, et al, Prospective Crises: Some Challenges to Planning, (The Futures Group: Glastonbury, Connecticut), 4 September 1974.

[3] Kathryn H. Humes, et al, Forecasts and Assessments of Future Civilian Space Activities (Forecasting International, Ltd.: Arlington, Virginia), 28 September 1974.

[4] Kathryn H. Humes, et al, Two Alternative Futures and Their Impact, (Forecasting International, Ltd.: Arlington, Virginia), 21 October 1974.

the future; another was an attempt to develop a set of national goals and objectives; and the third was a collection of brief essays on some potential crises that could radically change the future.

The scenarios, four in number, were derived from a "scenario map" in which the two dimensions were (a) the degree to which the U.S. Government intervenes in domestic economic activities and (b) the degree to which the U.S. participates in the solution of international problems. Of the four scenarios possible with these two dimensions; (a) nationalist - laissez faire, (b) nationalist - planned, (c) cooperative - laissez faire, and (d) cooperative - planned, two were chosen for more detailed description; i.e., (a) and (d). Finally, in this approach, space programs which best fit each of the two future scenarios were discussed.

The second approach developed was to forecast and assess future space activities in the context of national goals and objectives. The immediate difficulty with this approach is that there does not exist in one place for all to know a statement of America's goals as a nation. The report surveyed the various studies and public polls on goals and objectives, selected a set which seemed most reasonable to the investigators and proceeded, in a semi-quantitative way, to weigh the contributions that space activities might make to meeting these various goals. The result was a matrix of numbers showing the contribution of space missions to weighted national goals.

The third approach was to develop a set of brief essays or descriptions of potential future crises which, it was deemed, would prompt policy analysis and policy-making by the Government. In the time frame of the next twenty-five years, the following crises were discussed: nuclear war, food shortages, deterioration of the biosphere, imbalances in the distribution of wealth, shortages of mineral resources, energy sources and technology and inflation and international economics.

At the Study Group meeting at Marshall Space Flight Center in November 1974, these and other alternative approaches to examining the future were reviewed. The Study Group decided to proceed with an approach based on the potential crises essays, since, it was felt, this would provide the Group an indepth background on what was happening in society but would leave the Group itself free to evaluate space activities in the context of that background. The balance of the Forecasting International/The Futures Group study has been the preparation of a series of 20 essays on various selected issues in U.S. and World Trends.

The approach taken is outlined in the attached Figure 1. Six topics or Trends were selected: Non-renewable resources (including energy), Population and Food, etc. and within each of these Trends, a number of Issues are identified. One criterion for the choice of an Issue was that it might have, *a priori*, some direct or indirect implications for space flight in the future. In-depth analyses and narratives on each of the Issues were prepared. An overview or brief on each of the Trends was written.

This "trends and issues" approach was not intended to be comprehensive or in any way exhaustive. The specifics in one essay may conflict with those of another. There are many different views of what is changing, and how, in today's world. This approach was intended to provide the Study Group as wide-ranging and diverse a set of information as was possible within the time and resources available.

FIGURE 1

FUTURE ENVIRONMENTS: U.S. AND WORLD TRENDS

Non-renewable Resources:

Minerals

Energy - Energy and Growth

International Conflict:

Economic Disparities

Shared Resources

Warfare

Population and Food:

Fourth World

Food and Fourth World Starvation

Population Constraints on Growth

Urbanization - U.S.

Age Distribution - U.S.

Environment:

Contamination of Environment

Oceans

Land Abuse

Toxic Substances

Modification of Biosphere

Economics:

Inflation

Capital Shortages

Individual and Society:

Science/Technology Process

Changing Concept of Equality

Values

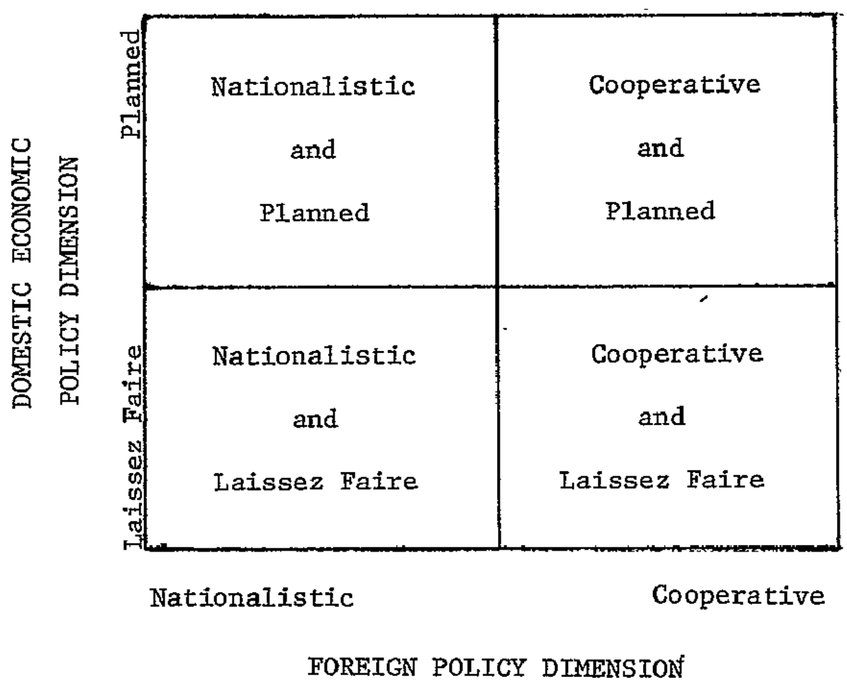
Institutional Failure

2. Two Alternative Futures:

A frequently used approach to characterizing the future is that of scenario writing which has been defined as a "tool for creative thinking in preparing policy decisions."[5] Properly executed, it is not a forecast of the future, but a systematic way of combining technological, economic or political developments to obtain a feel for the long-range consequences. To illustrate the technique, and to provide alternative futures to which space flight planning might be referred, we have created two significantly different and self-consistent scenarios. The first step was to construct a "scenario map" (Figure 2), which graphically presents the major boundaries of the scenarios. Two major boundaries or continua were chosen as being the dominant descriptions of these futures.

FIGURE 2

A SCENARIO MAP



[5] Gerardin, L., "Study of Alternative Futures, A Scenario Writing Method," in a Guide to Practical Technological Forecasting, J. R. Bright and M. E. F. Schoeman, Editors, Prentice-Hall, Englewood Cliffs, N.J., 1973.

One boundary is the degree to which the *U. S. Government intervenes in domestic economic activities.* This ranges from one extreme of a laissez-faire economy to a totally planned and regulated economy. In the laissez-faire economy, the belief is that industrial activities, left to the forces of market supply and demand, can most efficiently and effectively provide the necessary goods and services to the society and that only this way can a high standard of living be attained. The planned economy is based on the premise that industry does what is best for industry, which may not coincide with the interests of society and the common good. Hence, the Government must actively and aggressively intervene to ensure that industry acts in accordance with proscribed societal standards.

The second dimension is the degree to which the U.S. participates in the solution of international problems. One extreme is the super nationalist chauvinism while the other extreme is total cooperation and leadership perhaps at the expense of domestic standards of living.

The four scenarios which result from these combinations are shown on the map and include:

nationalist - laissez faire
nationalist - planned
cooperative - laissez faire
cooperative - planned

For this exercise we have chosen to describe the nationalist - laissez faire and cooperative - planned scenarios. Many other dominant boundaries could have been chosen. It is difficult, of course, to determine the causal events of characteristics from which a societ evolves. We have chosen these boundaries because, to a very large extent, they embody just the kinds of choices that the nation is presently making.

The country is erratically moving upward (in the map) in the continuum describing U.S. intervention in the domestic economy. Recent actions such as the establishment of Amtrak, the Lockheed loan, efforts to assist Pan Am, the proposed Consumer Protection Agency, manipulation of the U.S. wheat market, wage and price controls, housing subsidies and Model Cities legislation emphasize this trend. At the same time, when efforts such as these do not immediately achieve their stated goals regardless of the reason, policy quickly moves in the other direction. Among these shifts are Postal Service reorganization, abolition of wage and price controls, revenue sharing, and abandonment of the "Great Society" legislation.

Overall, however, the trend over the past two decades has been towards *increased* government planning and intervention in the domestic economy. This is often thought of as a departure from traditional American philosophy and intent, but examination of U.S. economic history suggests that the dominance of government over industry is in fact a *return* to the original concepts of the Founding Fathers. The "robber baron" era was, in fact, an anomaly made possible by loopholes in several legislative changes. Fearful of potential corporate power, it was not until late in U.S. history that the corporate body could own land in its own right. Hence, the concept of the government manipulating the economy and dominating the productive forces for the common good is, contrary to folklore, a basic American tenet.

The path of the U.S. along the second continuum, the degree of international cooperation, has been much more circuitous. Clearly, the nation is not wearing the blinders of the isolationism so prevalent in the early part of the century. However, neither have humane considerations and cooperation become fundamental forces of foreign policy. This was dramatically evidenced by the recent conditions of agricultural assistance to the starving nation of Bangladesh; in return for agricultural assistance the nation had to agree to forego the Cuban market for its only export -- gunny sacks. Concomitantly, in real dollars, U.S. foreign aid has been decreasing, and as a percentage of total GNP, the U.S. allocates less to foreign aid than most other developed nations.

Economic policy has always been a tool of foreign policy -- witness centuries of embargoes, tariff restrictions and the like. Recognizing the need for cooperative action in the face of resource shortages, grave international economic, pollution, famine and energy crises, the nation has yet to turn this recognition into any concerted action or policy plan. Nationalism is clearly not waning, and it is difficult to discern a conscious U.S. movement along this continuum.

The two boundaries for the scenarios were also chosen because they represent particularly sensitive issues for the acceptability of space missions. The space program, it can be argued, is necessary to maintain full employment, and this alone justifies substantial federal investment. The degree to which the federal government manipulates funding of the space program to achieve domestic goals may soon be a very real policy question.

Space missions can, of course, be used to satisfy international goals. In the 1960s, space activities were a dominant instrument of increasing U.S. prestige and world respect in the aftermath of the Cold War. Many of the international crises requiring international cooperative action -- degradation of the biosphere, resource and energy shortages, famine, proliferation of nuclear weaponery -- can all utilize different aspects of space capabilities.

The following scenarios are presented in summary form. The scenarios are self-consistent combinations of events depicting a likely world within the boundary definitions.

SCENARIO A: NATIONALIST/LAISSEZ-FAIRE SCENARIO

Assumptions of the Scenario:

This scenario is based primarily on two basic assumptions:

> First, the U.S. government will rely more on industry for the maintenance of the economy. The market forces of supply and demand will determine the proper allocation of resources.
>
> Second, the U.S. government seeks to maintain the U.S. position as the most advanced nation in the world, both militarily and economically.

To avoid the danger of a distorted reality, it should be mentioned that the above set of government policies, if carried to the extremes, would find few supporters. Most people would agree that some government involvement in the domestic economy, and some involvement in international cooperation is valuable. However, many people believe there is too much government involvement already and that the proper balance must be reached. This scenario, then, attempts to point out some possible effects of a change from the present set of government policies towards a system of less government involvement. The fundamental attributes of this scenario are presented in Figure 3.

There are several present or potential situations that could trigger this form of policy change. First, the government has increasingly tried to manipulate the domestic economy to stabilize it, -- in terms of employment and production fluctuations and price stability, -- while still promoting a high rate of economic growth. The present situation of high inflation, high unemployment and declining "real" economic growth has certainly disenchanted many people with the government's economic policies. The stronger the measures taken by government (price controls), the more ineffective they seem to be (created shortages which increased inflation instead of curbing it).

FIGURE 3

IMPORTANT ATTRIBUTES: NATIONALIST/LAISSEZ-FAIRE SCENARIO

- Maintenance of many current institutions, i.e., nuclear family, religious institutions.
- Individual choice continues to be a social goal.
- High rate of economic growth.
- Profit motive is best method of resource allocation.
- Economic independence for U.S.
- Strong defense system is necessary to maintain the international balance of power.
- Self-achievement is still an important goal of most individuals.
- Technology is important for economic growth and increased well-being.
- Prefer local solutions, rather than federal intervention into social problems.
- Some reduction in civil rights is necessary for the benefit of society.
- Foreign aid continues to be tied to national goals.
- Continuation of ideological split between "East - West" powers.
- Relaxation of some environmental and consumer protection legislation to maintain a strong national economy.

Another government policy, its attempts to fight poverty, has also been viewed by many as an utter failure, for several different reasons. Many people resent supporting those who do not work. They perceive no real improvement in the poverty situation and do not wish to pay higher taxes for more ineffective programs, especially now with inflation so high and "real" incomes declining.

Also of concern to a great many people is the size of the federal government and the problem of "red tape". How can any organization so large and unwieldly be expected to operate effectively? Such an attitude creates popular pressure to limit the scope of government and to keep it more efficient, or at least maintain its functions in smaller, local units where there is knowledge and care for local problems.

Obviously it is unreasonable, given our present values and conditions, to assume that government involvement will, or should, dry up completely. What is generally called for is a re-ordering of priorities. Individuals must be responsible for themselves, the government cannot be. There are certain areas that government involvement is necessary for the survival of society.

Crime prevention is one of those areas. The rapid increase in crime and violence in the recent past, and the prospect for continued increases in the future are alarming. The costs of crime are borne by everyone in society through increased prices, insurance rates, fear, etc. (of course, the costs are higher for the victims), and most people do want to decrease crime prevention activities. In recent years, crime prevention has often stressed rehabilitation and changing the environmental influences of crime. To many people these methods have been complete failures; crime has increased and recidivism is still high. This indicates a need for another policy change, a change to more stringent law enforcement.

If the political process is at all sensitive to the wishes of the people, and if the government is responsive and if the number of people with these views grows in the future, government involvement is likely to change in these directions.

In terms of international involvement, there are several conditions that will cause the United States to maintain a strong nationalist policy. For example, increased international competition has hurt many U.S. industries, causing the loss of many jobs. Many cooperative efforts benefit other countries more than the U.S., and sometimes involve sacrifices in the U.S. If the U.S. economy continues to suffer its present condition of economic doldrums, it is unlikely that many Americans will want to sacrifice their well-being for someone in another country. With jobs very difficult to find, few people are willing to give one up to foreign competition.

Another situation that is likely to increase the nationalism of U.S. foreign policies is the shortage of materials, including food and energy. Especially important is the likelihood of the formation of cartels to limit the supply and raise the price of essential materials, i.e., oil. The goals of resource independence and national security are likely to become more important, necessitating strong nationalist foreign policies to preserve our national well-being.

SCENARIO B: PLANNING/COOPERATION SCENARIO

Assumptions of the Scenario:

This scenario is based on two fundamental premises:

> the U. S. government actively intervenes in the U.S. economy to manipulate and direct the actions of the productive forces of the economy for the common good; and
>
> the U.S. government actively participates and cooperates with other nations and international organizations to assist in the solution of existing and prevention of potential international crises.

This scenario could logically develop from the present domestic and international troubles that the U.S. finds itself in. First, industry with some oversight and regulation by the U.S. government seems unable to sustain continued economic prosperity without severe economic fluctuations incorporating material shortages, insufficient supply and inadequate quality of goods and services, rampant inflation, and rising balance of payments deficits. At the same time, while the national economy is experiencing difficulty, many firms are enjoying excellent sales and history making profits. Hence, decision making becomes centralized in the federal government which increases its regulation and intervention to "guide" the performance of the economy along acceptable lines. This could include stringent, yet realistic, wage and price controls; allocation of existing supplies of scarce resources and stockpiling supplies for the future; government takeover of "true monopolies" such as utilities, transportation and communication firms; and institution of excess profits taxes and elimination of depletion allowances. The fundamental attributes of this scenario are illustrated in Figure 4.

At the same time great control would be exercised over the nature of the goods and services produced and the methods by which they could be produced and distributed. This would include stringently enforced quality

FIGURE 4

OTHER ATTRIBUTES: PLANNED/COOPERATIVE SCENARIO

- Tolerance of new and different lifestyles.
- Moderate economic growth.
- Rigid consumer and environmental legislation.
- No self-sufficiency in energy.
- Possible fear and distrust of U.S. as an international "do gooder".
- Increases in per capita real affluence.
- Food/Energy/Resource crisis present but considerably less severe.
- Active multi-country exploration and exploration of the oceans.
- Economic interdependence among developed nations and between underdeveloped and developed nations.
- Continued worldwide inflation.
- Decrease in use of military force and interdependency creates fear of using economic force.
- Recognition that social problems require institutional and political remedies rather than technological panaceas.
- Decrease in per capita domestic resource use and waste generated.

and safety regulations and standards for *all* products, rigid pollution abatement requirements without exception, consumer legislation governing the integrity of firm's conduct, provision for damages to the consumer as a result of industrial malfeasance, strict regulations governing occupational safety and protection of the employee.

Internationally, the U.S. would actively assist in solving and preventing international crises by contributing two of the nation's greatest strengths: its managerial and technical capability as well as substantial financial assistance. Individuals representing the nation's best would be "loaned" full time at federal expense to international organizations charged with attention to a given problem. International cooperation would include automatic large scale disaster relief; mutual interdependence for supplies of scarce resources, especially food and energy; U.S. medical, technical, and population planning assistance; and a forum with supralegal powers for resolution of conflict and monitoring of the proliferation of weaponery.

Concomitantly, the government would assume more and more responsibility for the individual and the scenario implies implementation of large scale social welfare programs. Among them would be income redistribution through a negative income tax, taxing of the super rich, and abolition of tax shelters; government financial insurance including medical and dental health care, retirement insurance; day care centers; food and housing allowances to offset inflationary trends (no household would have to pay in excess of 45% of their disposable income for minimum standards of food and housing); government subsidies to education, revitalization of the cities, medical health care and research, and so forth.

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Individual behavior would be deregulated and there would be a great deal of choice among life styles, living arrangements and work relationships.

The Implications of this World:

What does this world mean? First, while economic growth will continue at moderate levels, it will be an inflationary world at the outset because of the large amounts of government spending. Over time, however, the inflationary aspects could be dampened through tax reform and income redistribution so that government programs could be financed through general revenues.

Secondly, the scenario implies that the institutions will be created that can effectively provide the necessary national and international mechanisms for the scenario events to occur. This is probably the weakest link of the scenario. The scenario implies threats to existing power bases such as industry leadership, political patronage, even individual national identity would be subservient to international liaisons and organizations. Because of the threats to existing power bases, it will be extremely difficult to move completely into this path. Institutional insufficiency is the major difficulty. Only through creation of effective and responsive bureaucracies can this scenario be successful.

Thirdly, the scenario also implies a great deal of individual freedom of action and choice. There are many incentives built into it *not* to join the labor force. This could have exceedingly disrupting implications not only in terms of inadequate supplies of available labor but also increasing demands for government services.

Finally, the world implies a great deal of support for space activities, both to ensure domestic full employment and to assist in international activities. It is likely that these efforts would be largely government-financed through government agencies rather than as sole ventures of private industry.

This world may be inherently unstable. The threats of inflation and the drains that the social welfare programs and international cooperation would entail may be too severe. The success and stability of this scenario would depend upon several factors:

- institutional reform and creation of an effective and responsive bureaucracy;
- income redistribution to prevent massive deficit financing and, hence, rampant inflation;
- adequate incentives to participate in the labor force;
- form for resolution of international conflict.

3. Forecasts and Assessments of Future Civilian Space Activities:

a) The Development of National Goals

At best, the concept of national goals is ambiguous, at worst controversial. There is no national consensus about priorities, no set of national goals neatly summarized in a document. Indeed, the great discussion about "re-ordering of national priorities" has made it clear that no consensus exists concerning national objectives and their integration in a set of ordered priorities. Only through analysis of actions by the Congress, the Executive branch of the government, the business community and the private consumer sector, can one discern a phantom set of national goals and priorities implied in those actions.

It has been argued[5] that national goals can be inferred from the level of expenditure allocated to a given area. The argument goes as follows.

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[5] Lecht, Leonard A., Changes in National Priorities During the 1960s: Their Implications for 1980, (National Planning Association, Washington, D.C.), 1972.

Lecht, Leonard A., Goals, Priorities and Dollars: The Next Decade (The Free Press: New York), 1966.

The allocation of the total efforts of the nation at any given point in time should indicate the momentary sense of priorities, and changes in allocations over a period of time should indicate changing trends in those priorities. The best available common denominator for the allocation of the nation's efforts is the dollar expenditure toward each of the phantom goals.

In the aggregate, U.S. dollar expenditures represent the blending of judgments on national priorities by government, business and private consumers. The government responds to perceived needs, and through debate and compromise, charts new directions and changes in priorities. The business community, labor unions and private consumers act on the basis of what they perceive to be in their best interests and their actions collectively are a measure of their current priorities with a discounted future interest.

Elements of national expenditures which comprise the Gross National Product (GNP) thus constitute one measure of priorities for the nation as a whole.

However, level of expenditures may more accurately reflect a condition of the *past*, rather than a statement about where the nation wishes to be. Using expenditure levels for 1969 and 1962 one can see (Figure 4) that there were shifts in the aggregate levels of expenditure, the relative ranking -- priorities, if you will, of the different categories did not shift dramatically.

In establishing a set of national goals, it is important to develop a quantifiable statement of where the nation wishes to be in each area so that progress to or away from that goal can be monitored. Dollar expenditures are often the *means* to achieve the goal, but in and of themselves do not reflect a goal. Hence, in this task a great deal of effort was devoted to determining what the nation does wish to accomplish. This was done by reference to the existing goals, literature,[6] interviews and polling.

A list of the national goals obtained by this process is given in Figure 5. All national goals, of course, are not equal. Earlier efforts to determine priorities among competing goals were based on levels of expenditures of the past. In the effort here, we have asked the question: "In view of where we are today, to what activities should the nation's efforts be devoted?" Using a modified Delphi approach questioning a panel of experts and nonexperts, the relative weights and rankings shown in Figure 6 were determined. These weights were then used in the later matrix analysis. These weights, of course, are highly subjective and the public's view of them may change frequently and rapidly. For instance, the goal category "agriculture and food" was considerably higher in urgency due to recent concern with the world food supply. Any solution to this problem would undoubtedly lower the priority of that goal.

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[6] Albert H. Cantril and Charles Roll, Hopes and Fears of the American People (Universe Books: New York, 1971).

The "Quality of Life" Concept: A Potential New Tool for Division Makers (An Anthology of Selected Readings prepared by the Environmental Protection Agency) 1972.

The Economics of National Priorities, Hearings before the Subcommittee on Priorities and Economy in Government of the Joint Economic Committee, Congress of the U.S., 92nd Congress, First Session (June 1971).

Barry M. Blechman, E. M. Gramlich, and R. W. Hartman, Setting National Priorities: The 1975 Budget (Brookings Institution: Washington, D.C.) 1974.

Olaf Helmer, On the Future State of the Union, Report R-27 (Institute for the Future: Menlo Park, California), 1972.

FIGURE 5

EXPENDITURES FOR SOME GOAL AREAS
1962 Versus 1969
(Billions of 1969 Dollars)

Goal Area	Expenditures		Rank	
	1962	1969	1962	1969
Housing	37	35	8	9
Urban Facilities	47	59	2	6
National Defense	67	79	1	1
Social Welfare	46	71	3	2
Health	44	64	4	3-4
Education	42	64	5	3-4
Transportation	39	62	7	5
R&D	21	27	10	10
Natural Resources	7	10	11	11
Environment		6		12
Foreign Aid	6	5	12	13
Communication	22	37	9	8
Farm Product	40	51	6	7

b) Relationship Between Space Activities and National Goals

We drew up a list of possible space missions, functions, and activities (Figure 7) which might be conducted now or in the next two and one half decades. While an attempt was made to eliminate redundancies, no attempt was made to distinguish between new and innovative missions and missions which are currently being planned or studied.

It should be noted that the items in the list are not mutually exclusive. In some cases, a combination of items may be mutually supportive. For example, weather satellites can provide data for weather forecasting, and the weather forecasts could then be communicated to large numbers of individuals by broadcast satellites.

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FIGURE 6

NATIONAL GOALS - A RANK ORDERING AND WEIGHTING

Goal	Rank	Weight
Agriculture and Food	1	8.4
Natural Resources and Material Supply	2	6.8
Housing	3	6.7
Environmental Quality & Pollution	4	6.5
Education	5	6.3
Jurisprudence	6-7	5.9
National Economy	6-7	5.9
Law and Order	8	5.6
Medicine & Health	9	5.4
Defense	10-11	4.8
International Cooperation	10-11	4.8
Social Interaction	12	4.3
Urban Design & Environment	13	4.2
Foreign Aid	14-16	3.4
Cultural Activities	14-16	3.4
Economics of the Individual	14-16	3.4
Transportation	17	2.9
Disaster Prediction and Control	18	2.6
Recreation and Leisure	19	2.4
Public Utilities	20	2.3
Communication	21	2.2
Maintenance of the Bureaucracy	22	1.6

We then carried out a cross support analysis of the identified space missions/functions/activities, and their contribution to national goals. The possible missions were treated both as independent variables and as dependent variables. That is, two kinds of cross support analyses were performed.

The first analysis was conducted by assigning numbers (representing judgments of the degree of cross support) in answer to the following questions: "Assuming this particular mission were conducted successfully, to what degree would its results support the achievement of the particular national goal?". Numbers were assigned according to the following scale:

1 = little or no support

2 = some support

4 = considerable, significant degree of support

8 = major support

Because of the difficulties which can arise with combining negative and positive numbers, no negative numbers were utilized.

The second analysis was conducted in a similar manner, representing a response to the following question: "Assuming the United States makes a commitment to this particular goal, to what degree will this commitment tend to support this particular space mission?". Numbers were assigned as in the first analysis.

The national goal areas previously defined were used in the cross support analyses.

c) Mission Support for Equally Weighted Goals:

The detailed results of the cross support analysis (matrix worksheets) are given in the September 28, 1974 report. Figure 7 summarizes the results

FIGURE 7

RANK ORDERING OF MISSIONS

(Assuming Goals are Equally Weighted)

PANEL 1

1. Pollution Monitoring
2. Resource Mapping/Monitoring
3. Data Network
4. Reflectors
5. Broadcast Satellite
6. Weather, Climate Control
7. Disaster Warning
8. Meteorological
9. Atmospheric Physics
10. International Missions
11. Multiple Access
12. Navigation/Traffic Control
13. Data Commercialization
14. Common Carrier
15. Colonization
16. Aircraft Noise Reduction
17. Hazardous Material Tracking
18. Orbiting Power Station
19. Ionospheric Physics
20. Defense System Monitoring
21. Manufacturing
22. Aerodynamics Research
23. High Energy Physics
24. Private Communications Satellite
25. Waste Disposal
26. Health Treatment
27. Electromagnetic and Particle Experiments
28. Intra-solar System Probes
29. Astronomy
30. Paired Probes
31. Extra-solar System Probes
32. Satellite Servicing
33. Extraterrestrial Communication
34. Solar, Other Measurements
35. Meteor Analysis
36. Assembly

PANEL 2

Disaster Warning
Weather, Climate Control
Resource Mapping/Monitoring
Broadcast Satellite
Data Network
Common Carrier
Meteorological
Multiple Access
Navigation/Traffic Control
Aerodynamic Research
Hazardous Material
Pollution Monitoring
Satellite Servicing
Aircraft Noise Reduction
Reflectors
Orbiting Power Station
Private Communications Satellite
Atmospheric Physics
International Mission
Health Treatment
Data Commercialization
High Energy Physics
Defense System Monitoring
Solar, Other Measurements
Ionospheric Physics
Waste Disposal
Electromagnetic and Particle Experiments
Paired Probes
Assembly
Colonization
Manufacturing
Meteor Analysis
Astronomy
Intra-solar System Probes
Extraterrestrial Communication
Extra-solar System Probes

by rank ordering the missions according to the total support each provides for the national goals.

Although there are differences in the two independent rankings, considerable agreement exists. For example, four of the top six missions are common to both rankings.

- weather, climate control
- resource mapping/monitoring
- data network
- broadcast satellite

Out of the top one-third (12) missions, the two rankings list eight common missions. In addition to the above four, these include:

- disaster warning
- meteorological satellites
- multiple access communications satellites
- navigation/traffic control

The differences in rankings may be attributed to one or a combination of the following factors: unintentional biases based on perceived feasibility, differences in perceived opportunities and in future values, and different judgments as to the strengths of perceived impacts.

d) Relationship Between Weighted Goals and Missions:

The mission to goal analysis to this point has assumed that all national goals have the same weight. If we add the dimension of differences in priorities among the goals, as shown earlier in Figure 6, we find that space missions are able to substantially contribute, in theory, to the achievement of some of the highest priority goals. The Figure 8 below indicates that environmental quality and agriculture and food receive the greatest contribution from space missions.

FIGURE 8

NATIONAL GOALS RECEIVING SUPPORT FROM CIVILIAN SPACE MISSIONS

Goal	Total Space Contribution
Agriculture and Food	2368.8
Natural Environment	2132.0
Natural Resource and Material Supply	1768.0
Urban Environment	1699.2
Health and Medicine	1609.2

When consideration is made of the priorities among the goals, the rank orderings of the missions are somewhat different than those rankings which assumed equal weights. The highest ranking missions are:

- Pollution monitoring
- Resource Mapping/Monitoring
- Data Network
- Broadcast Communications

4. <u>Prospective Crises: Some Challenges to Planning</u>

This section describes another dimension of planning for the future; i.e., the understanding of potential future crises which might face the U.S. over the next decades, and an examination of the relative importances of these crises in terms of their impacts on society. The crisis orientation is an important point of departure in creative thinking about the future because it is the nature of our society to respond to crises.

For example, in describing our time to a visitor from the past, we would almost certainly include the energy crisis, the Middle East crisis, the Watergate crisis, and the inflationary crisis in our list of descriptors of the present. Without focusing on potential crises, as depressing as that might be, our descriptions of the future would be totally inadequate; more importantly, little would be known of the immediate need for creative and decisive policy-making. We talk of crises, of unpleasant futures, to prompt policy analysis and policy-making where it may count the most.

Inevitably, this approach presents arguments which will be discouraging. If the projection of crises are believable, the import will be one of Gotterdammerung. But the future is not likely to be as dismal as these essays might indicate for several reasons:

- The crises are plausible but not necessarily probable.
- The consequences, as mentioned above, may be seen in a different perspective than we think.
- We have focused only on crises not, their opposite. (For reasons which are not very clear, it is easier to visualize odious situations than desirable states).
- As the probability of a crisis increases, it is more likely that action will be taken in an attempt to avert the evolving situation.
- Some of the crises discussed here are apparently casually connected; correction of one may mitigate others.

Yet running throughout the discussion is the suggestion that the coming twenty-five years is indeed a time of climax, a time of issues of unprecedented magnitude and permanence. Food shortages, materials and energy availability, and monetary instability: all of these issues have affected society before; what is new is their potential simultaneity and world scope. Certainly within these crises, and their concomitant consequences, are the seeds of the future.

Important changes of the next two and a half decades seem likely to come not only from science and technology, from the waxing and waning of institutions responding to external pressures and internal decay, from policies of Governments and the values and actions of groups of people, but from the unexpected and deleterious actions of the socio/economic/political system. These unexpected system responses can trigger crises.

"Crisis" can have several definitions; the meaning employed in this essay is:

> A crucial situation; a situation whose outcome decides whether possible bad consequences will follow.

Thus, this section on future crises deals with potential situations which may have grievous consequences. At least two degrees of uncertainty are involved in each crisis: the inevitability of the crisis itself and the likelihood that the anticipated consequences will flow from the crisis situation. With respect to the former uncertainty, each crisis is defined in terms of trends already well-established, which, through their coincidence and reinforcement make the crisis, if not likely, at least plausible. The second uncertainty, that of the consequences of the crisis, is more difficult. Society has a marvelous propensity to adapt, and situations which seem onerous and threatening to us may, to some future society, seem part of the natural order and a desirable state of affairs. For example, a chronic energy shortage is perceived by many economists as a potential cause of inflation, recession and perhaps economic depression. Yet this image assumes a continuation of current lifestyles; it is possible that society, faced with high energy costs, will change to lifestyles requiring lower energy inputs. Thus the crisis, energy shortage, may have occurred, but its consequences will be viewed with quite a different feeling in retrospect than some view it prospectively. There is no alternative, however, to using current values in projecting crisis.

It is one thing to suggest that recognizing key future crises can form an interesting forecasting model; it's quite another to develop a metric for selecting a subset of issues to address. John Platt, in his paper "What We Must Do," suggested as an index of crisis intensity, a measure which included the number of people likely to be affected, the degree of this effect, and the time until the effect is realized. In his scaling, a grade 1 crisis represented total annihilation; a grade 2 crisis, great destruction or physical, biological, or political change; a grade 3 crisis, almost unbearable world tension, and so on.[7]

Recent work in technology assessment has added other criteria to Platt's list. One might include "relative confidence" or certainty in the degree of effect of the crisis. For example, a potential crisis which is very uncertain and yet which could have a tremendous effect might be accorded a very high priority. The list might include "reversibility" (that is, the ability for any policy to reverse the consequences of the crisis -- an irreversible crisis is much worse than a reversible one). Finally, "responsibility" could be an important priority-ordering criterion: does the responsibility for curing the crisis lie clearly within some existing institution's mission? The responsibility criterion also becomes important when more than one institution thinks it has the job of correcting a problem, because more often than not, jurisdictional disputes will arise that can inhibit clear-cut and decisive action.

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[7]John Platt, "What We Must Do," Science, Vol. 166, No. 3909 (November 28, 1969), pp. 1115-1121.

Thus the dimensions by which the severity of a future crisis might be judged (although these criteria are clearly not of equal weight) include:

1. Number of people affected.
2. Degree of effect.
3. Probability of timing of the impact.
4. Reversibility.
5. Responsibility.
6. Confidence in judgments.

A most important crisis would be one in which a large number of people are likely to be severely affected, almost immediately, in an irreversible way, with no institution clearly having responsibility for detecting or curing the problem. This situation would obtain at either of two levels of confidence: great certainty in the judgments, or great uncertainty.

What then are some of the issues which meet these criteria? While others could certainly extend this list considerably, our nominations for the top set are shown in Figure 9.

We made an attempt to understand the relationships among the crises on this selected list, using the cross-impact matrix technique.

Figure 10 is a cross-impact matrix of crises discussed in this section. As in the case of all cross-impact matrices, this figure shows the relationships which appear to exist among the variables considered. The seven postulated crises appear on both the ordinate and abscissa. The numbers in the cells of the matrix are in answer to the question:

> If the crisis shown in the ordinate occurs, how will the crisis, shown in the abscissa, be effected?

FIGURE 9

SOME IMPORTANT CRISES

CRISIS	CRITERIA					
	NUMBER OF PEOPLE AFFECTED	SEVERITY OF THE EFFECT	PROBABILITY	REVERSIBILITY OF THE COURSE OF DEVELOPMENT OF THE CRISIS	RESPONSIBILITY	CONFIDENCE IN JUDGMENT
Nuclear war	Very Large	Very Great	Very Low	Possible	Diffuse	Moderate
Severe food shortages	Very Large	Very Great	High	Possible	Diffuse	High
Deterioration of the biosphere	Very Large	Moderate-Great	Moderate	Difficult	Diffuse	Low
Imbalances in the distribution of wealth	Very Large	Great	Very High	Very Difficult	None	Moderate
Shortages of mineral resources	Large	Moderate-Great	Very High	Very Difficult	None	High
Energy shortages	Moderate-Great	Moderate-Great	Very High	Very Difficult	Diffuse	High
Inflation and monetary instability	Moderate-Great	Moderate-Great	Very High	Very Difficult	None	Moderate

FIGURE 10

CROSS-IMPACTS AMONG CRISES -- OCCURRENCE

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IF THESE OCCUR ⇩ THESE ARE AFFECTED AS SHOWN IN THE MATRIX ⇨	Nuclear War	Food Shortages	Deterioration of the Biosphere	Imbalances in the Distribution of Wealth	Shortages of Mineral Resources	Energy Shortages	Inflation, Capital Shortages
Nuclear War		-4	+4	?	?	?	-2
Food Shortages	+2		+4	+4	0	+2	+2
Deterioration of the Biosphere	0	+2		0	+1	+1	+2
Imbalance in the Distribution of Wealth	+2	+1	0		+3	+3	+3
Shortages of Mineral Resources	+2	+1	+1	-2		+2	+2
Energy Shortages	+2	+3	+2	-2	0		+3
Inflation, Capital Shortages	+1	+2	0	+2	+2	+2	

Key: +4 = Greatly intensified
0 = No effect
-4 = Greatly mitigated
? = Uncertain

A +4 indicates a judgment that the dependent crises will be greatly intensified; a -4 indicates the judgment that the dependent crisis will be greatly mitigated.

The preponderance of + signs in the matrix indicates that by and large the occurrence of any of the crises seems likely to intensify the crises which have not yet been realized. More specifically:

- All of the crises lead in the direction of war, and except for war itself, in the direction of inflation and capital shortages.
- Imbalance in the distribution of wealth seem likely to be intensified by food shortages, inflation and capital shortages, but are mitigated by shortages of mineral resources and energy shortages, particularly if energy supplies and mineral resources are owned by currently impoverished countries.

Figure 11 shows the other side of the coin. In this cross-impact matrix, it is assumed that the crises are corrected and the matrix displays the consequences of these corrections. For example, the numbers contained in the cells of the matrix answer the question:

> If the crisis shown in the ordinate were to be prevented, how would the other crises be affected?

In this case, the matrix shows a preponderance of minus signs, showing that correction of the crises generally leads to improvement in other areas as well. However, the intensities contained in this matrix as compared with the previous matrix shows that the situation is probably non-linear; that is, the occurrence of one crisis seems more likely to trigger other crises than the curing of one crisis is likely to cure other crises. For example, eliminating the possibility of nuclear war probably has little affect on any of the other crises except food shortages which may be intensified.

FIGURE 11

CRO[illegible]MPACTS AMONG CRISES -- NONOCCURRENCE

IF THESE DO NOT OCCUR ⇩ THESE ARE AFFECTED AS SHOWN IN THE MATRIX ⇨	Nuclear War	Food Shortages	Deterioration of the Biosphere	Imbalances in the Distribution of Wealth	Shortages of Mineral Resources	Energy Shortages	Inflation, Capital Shortages
Nuclear War		+2	0	0	0	0	0
Food Shortages	-1		-3	-4	0	-1	-1
Deterioration of the Biosphere	0	0		0	0	0	-2
Imbalance in the Distribution of Wealth	-2	-4	-1		-1	-1	?
Shortages of Mineral Resources	-1	0	0	+2		0	-3
Energy Shortages	-1	-2	-3	+2	-3		-3
Inflation, Capital Shortages	-1	0	0	-1	0	0	

Key: +4 = Greatly intensified
0 = No effect
-4 = Greatly mitigated
? = Uncertain

Curing of deterioration of the biosphere seems to be ineffective in all other areas except inflation and capital shortages which it will help (since the need for spending for anti-pollution devices will be diminished). Cross impacts of specific note include:

- Curing of imbalances in the distribution of wealth will greatly mitigate food shortages since developing countries would be able to purchase agricultural inputs and food; in other words; the free market system could be brought into play to help avoid starvation.

- Energy shortages reduce the intensity of deterioration of the biosphere since freely available energy could be used to clean the environment.

- Similar abundant energy can be substituted in many instances for short raw materials; therefore the availability of energy mitigates the potential mineral resource crisis.

Anticipating crises, understanding their nature to the degree possible, and moving to implement policies which mitigate them, would seem to be an important thrust for the political sciences in the next two decades. We need, following the suggestion of John Platt, a metric for crises; and following the suggestion of Hal Linstone, a system of crisis discounting akin to cash flow discounting which could help sort out priorities for the nation.

The dimensions of these and other potential crises are discussed in the next section which constitutes the bulk of this report since the Study Group decided that its approach to characterizing the future would be based on the examination of certain Trends and Issues facing the nation.

5. Conclusions

There is no doubt that the next twenty-five years will be a period of crisis and challenge. The principle components of the "problematique" and the idea that the world is in the midst of a major transition in its historic developmental patterns are familiar to almost everyone. The contents of this report, particularly the essays on Trends and Issues, have provided some measures of the dimensions of the problems; food, population, warfare, energy, pollution, etc. and their intense interactions. The core issue may well be stated as *the maintenance of an equitable and dynamic equilibrium between world population and world resources.* This issue is not new; Malthus advanced it, albeit pessimistically, at the beginning of the 19th century. What is new, in addition to the exponentially growth of the crises, is the profound changes in the world's *perceptions of equity and social justice,* which would require, if pursued, a redistribution of the wealth and basic changes in the rules of the "system". It is not reasonable to expect that a system in which "the rich get richer and the poor get poorer" will survive without the imposition of imperialism on the international scene and a paternal fascism in domestic affairs.

The alternatives are the challenges that face the nation and the world.

It became clear to us during the course of this study on the Outlook for Space that space flight with its global perspective, its ability to tie nations and peoples together, and its unique capabilities to illuminate man's universe and his nature has an enormous, untapped potential for contributing to the solutions of the world's problems and to meeting its needs.

With tools such as space flight, mankind has the means to make the difficult transition into the twentieth century. He needs only the will and determination.

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ENERGY AND OTHER NON-RENEWABLE RESOURCES

The United States and other countries, both developed and developing, have assumed a future course of action which includes growth at an increasing rate, despite their expanding populations. It is only recently that we have freed the realities of growth costs, especially in the area of new technologies, and finite resources on a world-wide basis. The desire for a rising standard of living and a more equitable level of distribution within the U. S. and elsewhere simply cannot happen immediately. A totally free, market enterprise system would leave less developed areas unable to compete in the bidding for scarce resources, now rising in price. Furthermore, existing political allegiances have controlled such resources as oil, phosphate, mercury and bauxite; and we can expect future cartel-like actions to further limit an "ideal" distribution of mineral resources.

The fact is future U. S. demands for non-renewable resources, based upon traditional consumption patterns, lead to requirements of materials which significantly exceed anticipated domestic supply. In 1974 it was necessary to import $28 billion dollars worth of oil; and despite increases in the price of oil, 1975 demands are projected to increase another 6%. By the year 2000, it is estimated that the U. S. will import 90% of the chromium, tin, titanium, platinum, berylium, aluminum and flourine needed for production. A world-wide projection for the year 2000 forecasts a doubling of the population and an increase in per capita mineral consumption by a factor of 4, increasing total mineral consumption by a factor of 8. Given this view, we should find our resources of silver and mercury depleted within the next 10-15 years and copper, lead, tin, zinc, tungsten and barite within

25 years. Decreases in energy sources and other minerals due to scarcity and/or increased prices may mean a percentage reduction in our Gross National Product, until more efficient technologies and substitute materials come to pass. The U. S. and others must pay now for future growth, as new technologies and legislative standards are expensive to develop and not readily available.

Beyond the limitations inherent in our supply of natural resources, the U. S. cannot assume the availability of imported minerals and fuel oil. First, there is the problem of maintaining a balance of trade in the world economy. Second, the desire for world-wide growth, particularly in newly developing areas, will decrease the large percentage of materials we have in the past been able to purchase. Third, the political groupings now forming among smaller nations have increasing economic overtones as trade controls become a means to world power.

The question is what can we do now, to become more independent and yet, at the same time, cognizant of our responsibility to the world environment? In the area of energy, we must move toward independence to provide for the monumental demands forecasted for the U. S.: 103 to 118 x 10^{15} BTU by 1985. Development of other sources of energy beyond oil is essential. Unfortunately, the econimic feasibility to develop efficient new energy technologies has come about after the "energy crisis". Despite the increased pollution and transportation problems involved, coal will provide a greater percentage of our energy demands in the near future, than in the past. The technology problems of solar energy and pollution fears of nuclear energy hamper our immediate use of these sources to a large degree; however, these sources plus coal and electricity, which advantageously uses less desirable energy products, will enable the U. S. to reach a stable importation rate of fuel by 1985 and become independent by the year 2000, if a modicum of conservation is also carried out.

In the immediate sense, education toward conservation and recycling of finite, not just immediately scarce, resources will aide the U. S. in closing the gap between supply and demand and could reduce our energy needs 15%; and legislative tax incentives and controls which stimulate new efficient technologies and preserve virgin resources will help the overall picture and specifically reduce energy demands another 15%. Additionally, in the socio-economic sector, the U. S. may attempt to form trade cartels of its own.

For the long-term changes necessary in the energy and mineral supply and demand gap, new technologies and substitute materials, hopefully, will provide for most of our future needs. Ocean mining for mineral nuggets and traces within the water itself proposes to be one large source of minerals, as well as more efficient and automated mining processes for coal, shale oil, etc.

NON-RENEWABLE RESOURCES: THE ISSUES

Future U. S. Mineral Demands Based Upon Traditional Consumption Patterns Lead to Requirements for Economically Important Materials Which Significantly Exceed Anticipated Domestic Supply

Future U. S. Energy Demands Based Upon Traditional Consumption Patterns Lead to Requirements Which Significantly Exceed Domestic Supply

FUTURE U. S. MINERAL DEMANDS BASED UPON TRADITIONAL CONSUMPTION PATTERNS LEAD TO REQUIREMENTS FOR ECONOMICALLY IMPORTANT MATERIALS WHICH SIGNIFICANTLY EXCEED ANTICIPATED DOMESTIC SUPPLY

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ISSUE: FUTURE U.S. MINERAL DEMANDS BASED UPON TRADITIONAL CONSUMPTION PATTERNS LEAD TO REQUIREMENTS FOR ECONOMICALLY IMPORTANT MATERIALS WHICH SIGNIFICANTLY EXCEED ANTICIPATED DOMESTIC SUPPLY.

The Issue:

The economic condition of the United States depends, in large measure, on the continued availability of reasonably priced, economically important materials. These materials can be derived from domestic or foreign sources. In either case, there is now reason for concern about both continuity of supply and price stability. This concern stems from three basic forces: the potential for the formation of OPEC-like oligopolistic consortia; the growing competition for raw materials on the world market as developing countries industrialize; and the possibility of depletion of economically viable resources.

Dimensions of the Problem:

The Possibility of New Materials-Controlling Oligopolies

The economy of the United States is a voracious consumer of raw materials and as the economy grows in the future, so will demand for raw materials. Figure 1 lists for several key materials, current per capita levels of consumption and assuming a real economic growth rate of 4-5 percent, the expected growth per capita of material use. Of course there are a host of factors that could change this forecast from the Department of the Interior such as changing prices and the introduction of

FIGURE 1

U.S. MATERIALS CONSUMPTION

	QUANTITY 1970 (SHORT TONS/1000 PERSONS)	PERCENT CHANGE (PER CAPITA) 1970-1985	PERCENT CHANGE (PER CAPITA) 1970-2000
ALUMINUM	19	140	360
CALCIUM	0.44	34	84
CHLORINE	48	70	200
FLUORINE	3.0	61	170
IRON	410	10	24
MAGNESIUM, METAL	0.47	100	310
NICKEL	0.76	29	68
NITROGEN, COMPOUNDS	51	60	162
POTASSIUM	19	44	110
SILVER (TROY OZ./1000 PERSONS)	360	39	96
SODIUM	99	49	130
SULFUR (LONG TONS/1000 PERSONS)	45	48	120
TITANIUM, METAL	0.12	170	370
TITANIUM, NONMETALLIC	2.3	63	170
ASBESTOS	3.6	50	130

Source: Derived from U.S. Department of the Interior First Annual Report of the Secretary of the Interior under The Mining and Minerals Policy Act of 1970 (P.L. 91-631) (Washington, D.C.: 1972), p. 63.

substitute materials, but the point is clear: economic growth demands increased mineral consumption. To meet its needs, the United States has to depend increasingly upon imports of certain materials--domestic production has lagged behind consumer demand (see Figure 2).[1]

MATERIAL	IMPORTS AS A PERCENT OF TOTAL U.S. CONSUMPTION		
	1950	1970	CHANGE
ALUMINUM	71	86	+15
COPPER	35	8	-27
LEAD	59	40	-19
MERCURY	92	38	-54
PLATINUM	91	98	+ 7
TIN	100	100	-
TITANIUM	32	47	+15
ZINC	37	60	+23
IRON ORE	6	14	+ 8
CHROMIUM	100	100	-
COBALT	92	96	+ 4
COLUMBIUM	100	100	-
MANGANESE	77	94	+17
NICKEL	99	91	- 8
TUNGSTEN	80	40	-40
PETROLEUM	8	22	+14
NATURAL GAS	0	3	+ 3
TIMBER	11	8	- 3

Figure 2. Changing United States reliance upon selected materials from abroad.

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[1]Material Needs and Environment Today and Tomorrow, Final Report of the National Commission on Materials Policy (Washington, D.C.: June 1973), pp.9-8.

Dependence on imports seems almost certain to grow. As shown in Figure 3, under the assumption of continued economic growth in the United States, reasonable projections indicate that by 2000, imports will account for more than 90 percent or more of all the chromium, tin, titanium, platium, beryllium, aluminum and flourine the country consumes.[2]

As the Middle East situation demonstrated, when a few nations control a resource in demand, they can readily assert oligopolistic power. Without competition, they can set prices, control production rates, demand political compliance with their goals, seek favorable trade arrangements, and become generally obnoxious. Oligopoly is illegal within the United States except under Federal charter; but not in the world market.

A paradigm for forecasting future OPEC-like situations might be to identify key materials used by industrial nations which are concentrated in a few other nations that could be linked politically. The paradigm becomes particularly strong if the recipient countries do not have access to economically viable substitutes. Figure 3 presents some possible groupings.[2]

The United States imports some minerals which are present in the United States but have not been tapped; sometimes it is cheaper to import than to

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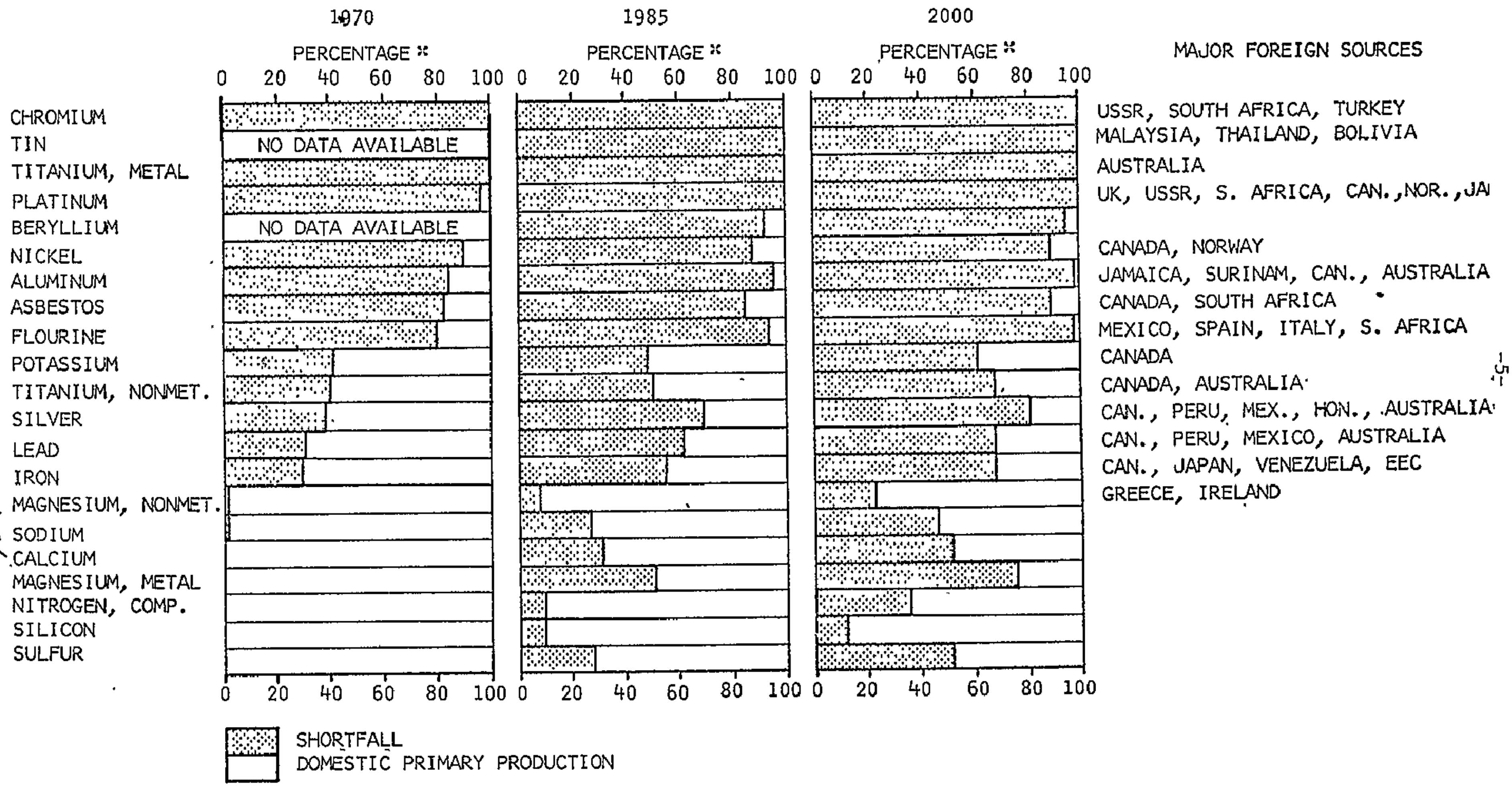
[2]U.S. Department of the Interior, First Annual Report of the Secretary of the Interior, under the Mining and Minerals Policy Act of 1970 (P.L. 91-631) (Washington, D.C., 1972) p. 63, and Material Needs and the Environment Today and Tomorrow, Final Report of the National Commission on Materials Policy (Washington, D.C., June 1973), pp. 2-25.

FIGURE 3

DIFFERENCE BETWEEN U.S. MATERIAL SUPPLY AND DEMAND



*BASED ON WEIGHT

SOURCE: U.S. DEPARTMENT OF THE INTERIOR, FIRST ANNUAL REPORT OF THE SECRETARY OF THE INTERIOR, UNDER THE MINING AND MINERALS POLICY ACT OF 1970 (P.L. 91-631) (WASHINGTON, D.C., 1972), P. 63, AND MATERIAL NEEDS AND THE ENVIRONMENT TODAY AND AND TOMORROW, FINAL REPORT OF THE NATIONAL COMMISSION ON MATERIALS POLICY (WASHINGTON, D.C., JUNE 1973), PP. 2-25.

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develop domestic reserves. If, shortages developed in materials for which indigenous but untapped reserves exist, we would undoubtedly develop those resources. Vincent E. McKelvey, Chief of the United States Geological Survey, believes that at higher prices, most of our mineral needs could be met through the turn of the century at least, by using materials which lie within our borders.[3] However, among materials not to be found in quantity in the United States are tin, manganese, and chromite.

The world already has several examples of cartel-like actions cast in the image of OPEC. Morocco, Tunisia, Senegal, and Algeria recently agreed to raise the price of phosphate rock; this has led to increases in the price of fertilizer and detergent. These price increases are particularly unfortunate since they occur at a time when fertilizers based on the use of nitrogen are in short supply because of the energy problems the world is experiencing, and when alternatives to phosphate based fertilizers are being seriously questioned from an ecological standpoint.

The suppliers of bauxite, the principal raw material used in aluminum production, have met several times, most recently in Kingston, Jamaica, and in Belgrade, Yugoslavia. According to the British publication, New Scientist, the major producers, including Australia, Guiana, Guinea, Surinam, and Yugoslavia (and perhaps Jamaica as well) are likely to form a cartel.

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[3] "Raw Material: U.S. Grows More Vulnerable to Third World Cartels," Science (January 18, 1974).

> Nationalization appears to be the most likely strategy of the bauxite producing countries: Guiana is one success story from which they might draw inspiration. In 1971, Guiana nationalized the Demba Bauxite operation owned by Alcan Aluminum. Bauxite is responsible for the major part of Guiana's economy, and western experts were quick to forecast the troubles which would undoubtedly beset the country after the takeover. They were proved sadly wrong. Despite a severe aluminum market recession in 1971-72 the Guiana Bauxite (Guybau) operation has gone from strength to strength and Guiana is now negotiating the takeover of its remaining bauxite mining company, Reynolds Mines, owned by Reynolds Metals, a U.S. company. Guiana's dream is that of many other bauxite producing countries: a national integrated aluminum industry.[4]

Producers of mercury met in Queratano, Mexico, last year to agree on a general pricing strategy and to form a group of mercury producing countries. Central American nations have recently established a tax on exported fruit. Other organizations, such as the International Tin Council and the Inter-governmental Council of Copper Exporting Countries, already exist and it would not be unexpected to see cooperative action being suggested within these groups.

Unfortunately, if groups of nations exercise oligopolistic pressures, others may be hurt severely. For example, while the oil situation confronts the developed nations with uncertainty about their balance of payments and economic stability, the underdeveloped countries may be on the verge of disaster. Treasury Secretary George Shultz recently stated that they were victims of a "horrible chain in which the lack of fuel goes to a lack of fertilizer, goes to lack of food, and which goes to starvation."[5]

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[4]Andrew Staines, "Digesting the Raw Materials Threat," New Scientist (March 7, 1974), p. 610.

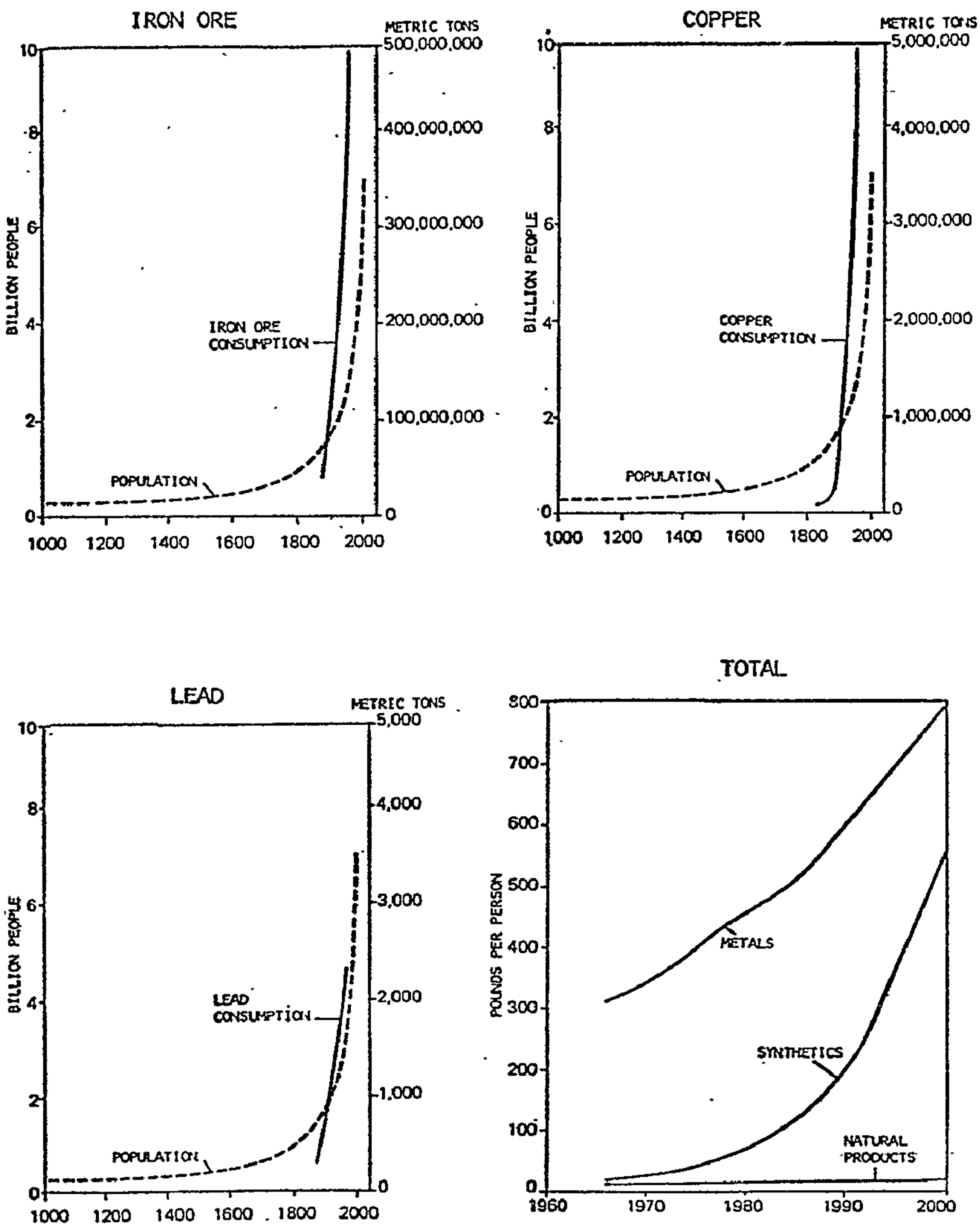
[5]New York Times (February 17, 1974).

Competition for Raw Materials on the World Market

This rising world demand for raw materials is based on two factors: the number of people in the world is increasing and per capita consumption is increasing (see Figure 4). By the end of the century, the total world population will nearly double. Concurrently, following past trends, per capita mineral consumption will increase by a factor of four.[6] Therefore, by combining these two forces, by the year 2000, the world as a whole may increase its mineral consumption by a factor of eight or so. Failure to achieve this growth would mean that developing countries are not able to achieve their current economic goals.

The dilemma implied by this tremendous growth rate is illustrated in Figure 5. Since 1945 annual world production of the indicated minerals has doubled every seven or eight years, while in the United States the production doubling rate was approximately twenty-five years. In 1945 the United States consumed about 60 percent of the world total for the minerals shown; by 1971, primarily because of the growth of consumption of other nations in the world, this figure had fallen to 16 percent.

[6] Eugene N. Cameron, "U.S. Contribution to Mineral Supplies, "Mineral Position of the United States, 1975-2000 (Madison, Wisc.: University of Wisconsin Press, 1973), p.21.



SOURCE: MCHALE, JOHN, WORLD FACTS AND TRENDS (NEW YORK: COLLIER BOOKS, 1972).

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FIGURE 4 The Effect of Increased Population on Natural Resources

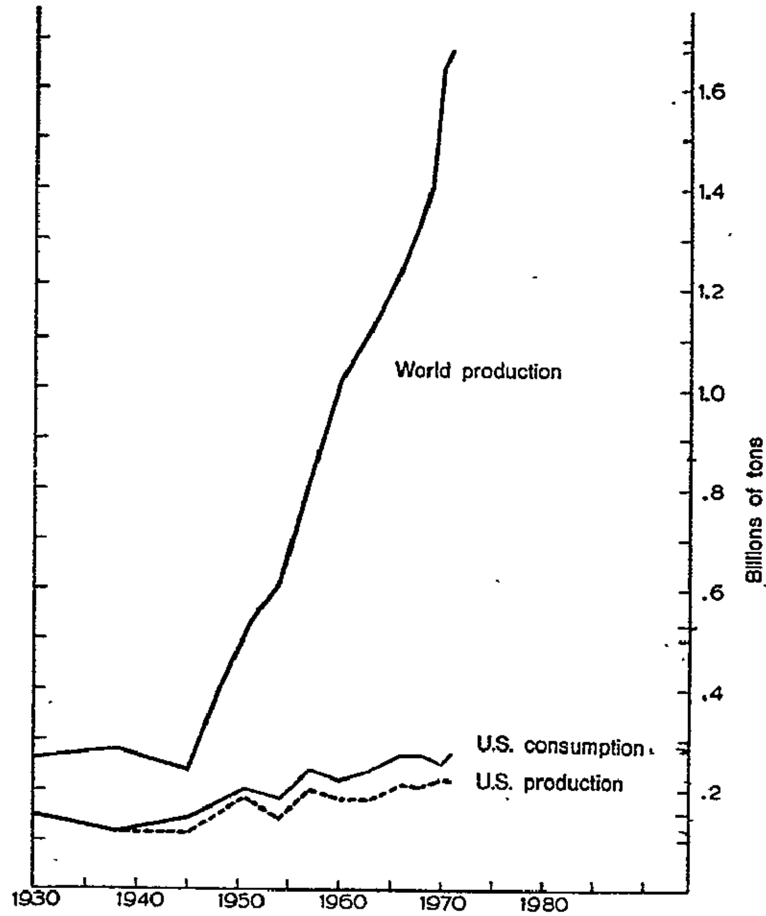

FIGURE 5

World production and United States production and consumption, 1930-71, of eighteen minerals (iron ore, bauxite, copper, lead, zinc, tungsten, chromium, nickel, molybdenum, maganese, tin, vanadium, fluorspar, phosphate, cement, gypsum, potash, and sulfur), in metric tons.7

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[7] Data compiled at the University of Wisconsin by Kenneth D. Markart and E.N. Cameron, from U.S. Bureau of Mines, Minerals Yearbook and Commodity Data Summaries. From Mineral Position of the United States, 1975-2000 (Madison, Wisc.: University of Wisconsin Press, 1973), p. 19

From the end of World War II, to the early 1970's, worldwide production of eighteen important minerals increased by 600 percent, reaching a level of about 1.7 billion tons in 1971. Consumption in the United States during this period increased by about 75 percent, reaching a level of about .3 billion tons in 1971.[8] Hence, the United States finds itself in growing competition for the increasingly short supply of many mineral resources.

The Prospects for Depletion

It does not appear that the world will be depleted of any major mineral resource in this century. This statement is based on the following assumptions:

1. World rate of consumption of raw materials will continue to increase exponentially. Projected growth rates run from 1.1 percent per year for tin to 6.4 percent per year for aluminum.

2. Known reserves will increase by a factor of five before the turn of the century. This assumption is intended to capture the effect of price elasticity: as the resource nears depletion its price will rise; as prices rise, there is additional incentive for exploration and recovery of previously marketable resources. This "factor of five" assumption could, of course, be wrong.[9]

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[8] Eugene N. Cameron (ed.), The Mineral Position of the United States, 1975-2000 (University of Wisconsin Press, 1973), p. 19.

[9] These assumptions and the figures shown in the text are from Donella H. Meadows, et al., The Limits to Growth (New York: Universe Books, 1972). In their computations, the known global reserves were derived from U.S. Bureau of Mine estimates.

The proven world reserves of selected materials, especially critical materials, range from about ten years to more than 100 years (see Figure 6)[10]. However, several materials are in relatively short supply as far as proven reserves. Reserves of copper, lead, tin, zinc, tungsten, and barite range up to about 25 years, whereas supplies of mercury and silver are estimated at only 15 years. Certainly the world will continue to find new supplies of minerals. In the period 1950-1970 the proven reserves of potash increased by about 2400 percent and those of iron ore about 1200-1300 percent (see Figure 7).[11] However, certain materials, such as lead, were found only in relatively small additional quantities in terms of those previously known. In the case of tin, manganese, and tungsten, exploration for additional reserves essentially proved fruitless during this period.

* * *

Thus there are three reasons why we may have shortages in the future: the possibility of oligopolistic practices by foreign nations, increasing world competition for scarce supplies, and the near exhaustion of certain economically recoverable ores.

There are important consequences which flow from these new forces. Among them are:

- All of these forces are inflationary and will cause balance of payment difficulties.

- "Repatriation" of export dollars could cause problems of world financial stability.

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[10] Executive Office of the President, Council of International Economic Policy, "Critical Imported Materials" (December 1974) p. 15. (Hereafter called Critical Imported Materials.)

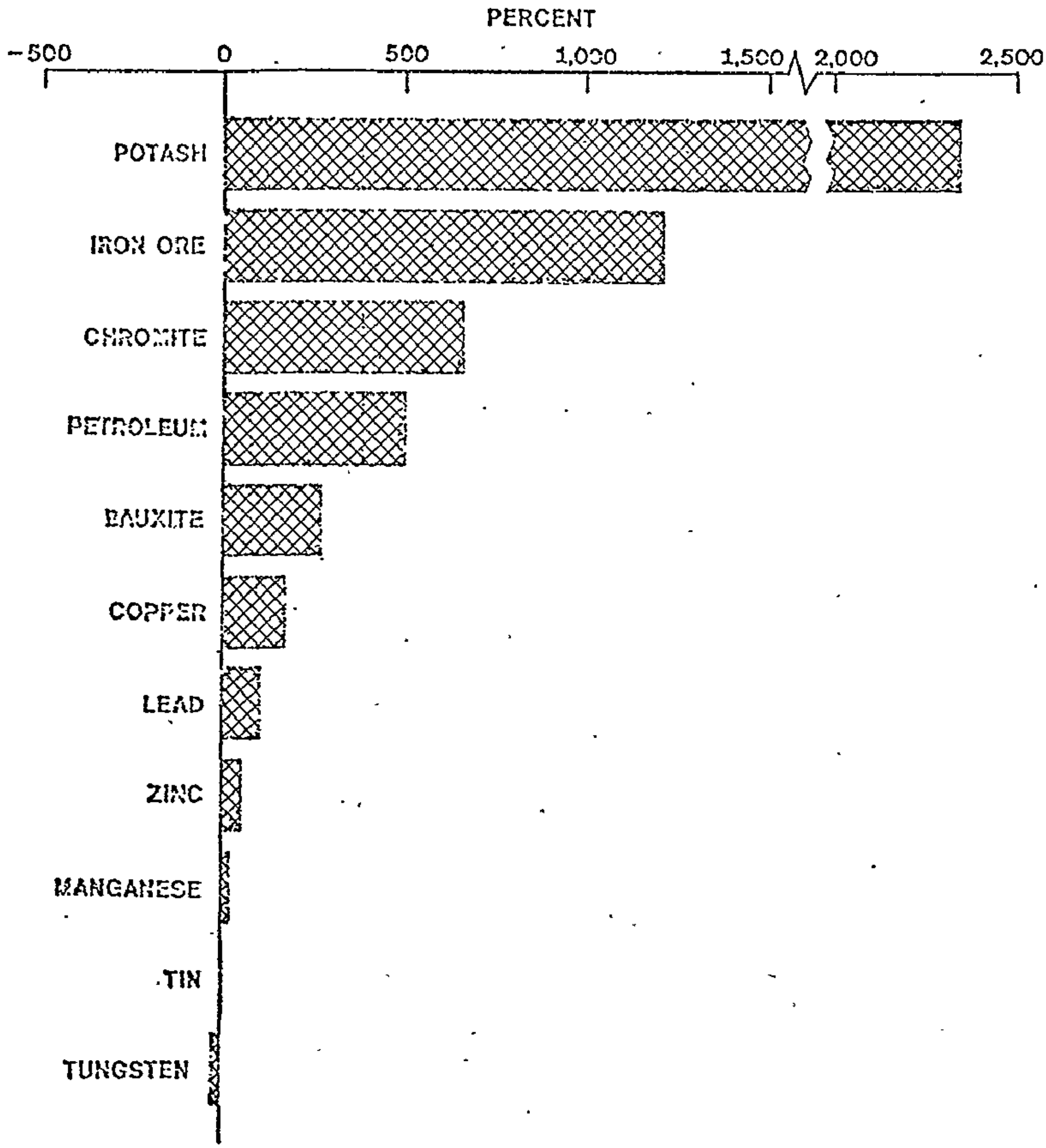
[11] Critical Imported Materials, p. 14

TABLE 2

PROVED WORLD RESERVES OF SELECTED MINERALS

More Than 100 Years:	Columbium Potash Phosphorus Magnesium
51-100 Years:	Iron Ore Chromite Nickel Vanadium Cobalt Asbestos Molybdenum
26-50 Years:	Manganese Bauxite Platinum Titanium Antimony Sulfur
15-25 Years:	Copper Lead Tin Zinc Tungsten Barite
10-15 Years:	Mercury Silver

SOURCE: Executive Office of the President Council on International Economic Policy "Critical Imported Materials" December, 1974, p. 15.



SOURCE: Executive Office of the President Council on International Economic Policy "Critical Imported Materials" December, 1974, p. 14.

Figure 7 Change in world proved reserves 1950-70

- Higher costs of minerals on a world market will affect the ability of certain countries to purchase needed commodities on the open market and affect their rates of industrialization and agriculture.

- Economic growth of developed nations will be slowed.

- International political stability will diminish.

Potential Actions

The actions that may be implemented to affect United States material demand and domestic supply may be classed into four major categories: education, science and technology, legislation, and socio-economic strategies. A summary of such programs is shown in Figure 8.

Educational programs and public relations campaigns relating to conservation and recycling within the United States might be important. The recent OPEC oil embargo and concomitant public awareness of the need for conservation resulted in major fuel conservation. Similarly, such conservation programs might be imagined for critical materials in short supply. The National Adademy of Sciences recently recommended that:

- The federal government proclaim and deliberately pursue a national policy of conservation of material, energy, and environmental resources, informing the public and private sectors fully about the needs and techniques to reducing energy consumption, the development of substitute materials, increasing the durability and maintainability of products, and reclamation and recycling.[12]

In addition, educational programs might be directed toward foreign suppliers. These programs might stress the implications of price changes and continuity of supply on the relations between countries and world economic stability.

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[12] Mineral Resources and the Environment, National Academy of Sciences (Washington, D.C., 1975), p. 37. (Hereafter called Mineral Resources and the Environment.)

Education

- Educational programs and public relations campaigns about conservation and recycling.

- Programs for domestic and foreign suppliers on the socio-economic implications of materials availability and cost.

Science and Technology

- Development of materials for and methods of substitution.

- Development of techniques for more efficient use, recycling, and reuse of end product materials.

- Development of techniques to economically utilize lower grade ores.

- Development of improved techniques for identifying, location, and assaying material deposits.

- Development of improved techniques for extraction and mining (e.g., automated mining, offshore procedures, reclamation technologies to prevent environmental degradation).

Legislation

- Financial incentives (e.g., taxes, subsidies) for conservation of scarce resources.

- Prohibition of certain non-recyclable/non-reusable materials and establishment of packaging standards.

- Financial incentives to increase mineral supplies (e.g., differential pricing to encourage exploration and R&D).

- Federal stockpiling of materials.

- Rationing/allocation of materials.

Figure 8 Actions that may affect U.S. material demand and domestic supply

Legislation (Cont'd)

- Relaxation or abolishment of environmental quality and occupational safety standards.
- Enactment of federal land use regulations.
- Establishment of material export quotas and/or taxation on exports.
- Enactment of anti-exodus laws for U.S. materials-producing corporations.

Socio-Economic

- Formation of a multinational material users cartel.

Figure 8 (Cont'd)

Scientific and technical developments will be urgently important in solving material problems. Technology could have an important role to play in providing substitutions, improving processing efficiencies, promoting recycling and re-use, developing economic processes for the use of lower grade ores, and in improving techniques of exploration and recovery.

In the area of exploration, clearly improved methods would be useful in helping to identify the location of mineral deposits, both in the United States and throughout the world. These techniques include, for example:

- Geological techniques, including field work, aerial surveys, subsurface investigations, mapping or rock types, and petrological studies.

- Aerial or orbital surveys using visible light, infrared, and microwave photography, as well as gravimetric and magnetic sensing.

- Geochemical exploration involving analyses performed on solid, liquid, and gaseous samples derived from surface manifestations and drilling cores.

- Geophysical techniques including measurements of temperatures, electrical conductivity, propagation velocity of elastic waves, and density and magnetic susceptibility of various strata.

- Seismographic techniques, including active or passive seismic methods (active methods include reflective and refractive; passive techniques involve recording naturally generated microearthquakes or acoustic noise patterns within prescribed frequency ranges).

- Electrical methods including self-polarization, induced polarization, and telluric approaches.[13]

In addition to simply developing improved methods for identifying the location of resource deposits, general improvements in the field of geology would probably be very helpful. These improvements could lead to the

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[13] T.J. Gordon, et al., A Technology Assessment of Geothermal Energy, Report 164-46-11 (Glastonbury, Conn.: The Futures Group, September 1974).

development of statistical and mathematical methods for projecting the extent of the deposits, given certain surface and subsurface geologic information. 14

The mineral position of the United States might also be improved through the development of new mining technologies. The industry in general is in a depressed state, as evidenced by the relatively slow advance of mining technology and the large number of imported technologies. The National Academy of Sciences recently recommended several potential research programs associated with improved mining technology. For example:

> In conventional approaches there is a need to determine whether harder cutting materials can be synthesized in suitable sizes and shapes (tungsten carbide and synthetic diamond have led to considerable progress in this respect), and to explore their capabilities in factors affecting bit performance in various types of rock. Novel approaches for both soft and hard rock should be fully explored and evaluated for various mining conditions. These include the use of high powered lasers, electron beam, plasma torches, thermal fragmentation, ultrasonics and shock waves, percussion and hydraulic jet techniques, and automated continuous explosive sytems."
>
> "It is recommended that research be accelerated on ways to automate mining operations. Such automation requires the development of suitable sensing devices (to monitor rock composition, for example), information processing equipment (minicomputers), and servo-mechanisms (robots), all of which have to be exceptionally rugged."15

Scientific and technological developments will also be important in the economic utilization of lower grade ores. The country will move from the use

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[14] L. Heston and H.S. Becker, Focal Points in the Future of Food and Mineral Resources, Report 151-46-10 (Glastonbury, Conn.: The Futures Group, July 1974). (Hereafter called Mineral Resources.)

[15] Mineral Resources.

of its richest ores to those which are currently marginal. Therefore, a series of developments which improve the economics of the use of low grade ore will be necessary; these may involve for example, in situ leaching of ore deposits, improving methods of beneficiation (e.g., beneficiation of magnetic taconite in coarse crushing plants in the process of producing iron), lower cost transportation, new grinding and separation techniques, diminished energy requirements, etc.[16]

Ocean mining is a particularly promising era. Here the processes involve both the removal of minerals from sea water through distillation or osmotic processes and the direct recovery of minerals from the ocean floor. Sea water contains almost all of the chemical elements, although only four elements--sodium, chlorine, magnesium, and bromine--are now being recovered in relatively large quantities. Landsberg, Fishman, and Fisher project that:

> It is not unreasonable to expect that within the next twenty to forty years some byproduct recovery will be carried out in sea water conversion plants built for meeting fresh water needs. But these plants will probably be of a limited number in the United States, at least in this century; barring the achievement of the extremely low-processing costs, application will probably not be of major significance except for the sea water minerals already being recovered.[17]

With respect to use of the ocean bottom, mineral resources may be "mined" from beneath the surface of the Continental Shelf, recovered in the form of deposits from silt, slime, and solid debris covering the ocean floor (these

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[16] Mineral Facts and Problems, Bureau of Mines Bulletin 650, United States Department of the Interior, 1970.

[17] H.H. Landsberg, L.L. Fishman, and J.L. Fisher, Resources in America's Future, 1963, p. 495. (Hereafter called Resources in America's Future.)

materials are believed to have collected from land erosion and deterioration of submerged rock), and nodular material lying on the ocean bottom, at considerable depth. The recovery of nodules is particularly interesting since they appear to be primarily maganese and also contain nickel, copper, and cobalt. Nodules have been found at depths of from 500 to 3000 feet off the United States southeast coast, and to a range of 5000 to 14,000 feet in the eastern Pacific Ocean.

> ...One square mile would contain 70,000 tons of nodules or 20,000 to 35,000 tones of maganese...a breakthrough here would almost at once shake free the United States of growing dependence upon overseas sources. Recovery of phosphates from the ocean bottom, especially along the west coast, may proceed that of maganese.[18]

Recycling technology is indeed promising. Americans discard approximately 250 million tons of solid wastes per year. Today nearly all major materials are to some extent recycled. The rate varies from nearly 100 percent for lead to 50 percent for copper, 31 percent for iron and steel, and 19 percent for paper and board, to 4.2 percent of glass.[19] Considering just iron and steel, non-ferrous metals, glass, textiles, and rubber, about 25 percent of the materials consumed in the country are currently recycled. Improved processes of recovery for the huge waste stream will reduce demand for virgin materials. The National Commission on Materials Policy has recommended that the government accelerate research and development and technology transfer on resouce recovery from scrap, especially encouraging the recovery of resources in municipal waste.[20]

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18 Resources in America's Future, p. 496

19 "Report to Congress on Resource Recovery", Environmental Protection Agency, February 1973.

20 Needs in the Environment, Today and Tomorrow: Final Report of the National Commission on Materials Policy, June 1973, p. 4d-19. (Hereafter called Needs in the Environment.)

Finally, science and technology can aid in the development of materials which can substitute for currently imported minerals or minerals which are likely to be in short supply in the future. Several of these substitutions are already in progress; for example, the use of plastics for metals in automobiles. This substitution began in 1960 and had reached a level of about 10 percent by 1970.[21] The National Academy of Sciences recently urged that the search for substitute materials begin immediately:

> We cannot emphasize too strongly that the discovery and development of new and improved materials as possible substitutes for existing ones takes time, and that the process is generally driven by clearly perceived functional objectives rather than by ill-placed optimism that "something will turn up when the crunch comes."[22]

There are three major difficulties encountered in seeking to substitute one material for another: complexity of design, considering specialized uses; accounting for the many uses of single materials of different combinations; and accommodating the huge volume of use which is experienced in the case of many commodities. In technically complex applications, such as nuclear reactors and jet engines, some substitute materials are nearly impossible to find. In other cases, the material is so crucial to adequate performance (e.g., palladium in telephone systems) that a substitute would mean redesign of the entire system if that were possible.

There are many political actions possible in this domain that relate to creating incentives or removing barriers in order to influence production or consumption of minerals. For example, taxes or subsidies could be created

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[21] J.C. Fisher and R.H. Pry, "A Simple Substitution Model of Technological Change", <u>Technological Forecasting and Social Change</u>, Vol. III, No. 1, p. 75.

[22] <u>Mineral Resources and the Environment</u>.

to promote conservation of scarce resources, federal stockpiling programs could be introduced, or materials rationed. As a single example, the Congressional Office of Technology Assessment recently pointed out that more than a hundred million acres of federal lands including wildlife refuges, national parks, and land administered by the Department of Defense are hardly used to produce materials, yet these lands are thought to be quite rich in mineral wealth. The various institutional factors which affect the use of such land include:

- environmental policy, laws, and regulations
- mining and leasing laws and regulations
- administrative processes for environmental and other certification reviews
- economic policy (e.g., tax provisions such as depletion allowances and accelerated amortization of facilities or investment tax credit)
- transportation policy (e.g., construction and operation of rail lines)
- government programs for geological and geophysical surveying, exploration and mapping.
- conflicting or concurrent federal-state jurisdictions (e.g., sovereignty and unitization of oil fields involving federal lands) [23]

The National Commission of Materials Policy recently recommended a full legislative program in this area. They urged that federal agencies intensify their efforts to encourage worldwide development of resources by diplomatic,

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[23] Request for Proposal from the Office of Technology Assessment: OTA/RP 75-4, February 1975.

financial, and educational means, that the federal government give users of materials economic incentives in the form of tax credits for expanded use of recycling materials and that Congress modify the existing General Mining law to modify the procedure for reclaiming abandoned mining claims. They urged that prospectors should be granted sufficient rights to encourage their active exploration for new mineral deposits.[24]

The possibility of forming an international-material-users-cartel needs to be examined. In the case of petroleum, such action has already been suggested by Secretary Kissinger and others. Whether or not the commonality of interests among consuming nations is sufficiently strong to utilize this "collective buying power" in order to control prices and ensure availability, is problematic.

Potential Effectiveness and Acceptability of Alternative Actions

Scientific developments and technology can provide the most far-reaching solution, but can help only in the long term. On the other hand, actions that focus on strengthening the legislative environment can be very effective in the short term, while education programs can be immediately helpful or very remote, depending on whether they are directed toward swaying popular opinion or focused on research and innovation. R&D programs that bring about more efficient mining and concentrating of ores as well

[24] *Needs in the Environment*.

as those that provide recycling and substitutability of currently processed materials are likely to be the most effective in reducing U.S. needs for imports while maintaining a viable economy. Aside from technological know how, the major barriers to the realization of these steps are the obtaining of consensus among the public and private sectors so that the required funds are allocated. Individual industries and companies are likely to resist the costs for new plant and equipment that recycling and substitute materials may bring and for the cultivation of new markets which such charges may necessitate. Implementation time is another problem. The Council on International Economic Policy estimates that, using present technology, the U.S. could achieve aluminum self-sufficiency, but only after at least 10 to 15 years. This assumes the construction of one new plant per year, each capable of producing one million tons of alumina from clay, starting in 1978 or 1979 of about $2 billion[25] for new mines and smelter capacity.

While R&D may be the most effective response, the greater feasibility of some legislative and educational steps make some of these alternatives attractive, especially in the near term. In particular, the establishment of federal stockpiling as well as the introduction of taxes or subsidies to encourage conservation of scarce resources and the construction of new plant and equipment could be instituted immediately. Other possible measures, such as rationing or enactment of material export quotas may be effective, but resistance by the public and private sectors respectively seems to place them at a lower priority.

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25. "Special Report: Critical Imported Materials," Executive Office of President Council on International Economic Policy, December, 1974, p. 28.

Finally, some actions may have effects that are uncertain and really need further study before their attractiveness can be adequately assessed. The development of improved techniques for identifying, locating and assaying mineral deposits, for example, will undoubtedly help the situation. David Swan reports that space technology "may have a significant impact on terrestrial mineral exploration," despite the problems of "precisely and economically determining undergroup ore locations, extent, and grade."[26]

Clearly, the United States is faced with a series of alternative courses of action. The action which the United States chooses to pursue obviously could be strongly motivated by an embargo of imported materials by suppliers. Such constraints might be removed by importing nations, such as the United States, if they were to take actions to control such sources, for example, through intervention. It is not clear that such steps are likely, nor are they recommended here, although it is recognized that such steps are being openly discussed with increasing frequency.

[26] Eugene H. Cameron (ed.) The Mineral Position of the United States, 1975-2000, (Madison, Wisconsin: University of Wisconsin Press, 1973), p. 92.

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The Issue:

Energy consumption in the United States and around the world has increased dramatically since the end of World War II. In the United States it has grown at 3.6 percent annually since 1960 and now stands at about 70 quadrillion Btu annually.[1,2] Energy consumption has risen in response to both increasing population and to increasing levels of affluence. In America, per capita consumption has grown steadily in all sectors, rising in the aggregate by about 2.8 percent annually since the early 1960's (see Figure 1).

When domestic production of crude oil and natural gas peaked in 1970-1971, increases in petroleum imports were required. For example, in 1970 3.5 bbls/day of petroleum were imported; in 1973 imports had increased to 6 bbls.day.[3]

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[1]C.E. Steinhart and J. S. Steinhart, Energy-Sources, Use, and Role in Human Affairs (North Scituate, Mass.: Duxbury Press, 1974).

[2]Shell Oil Company, The National Energy Outlook (March 1973), p. 10. (Hereafter called The National Energy Outlook.)

[3]Understanding the National Energy Dilemma, a report of the Joint Committee on Atomic Energy, The Center for Strategic and International Studies (Washington, D.C.: Georgetown University, 1973), and Project Independence, a Report by the Federal Energy Administration (Washington, D.C.: U.S. Government Printing Office, November 1974).

U.S.	1929		1939		1947		1955		1960		1970	
	10^{15}BTU	%	10^{15}BTU	%	10^{15}BTU	%	10^{15}BTU	%	10^{15}BTU	%	10^{15}BTU	%
Household & Commercial[a]	7.06	28	7.22	31	10.52	30	10.83	27	12.86	28	15.79	25
Transportation	6.55	26	5.79	25	8.17	23	8.09	20	9.21	20	16.31	25
Industry	9.32	37	7.78	34	12.46	36	15.71	39	15.95	35	20.71	32
Other[b]	2.06	08	2.22	10	3.73	11	5.44	14	7.34	16	11.78	18
Total	24.99	99	23.01	100	34.88	100	40.07	100	45.34	99	64.59	100

a. Commercial: Wholesale, Retail trade & Services.
b. Other: Defense, Public (mostly gov't), Agriculture (fuel only), Gas lost, and wasted, and Miscellaneous.

Source: Steinhart, C.E., and Steinhart, J.S., 1974, pp. 215, 230.

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Figure 1. U.S. energy use by sector: historical breakdown

The 1973-1974 Arab oil embargo vividly demonstrated the need for an ordering of national energy priorities and policies. The major questions which these priorities and policies address are: To what degree need we rely on foreign sources of energy? How will supply and demand come into balance? To what extent can domestic supply be stimulated and demand restrained? To what degree will lifestyle changes be required to bring about supply/demand balance?

Dimensions of the Problem--Energy Costs

Clearly, in the future, for the next 20 years at least, energy will be more costly than in the past[4] and is likely to be in short supply in some sectors in the United States, causing social values and economic conditions to change.

The basic reasons are:

- Energy demand is expected to increase at about the rate of 3.6 percent per year from 1970-1980.[5,6]

- Domestic crude oil production appears to have peaked in 1971. Optimistic projections (which include the North Slope) are for domestic crude oil production to slowly decline over the next 15 years.[5,7,8]

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[4] Energy Policy Project of the Ford Foundation Report, A Time To Choose--America's Energy Future (Cambridge, Mass.: Ballinger Publishing Co., 1974). (Hereafter called America's Energy Future.)

[5] Federal Energy Administration, Project Independence Report (Washington, D.C., November 1974). (Hereafter called Project Independence Report.)

[6] National Energy Outlook, pp. 10.

[7] National Energy Outlook, pp. 16-18.

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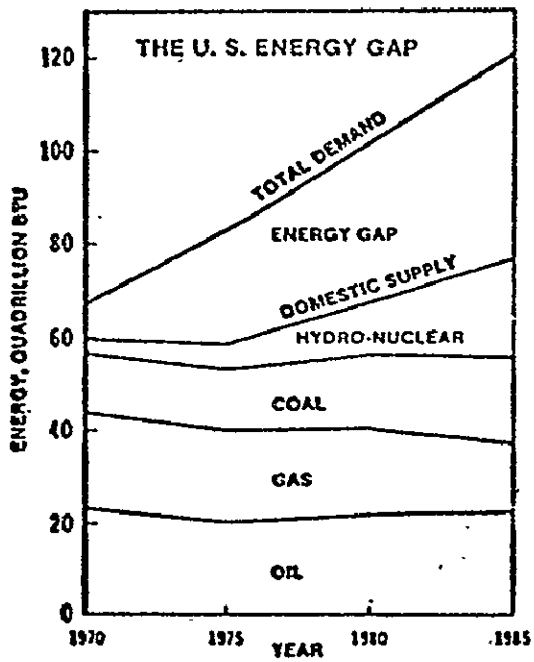
[8] The Office of Energy Research and Planning, Office of The Governor, State of Oregon, A Report to the Oregon Energy Council, Transition (January 1, 1975), p. 12.

- There have been delays in building nuclear power plants and bringing them to full power production due to environmental concerns and certain engineering difficulties.

- Recent environmental laws prohibiting the burning of high sulfur coal place an extra burden on oil and natural gas usage

- Environmental pressure has caused delays in the construction of oil refineries and other energy-related facilities.[9,10]

One of the most important consequences of these trends is the need to increase petroleum importation. Figure 2 shows a recent forecast for energy demand and domestic supply; the demand curve is predicated on the continuing growth of the U.S. economy and a continuance of current life-styles. The supply curves are based on industry and AEC projections.



Source: Shell Oil Company, The National Energy Outlook (March 1973).

Figure 2

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[9] Project Independence Report.

[10] National Academy of Sciences, Mineral Resources and the Environment (Washington, D.C., January 1975). (Hereafter called National Academy of Sciences.)

There are several ways in which this gap can be closed:

- Increasing amounts of petroleum can be imported.
- Policies can be established and technologies introduced in an effort to increase domestic supply.
- Policies can be established and technologies introduced in an effort to reduce consumption.

The prospect of importing ever increasing amounts of petroleum is disturbing for two reasons: it implies growing dependence on foreign nations' for a material which is intimately bound to our lifestyle and national self-determination,because it leads to an unfavorable balance of trade. In 1974, the United States imported 36.9 percent of the oil consumed,[11] 6,275,000 barrels per day,[12] at an estimated cost of $28 billion per year. It is estimated that oil imports in 1975 will increased over 1974 by 6.4 percent[13] with a corresponding increase in dollar outflow for oil payments. Figure 3 shows the fourfold increase in oil prices from OPEC.[14] A recent price for Saudi Arabian oil was $10.46/barrel (February 28, 1975). The OPEC oil prices have continuously increased from 1970 until now, and future price changes are presently uncertain.

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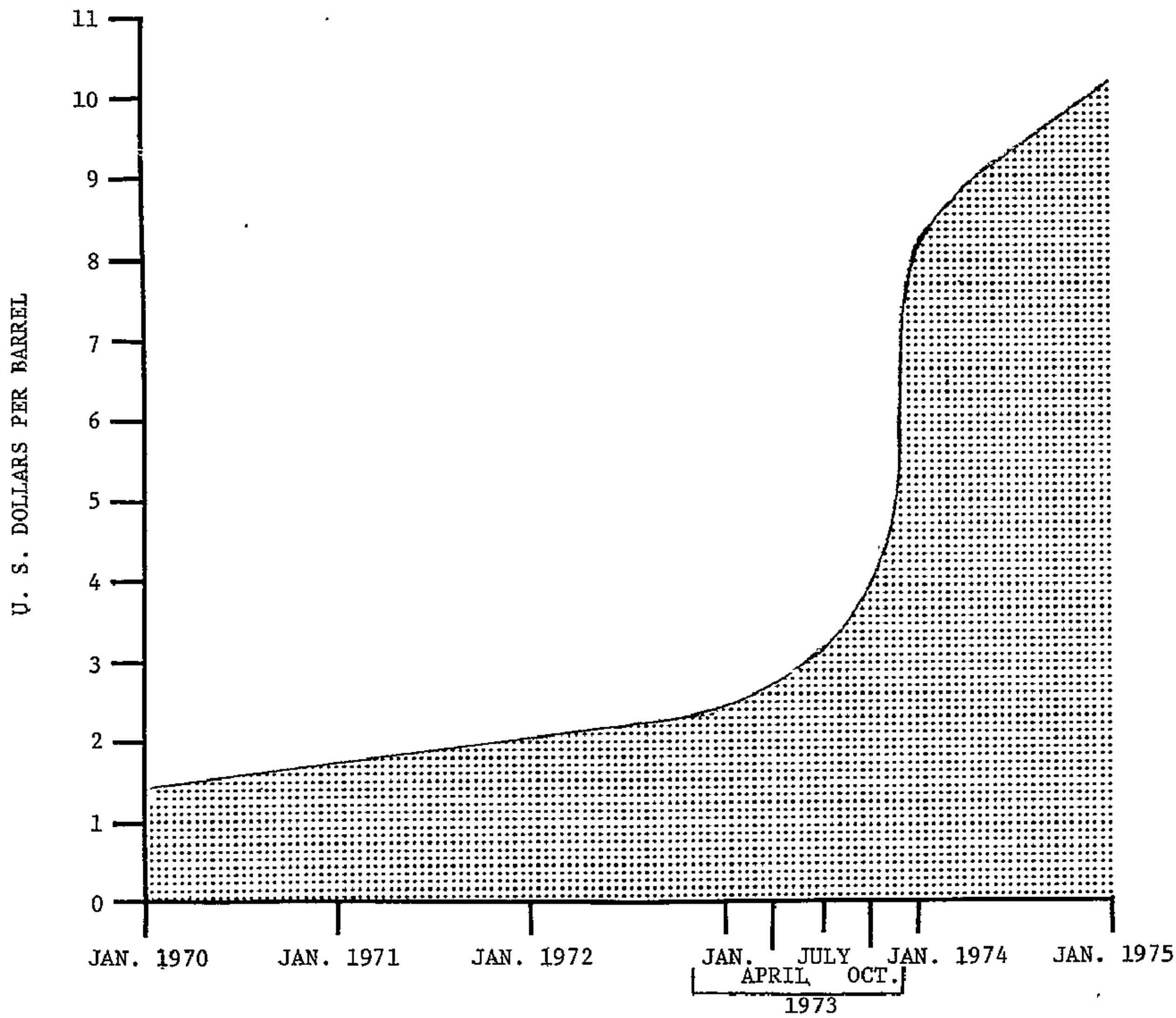
[11] American Petroleum Institute, News release, "Oil Demand, Imports," Washington, D.C., January 26, 1975.

[12] Oil and Gas Journal (January 27, 1975).

[13] Oil and Gas Journal (January 27, 1975), p. 104.

[14] America's Energy Future.

Figure 3. Average market price of Persian Gulf Oil



SOURCE: Energy Policy of the Ford Foundation Report, A Time to Choose-- America's Energy Future, p. 154.

Energy Use and Economic Growth

The level to which energy consumption can be reduced without impinging unduly on the country's economic viability is difficult to define because the precise relationships between energy costs and availability and the economy are largely unknown.[15]

Real growth in GNP per capita and in energy consumption per capita in the United States have been remarkedly parallel (see Figure 4).[16] Hence energy has long been viewed as a resource essential to economic growth[17] and to growth of the gross national product, both here and abroad (see Figure 5.).

> The economy of the United States and the technologically advanced nations is based on energy. Energy is the ultimate raw material which permits the continued recycle of resources into most of man's requirements for food, clothing, and shelter. The productivity, and consumption, of society, is directly related to the per capita energy available.[18]

It seems no coincidence that the United States, presently the world's largest economy with the highest per capita income, is also the largest consumer of energy. The United States, with about 6 percent of the world's population, is consuming about 36 percent of its energy. Annual energy consumption per capita in the United States is about 340 million Btu, the highest in the world.

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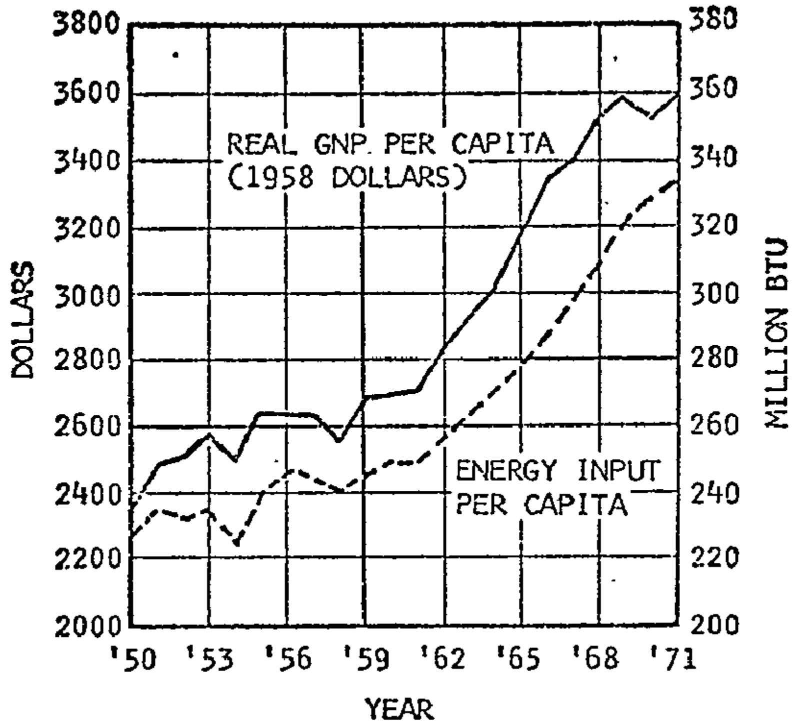
[15] National Academy of Sciences, pp. 266-280.

[16] The Conference Board, "Roadmaps to Industry," No. 1699 (October 1, 1972.

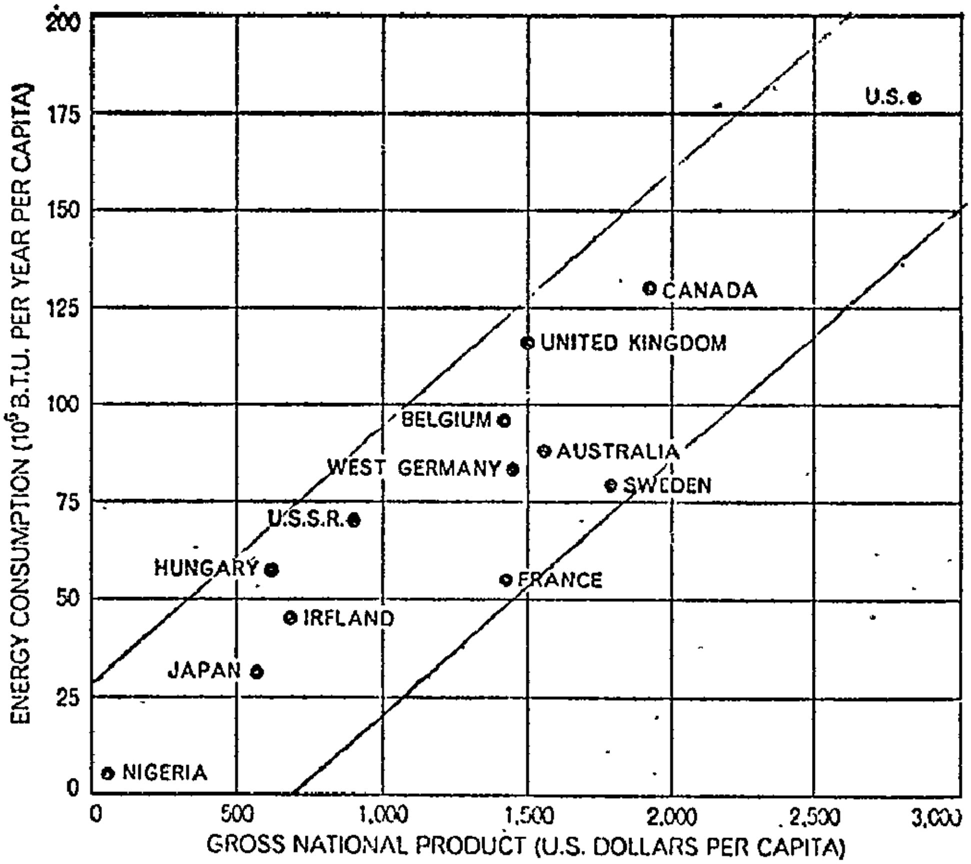
[17] C. Starr, "Energy and Power," Scientific American, Vol. 225, No. 3 (September 1971), p. 38.

[18] Joint Economic Committee of U.S. Congress, The Economy, Energy, and the Environment, September 1970, p. 5.



SOURCE: THE CONFERENCE BOARD, ROAD MAPS TO INDUSTRY
NO. 1699, OCTOBER 1, 1972.

Figure 4. U.S. energy consumption and economic growth



Source: Chauncey Star, "Energy and Power," Scientific American, Vol. 225, No. 3 (September 1971), p. 38.

Figure 5. Energy use and economic growth for 1968

Arguments are now being raised, however, that the historic relationships between growth in energy consumption and economic activity need not really apply in the long term. Although the growth in GNP and energy has been closely parallel, the rate of growth of each has not been equal. GNP has grown at a slightly greater rate than energy consumption. Since the early 1920's the U.S. energy/GNP ratio has been decreasing, as more intensive use of energy was offset by increased technical efficiency. But from 1966 through 1970, the trend reversed itself and the ratio moved steadily upwards (see Figure 6). This had alarming implications for the future and there was much speculation at the time that if the rise continued it would lead to even more drastic energy shortages than have been predicted. In 1971-1972, however, the ratio resumed its downward direction. Both the National Petroleum Council and the Bureau of Mines of the U.S. Department of the Interior anticipate that the ratio will continue to fall in the future. As a matter of fact, in comparing the energy efficiency of nations on the basis of energy use per dollar of GNP versus per capita GNP, the United States appears as a highly efficient user of energy (see Figure 7).[19]

Also, in a recent study, The Conference Board argues that as the national economy grows, energy consumption grows more slowly. The Conference Board states that energy needs can come close to zero growth as more efficient plants and processes become standard in the industry. The study also notes that continued transition to service industries, which are less energy intensive, will reduce per capita energy needs. However, the study also notes that major cutbacks in energy consumption are certain to cause immediate hardship and unemployment.

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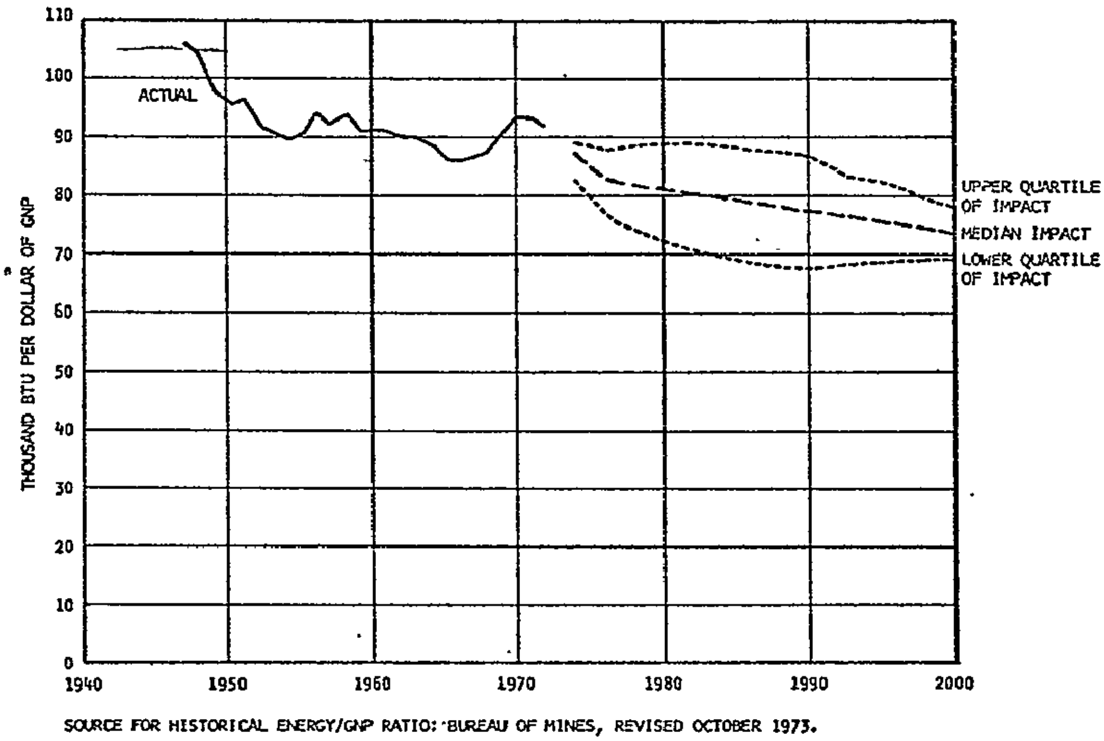
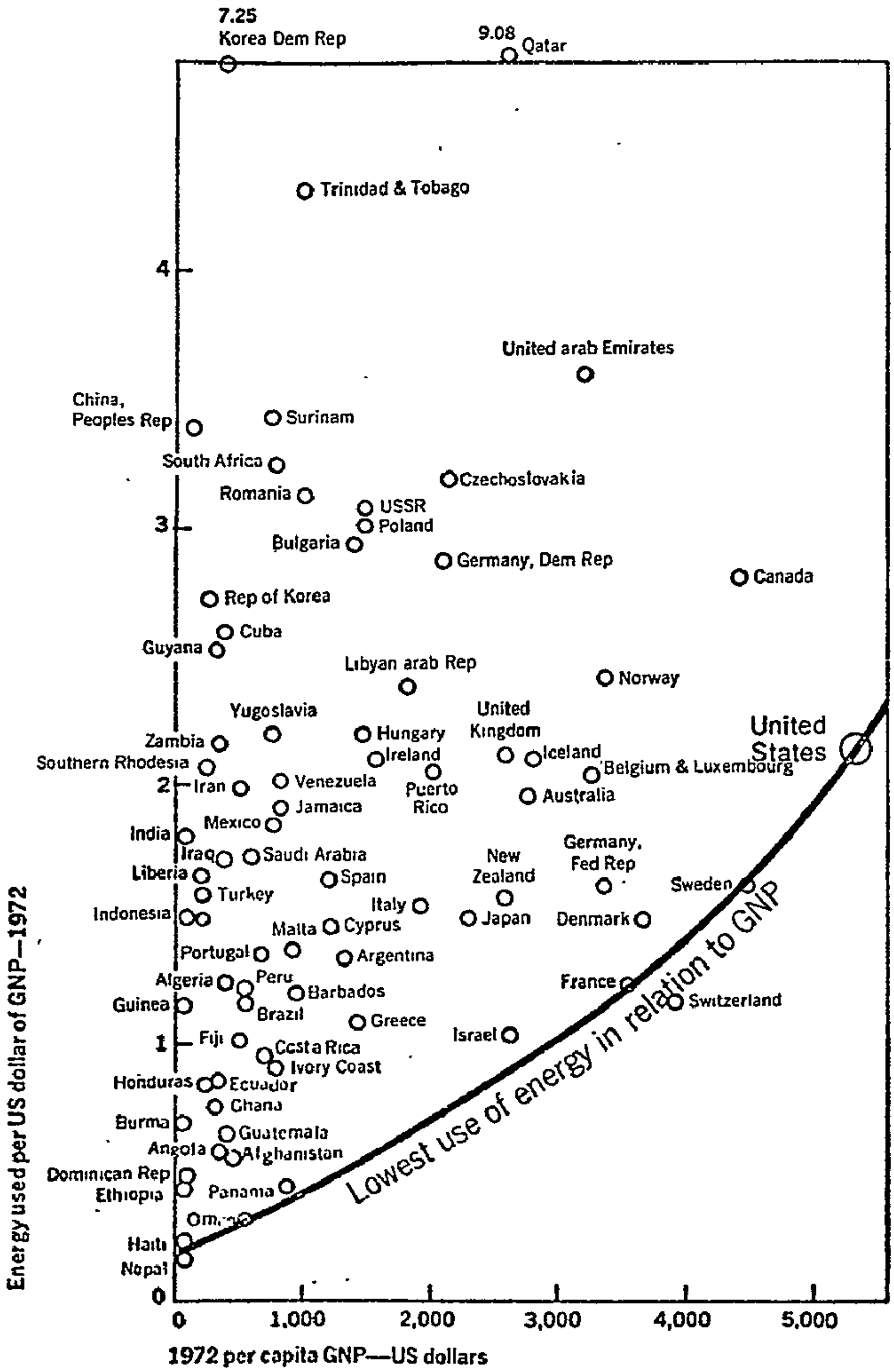
[19] F. Felix, "U.S. Using Electricity More Efficiently," Electrical World (December 1, 1974), pp. 59-62.



SOURCE: The Futures Group, A Technology Assessment of Geothermal Energy, Report 164-46-11 (Glastonbury, Conn., September 1974).

Figure 6. Forecast of U.S. energy/gap ratio (1970 constant dollars)



SOURCE: Electrical World (December 1, 1974), p. 59.

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Figure 7

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Future Demand for Energy in the United States

Most of the projections of total energy demand for the United States are actually projections of consumption made using more or less sophisticated analyses of past use trends. These projections describe what might be consumed if there were no supply constraints, if prices remained essentially constant, and if other factors affecting use (e.g., efficiency of consumption) remained essentially fixed. However, as is now known, supply is likely to be constrained and prices will surely remain high. Therefore, projections of future consumption must take into account the supply availability and price elasticity of the various kinds of energy, a very difficult chore.

Nevertheless, a range of forecasts of energy consumption have been made recently. The Project Independence study of the Federal Energy Agency analyzed demand as a function of oil price and, as shown in Figure 8, produced estimates of demand which ranged from 103 to 118 x 10^{15} Btu by 1985. A comparison with other recent studies is presented in Figure 9. Note that the FEA projections are lower than most previous forecasts for $11/barrel oil.

Figure 10 summarizes in graphical form eight forecasts of demand out to the year 2000. The range clearly is enormous, but a fair estimate of demand might be made by using the projection of Figure 7 and an average estimate of real GNP growth rate, say, 3.2 percent to the year 2000. In this case the demand in that year would be 150.7 x 10^{15} Btu.[20]

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[20] F. Maslan and T. J. Gordon, U.S. Energy Development: Four Scenarios, Report 165-69-01 (Glastonbury, Conn.: The Futures Group, October 25, 1974). (Hereafter called U.S. Energy Development.)

Price of Imports	Total Demand 1972 Actual	1985 Quads	1985 Estimated % Growth
$4	72.1	118.3	3.8
$7	72.1	109.6	3.2
$11	72.1	102.9	2.7

SOURCE: Project Independence Report.

Figure 8. U.S. total energy demand in the base case as a function of price (in quadrillion Btu per year)*

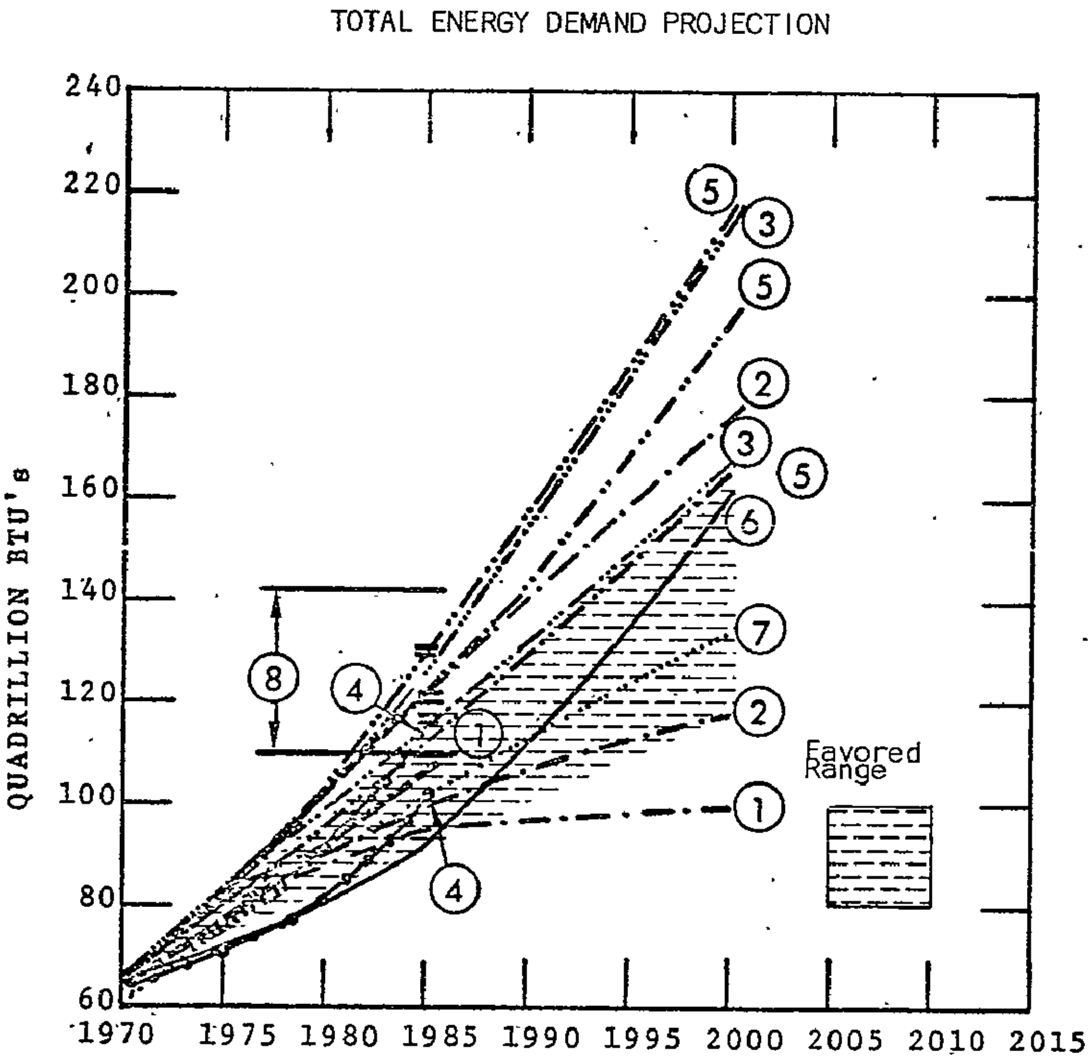
*Three units of energy used in this report are quadrillion Btu per year (Quads), millions of barrels of oil per day (MMBD), and trillions of cubic feet of natural gas per year (TCF). These are related by the formulas 1MMBD = 2 quad; 1TCF = 1 quad.

	Projected Demand 1985	Compound Annual Growth Rate 1972-1985
FEA @ $4 per barrel	118.3	3.8%
FEA @ $11 per barrel	102.9	2.7%
Ford Foundation, Energy Policy Project*	115.0	3.6%
Dupree-West	116.6	3.7%
National Petroleum Council	124.9	4.2%

SOURCE: Project Independence Report

Figure 9. Comparison of FEA projection of energy demand with other projections, 1985 (quadrillion Btu per year)

*America's Energy Future.



Source: Robert Anthony, et al, Technological Forecast of the Coal Extraction Process: Summary Report (Forecasting International Report to the U.S. Bureau of Mines) October 7, 1974.

Figure 10. Total energy demand projection

REFERENCES

ENERGY DEMAND CHART, FIGURE 10

[1]Bucyrus-Erie Company, U. S. Energy Independence By 1985. Milwaukee, Wis.

[2]The Ford Foundation. Exploring Energy Choices. A preliminary report-Energy Policy Project of the Ford Foundation, Washington, D.C., 1974.
High Projection - historical growth scenario
Moderate Projection - technical fix scenario
Low Projection - zero growth scenario

[3]Coal Age and Engineering & Mining Journal. "The Quest for U. S. Energy Sufficiency: National Mission for the 1970's." Coal Age LXXIX, (April, 1974), pages 69-71
High Projection - ordinary growth of demand
Low Projection - demand with energy conservation

[4]National Academy of Engineering. U. S. Energy Prospects: An Engineering Viewpoint, Washington, D.C., 1974.

[5]National Petroleum Council. U. S. Energy Outlook: A Summary Report of the National Petroleum Council, Washington, D.C. December, 1972.

[6]U. S. Congress. Committee on Interior and Insular Affairs, Summary Report of the Cornell Workshop on Energy and the Environment. Washington, D. C., 1972.

[7]Fisher, John C., Energy Crises in Perspective, John Wiley & Sons, New York, 1974.

[8]National Academy of Engineering, U. S. Energy Prospects: An Engineering Viewpoint, Washington, D. C., 1974. Appendix.

Future Energy Supplies

Now, despite the uncertainty in projections of demand, it is important to ask how much of the demand can be satisfied by indigenous resources. That portion which cannot be produced domestically must be imported or economic dislocations will result. The major sources of energy available to the United States include coal, petroleum, natural gas, nuclear, geothermal, solar, and hydroelectric. The historical evolution of these sources is shown in Figure 11.

Clearly, a great deal of information about each of these sources of domestic energy is available and need not be repeated here; nevertheless, in order to provide an overview, some important facets of the situation are summarized below.

Coal. The indigenous energy supply in the form of coal is very large. However, because of the availability of relatively cheap alternate fuels, air quality regulations, surface environmental concerns, and the prospect of nuclear energy rendering its product obsolete, the coal industry in the last generation has failed to grow in line with the rate of energy demand. Now, however, indications are that the trend is changing for an increased usage of coal in our national energy economy.

Coal is costly to transport compared to other forms of primary energy because it is a solid; and with emphasis on the huge western deposits which may be strip mined, improved transportation networks will be required to deliver these supplies to the major consuming areas at competitive prices. The growth of the coal industry will depend mainly upon solving safety, health, and environmental problems, the advent of improved mining technology, successful implementation of commercial processes for sulfur removal from stack gases, and successful processes for gasification and liquefaction. The gasification program is particularly important because it has a twofold potential use. First, low Btu gas can be used, after sulfur removal, as a very good fuel for combined cycle power plants which have potentially a very high thermodynamic efficiency, 45-55 percent. Second, high Btu gas is essentially pure methane and is a substitute for natural gas which is now in a state of declining resource in the United States.[21, 22]

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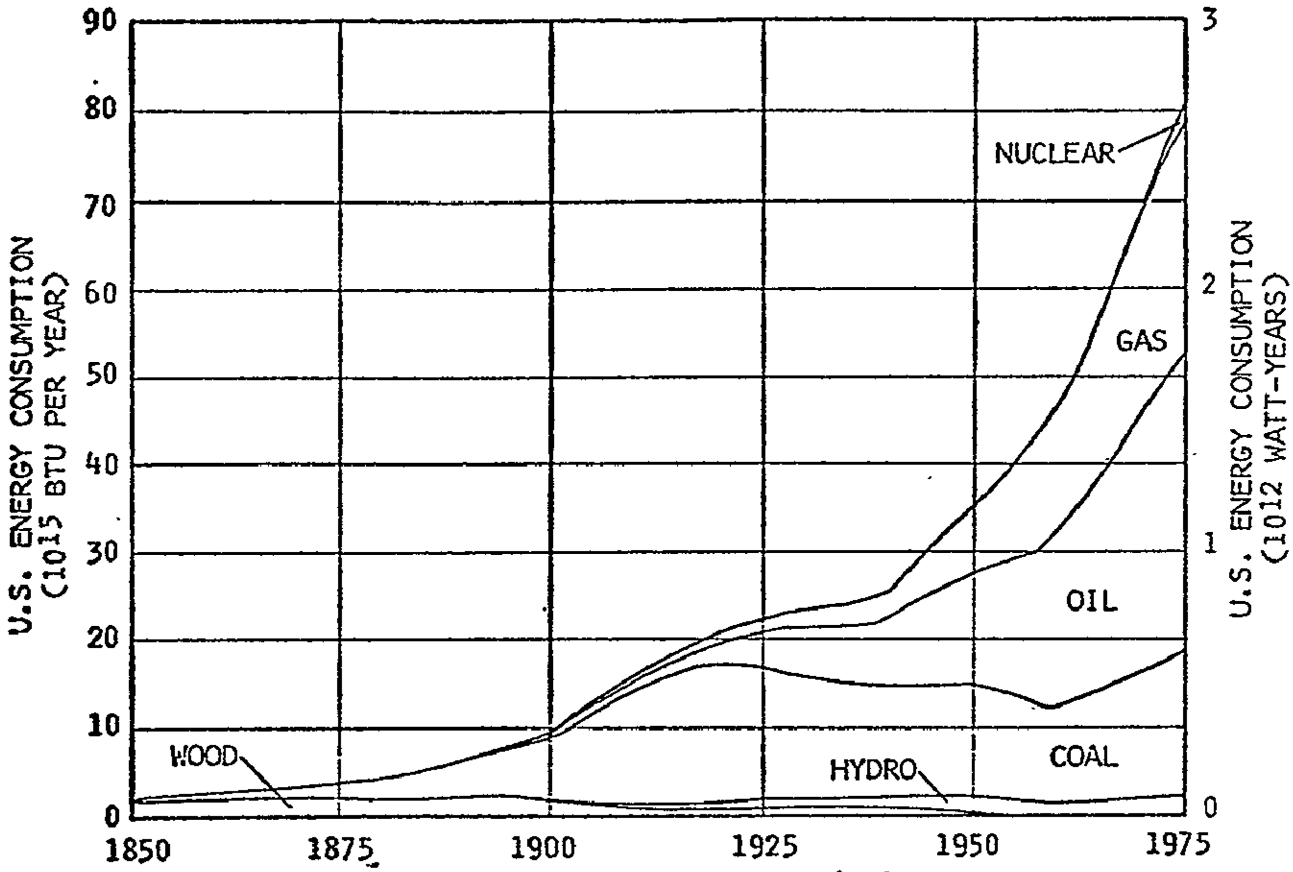
[21] S. H. Schurr, Energy Research Needs, Report PB-207516 (October 1971).

[22] U.S. Energy Outlook (Washington, D.C.: National Petroleum Council, 1972). (Hereafter called U.S. Energy Outlook.)



SOURCE: C. STARR, "ENERGY AND POWER," SCIENTIFIC AMERICAN (SEPTEMBER 1971).

Figure 11. Historical energy use patterns in the United States

Geothermal Energy. The potential for exploiting the extensive geothermal steam resources under public control is promising but still uncertain. There are five basic types of geothermal resources: dry steam, liquid dominated, hot dry rock, geopressure, and magma. In terms of systematic commercial exploitation of geothermal resources for general societal benefit, the chemical plant at Larderello (Tuscany), Italy, which was producing boric acid in 1818, predates all others. In 1904 the first attempt to generate electrical energy from geothermal energy was made on a small scale. By 1913 a capacity of 250 kWe had been installed. During World War II, a large part of the Larderello plant was destroyed by the retreating German Army; however, the plant has been fully restored and its capacity expanded to its present 384 MWe.

Geothermal programs exist in Italy, Iceland, New Zealand, Japan, Hungary, the Soviet Union, Mexico, the Phillipines, Turkey, and in several African countries, Greece, Israel, Yugoslovia, Guatemala, Nicaragua, El Salvadore, and India.

At The Geysers, California, a well was drilled in 1921 (by J. D. Grant of Healdsburg, California) for the purpose of generating electric power; however, large-scale production of electric power from this resource did not occur until 1960 when the Pacific Gas & Electric Company commissioned their Unit No. 1 (12.5 MWe). Total installed capacity of this installation is now 396 MWe (net), with an additional 110 MWe (net) under construction and an additional 406 MWe (net) committed for construction.

Geothermal energy can be a relatively important energy source in the United States by the year 2000. It is possible to supply on the order of 100,000-200,000 MWe, or more, compared to an expected U.S. total capacity of 2 million MWe. (For comparison, the State of California currently has a total generating capacity of 30,000 MWe.) At this level, by the year 2000 geothermal sources will be contributing more to our energy supply than will hydroelectric sources.[23]

Technology for conversion of geothermal energy from vapor-dominated and moderate salinity liquid-dominated geothermal systems is fairly well in hand. However, conversion processes and equipment for high salinity systems and moderate to low temperature systems are still experimental. Conversion processes for hot dry rock have not yet been developed, but will probably be similar to vapor- or liquid-dominated geological systems. Processes for geopressured resources are only conceptual at this time. The possibility of extracting and converting energy from magma is so remote that little or no serious thought has been given to this problem.

[23] The Futures Group, A Technology Assessment of Geothermal Energy, Report 164-46-11 (Glastonbury, Conn., September 1974).

Oil Shale. Except for a couple of demonstration plants, no shale oil is being produced commercially in the United States at this time. However, recent research and development by industry, the Bureau of Mines, and universities since the mid-1940's has provided the technological framework considered applicable to commercial oil shale operations that use mining and surface processing techniques. At least two 1000-ton per day demonstration plants are now being constructed or operated in Colorado.

In situ retorting, in which shale would be heated underground (thus avoiding mining) is relatively untried. Experiments by industry and the Bureau of Mines suggest that *in situ* processing may be feasible under certain conditions of rich oil shale deposits, but viable processes are not yet proven.

Coupled with this the western oil shale industry has some difficult environment problems in the disposal of the solid waste from the process and from a desperate lack of water in the region of the major deposits.

Currently, the estimates are that the required selling price of shale oil will be in the region of $10-15 per barrel (1973) in order to achieve an adequate return. Assuming a large national effort, production of shale oil could reach as much as 900,000 barrels a day by the mid-1980's.[24,25]

Oil-Tar Sands. Asphalt and heavy oil bearing sands have been recognized for many years as a potential source of synthetic crude oil. There are numerous tar sands occurrences throughout the world, including several in the United States. The largest known domestic tar sands deposits are in Utah, with lesser ones in California, New Mexico, and Kentucky.

However, the Athabasca tar sands deposit in northeastern Alberta, Canada, is the world's largest, followed by an almost equally large one in Venezuela. An American company placed a full-sized commercial plant, 45,000 barrels per day, in operation in 1967 at the Canadian site. Various difficult technical problems have been encountered and solved so that by now the process seems to be technically viable. Several other organizations are now also building plants at Athabasca.

Tar sands recovery requires a large initial capital outlay for plant construction and thus will require a high selling price for its oil product. It is currently estimated that oil from the Canadian oil sands will

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[24] G. V. Dinneen and L. Cook, Oil Shale and the Energy Crisis, Report ASME 72-WA/Fu-3 (Washington, D.C.: U.S. Department of the Interior, November 1972).

[25] "Secretary Morton Announces Prototype Oil Shale Lease Sales," Department of the Interior news release, November 28, 1973.

have to sell in the price range of $9-12 per barrel (1973) in order to achieve an adequate return.

A political point of great importance to the United States is that the Athabasca tar sands are in Canada and therefore cannot be regarded as a completely available domestic resource.[26]

Hydropower. Further hydropower utilization in the United States is limited by the number of available natural sites and by the very high capital costs of new projects. Although the Federal Power Commission has estimated a large undeveloped potential, few new additions are expected in the next generation and the forecast is that the percentage of power supplied from this source will decrease to about 6 percent of the total electricity generation by 1990.[27]

Solar Energy. Radiation energy from the sun falling upon the earth's surface is enormous. Sunlight falling on an area the size of Lake Erie in one day is equal to the energy from all fuels man has so far burned on the earth. Of course, this basic solar energy is the prime element in plant growth and in animal comfort; and was the initial source of the earth's fossil fuels.

The concept of the direct use of solar heat for space heating and cooling is technically feasible. Up to now solar heating and cooling has been generally uneconomical. Besides the dependence for advanced design and technology in the utilization of this solar heat, the architectural design of buildings must be considered and improved for the successful utilization of it, and reliable systems for incorporating solar heat on a continuous basis must be developed. On the other hand, the present sudden increase in the cost of all fuels has made the economics of solar energy more competitive. Although solar energy utilization systems use a fuel which is free, the capital costs have generally been very high so that the manufacturing cost in most instances is high.

At present the government is sponsoring extensive research in the utilization of wind power and ocean thermal gradient power, both originating from solar energy, for the generation of electricity. Successful development of both of these is regarded as 5-20 years in the future and

[26] J. Wade Watkins, "Tar Sand and Heavy Oil Sand Resources and Technology," Bureau of Mines news release, September 1973.

[27] U.S. Energy Outlook

will probably be, at best, auxiliary sources of power in the complete national system. 28, 29

A more sophisticated method of employing solar energy involves the conversion of solar radiation into electricity directly by the use of solid-state solar cells. The efficiency of these photovoltaic cells, which is defined as the ratio of the electric power output divided by the incident solar energy, is theoretically between 15 and 28 percent, depending on the specific semiconductor used. In the laboratory actual efficiencies of 14-16 percent have been obtained, while commercial units have a long-term efficiency of 6-8 percent. 30

An extensive R&D program is predicted to lead to improved materials for photovoltaic cells. It is believed that higher efficiencies can be obtained and that the capital costs of the units can be decreased by orders of magnitude. The present forecasts are that this may be accomplished by the 1990's. Starting at this time, it is believed that in the good geographic locations in the country, solar energy converted electricity will start to become commercially available. 30

Hydrogen Energy Economy. Hydrogen may be produced by the use of one of the new forms of commercial energy: nuclear, solar, geothermal, and oil shale. This hydrogen may then be utilized as a gas in the national gas supply or may be converted into other gaseous and liquid fuels. As such, hydrogen would act as a secondary energy carrier from the basic resource to the utilized fuel. In doing so, the hydrogen can be used as a means for developing a continuously available energy system and substitute for sources which have individual peculiarities such as non-continuous supply for solar and necessary base loading for nuclear and geothermal power plants. 31

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[28] Solar Energy As A National Resource (Washington, D.C.: NSF/NASA Solar Energy Panel, December 1972).

[29] L. O. Herwig, "U.S. Solar Energy Research Program," Paper presented at the International Solar Energy Society, U.S. Section Annual Meeting, October 3-4, 1973, Cleveland, Ohio.

[30] Solar Thermal Conversion Mission Analysis (The Aerospace Corporation, January 1974). (Hereafter called Solar Thermal Analysis.)

[31] E. Fein and J. Stover, Hydrogen: A Fuel for the Electric Utility, Report 86-08-12 (Glastonbury, Conn.: The Futures Group, May 1973).

Nuclear Power. Nuclear power is presently the long-term key to the U.S. energy future. New electric utility plants are forecast to be mostly nuclear in the future due to the increase in cost of fossil fuels, limitations on their availability, and the need to meet increasingly stringent pollution criteria. Also, it is presently forecast that electricity generation will account for approximately 50 percent of the basic national energy utilization by the year 2000. 32

The most probable course of reactor development appears to be a continued reliance on the light water reactors (LWR) types through 1990. Advanced converter reactors such as the high temperature gas-cooled reactor (HTGR) will probably start to be used extensively by the mid-1980's. The breeder type reactor is presently under development. The most advanced candidate is the liquid metal fast breeder reactor (LMFBR) which is visualized as becoming the dominant nuclear reactor type selected for central power plants by 1995-2000. The fast breeder reactor has many very difficult technical problems which still have to be solved and then demonstrated before it can be successfully commercialized. This will undoubtedly take a long term of years. 32

Meanwhile, the nuclear power industry also has its problems. Siting of new plants has become extremely difficult, and the adequacy of emergency core cooling design together with radiation emission standards is being continuously questioned. Much future effort is required in good engineering design before these basic questions can be answered in a manner that answers all of the previously mentioned social criteria.

Controlled thermo-nuclear fusion in which the nuclei of light elements fuse to form heavier nuclei and in the process release enormous quantities of thermal energy offers the possibility of direct conversion of this thermal energy into electricity based on an almost infinite energy resource, heavy hydrogen.

The scientific and technical problems facing the successful development of fusion are very great. In one of the two systems being developed, a workable magnetic containment system must be demonstrated. Then, the power required to energize the magnetic field and other power losses of the system must be less than that released by the fusion reaction. Achievement of this net energy gain may require extremely large reactors since the power output would depend directly on the volume of the reacting plasma. 32

Petroleum. Petroleum and natural gas production peaked in 1970-1971 and industry projections indicate that production is likely to remain lower than peak through the turn of the century. This is demonstrated in Figures 12 and 13. However, some potential recovery technologies are enormously

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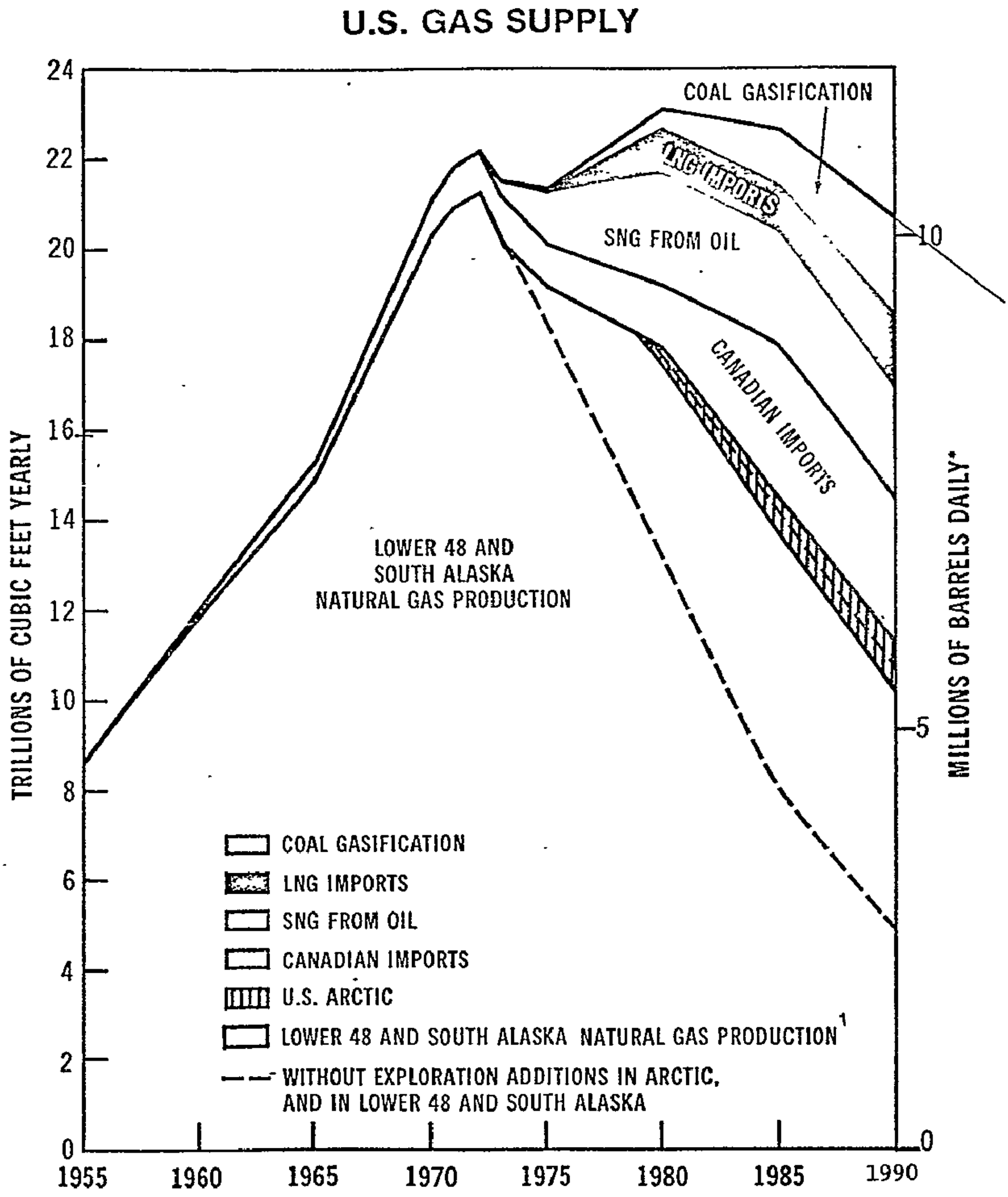
[32] Fusion Power, An Assessment of Ultimate Potential, Report AEC-WASH 1239 (Washington, D.C.: U.S. Atomic Energy Commission, February 1973).

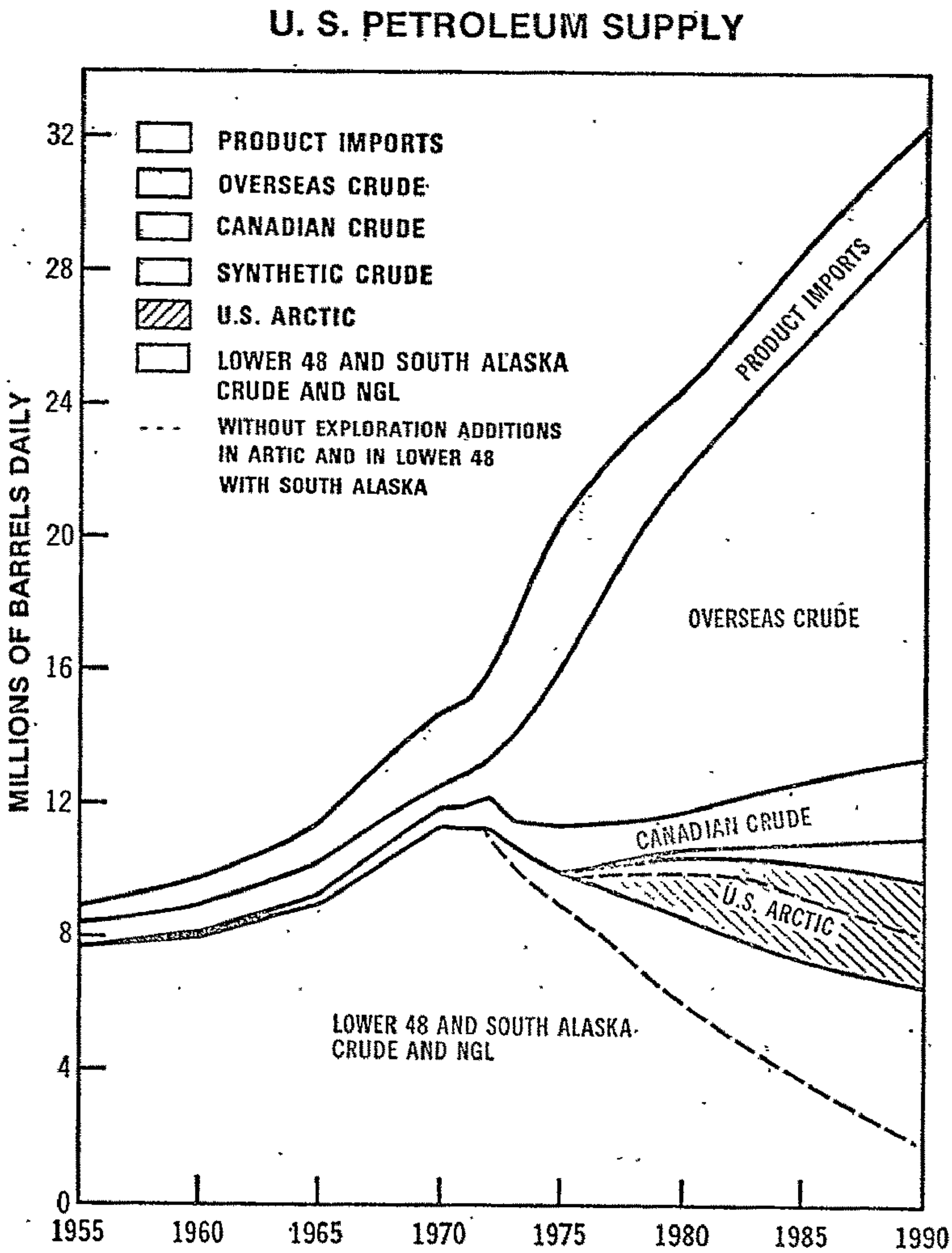


[1]*AFTER NET STORAGE, FIELD, TRANSMISSION AND EXTRACTION LOSSES*

**Crude oil equivalent*

SOURCE: Shell Oil Company, <u>The National Energy Outlook</u> (March 1973).

Figure 12



SOURCE: Shell Oil Company, The National Energy Outlook (March 1973).

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Figure 13

important. Present recovery from oil wells is some 32 percent.[33] Steady improvements in tertiary and secondary recovery efforts are likely to increase this percentage to about 35-40 in 1985 and may be substantially higher in the 1990's. These remaining supplies generally require additional in-place processing before recovery is possible. More than 150 billion barrels of oil having a viscosity above current equipment capability are estimated still in place in the United States.[34] Effective techniques to economically recover these quantities are required for effective utilization of the resource.

Improvement in assaying offshore deposits can also increase future production. Underwater assaying on the Contingental Shelf is currently limited to 600-800 feet below the surface of the water.[35] A projected increase to between 1500 and 2000 feet capability by 1990 will increase production approximately 10-15 percent over current levels.

The U.S. energy production in 1969 is given in Figure 14. This is compared to the estimated recoverable resources to provide a qualitative view of the relative importance of the domestic reserves in contributing to the resolution of the issue.

What Are the Limits to Conservation?

Consumption can and will be modulated by changing relative fuel electricity prices, government incentives designed to shape market forces, perceived relative abundance of various fuels, and regulations designed to control rate of use of various fuels. Which techniques are employed will depend on the political and economic situation in the United States and the world in the months and years ahead.

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[33] U.S. Energy Outlook.

[34] "Energy Resources of the United States," U.S. Geological Survey Bulletin 650 (1972).

[35] Personal communication, N. K. Anderson, The Bechtel Corporation, October 1973.

DOMESTIC ENERGY RESERVES AND RESOURCES

The 1969 production is compared with cumulative production proved-recoverable reserves, and estimates remaining recoverable resources.

Commodity	1969 Domestic Production[a]	Cumulative Production Through 1969	Reserves Proved Recoverable at end of 1969	Remaining Recoverable Resources
	(in units of 10^{15} Btu)			
Coal	14.951	1040	1087	64,400
Petroleum (crude oil)	18.922	501	166	594
Natural Gas Liquid	2.392	49	33	168
Natural Gas (dry)	20.466	382	284	975
Oil Shale	Neg.	Neg.	113	1066
Uranium: U-235[b]				
<$8/lb	5.15	83	83	200
$8-10/lb	--	--	56	278
≤$15/lb	--	--		687
Uranium: U-238[b]				
$8/lb	710	11,486	11,504	27,631
$8-10/lb	--	--	7,669	38,345
$15/lb	--	--	9,022	94,735
Thorium[b]	N/A	N/A	N/A	15,025
Geothermal[d]	Neg.	Neg.	--	770,000 MWe

[a]Bureau of Mines

[b]Conversion gives energy released from complete fissioning of uranium isotopes.

[c]U_3O_8 prices as high as $100/lb will be economically viable with breeder reactors. Resources in the $15-100/lb bracket were estimated to be 37,240,000 tons.

[d]A Technology Assessment of Geothermal Resource Development for the National Science Foundation by The Futures Group and Bechtel Corporation (to appear).

SOURCE: Joint Committee on Atomic Energy, Understanding the National Energy Dilemma (Washington, D.C., 1973); and Georgetown University (Washington, D.C.).

Figure 14

The consumption of primary fuels for the generation of electricity was about 25 percent of the total national energy input in 1970, and may reach 30-50 percent by the year 2000.[36] This increasing role for electricity involves conversion from primary energy sources and this conversion necessarily involves losses, increasing relative use of electricity will result in rapid growth in the use of primary fuels. In other words, relative growth of electricity results in consumption of larger portions of the total energy supply as conversion losses. Of course, the magnitude of the conversion losses depends heavily on the absolute levels of electricity generated, the state of generation technology, the fuel mix, and other factors. A recent study can provide an example of the magnitude of energy losses involved. The Ford Foundation Energy Policy Project projected conversion losses of 18.4 percent of total energy input in 1975; by 2000, these losses were projected to be 31 percent of total energy consumption.[37]

The second implication of the increasing relative use of electricity is that unusable energy sources can be more fully employed. For example, uranium, hydro-resources, solar, geothermal, coal, and residual oil can enter the overall fuel mix in the form of inputs to electricity generation. The cheapest and most abundant fuels are thus available for electricity generation, and scarce fuels such as natural gas and petroleum remain available for direct use. Furthermore, the primary energy sources useful in the

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[36] Joint Committee on Atomic Energy, Understanding the National Energy Dilemma (Washington, D.C., 1973); and Georgetown University (Washington, D.C.).

[37] Edward A. Hudson and Dale W. Jorgenson, U.S. Energy Policy and Economic Growth, 1975-2000 (Cambridge, Mass.: Harvard University and Data Resources, Inc. [part of the Ford Foundation Energy Policy Project], June 1974).

generation of electricity are, for the most part, indigenous; therefore, the increasing relative use of electricity moves the country towards energy independence from foreign supply with all of its associated political-financial headaches.

Among the conservation strategies which have been discussed within the various consuming sectors are:

Transportation

Increasing new car efficiency by limiting horsepower or gross weight, or by imposing MPG standards.

Imposing a 30¢ tax on gasoline (President Ford recently rejected this approach).

Encouraging the use of mass transit by providing capital, and operating subsidies.

Household and Commercial

Encouraging the improvement of building thermal insulation by offering tax credit, improved mortgages, and so on.

Reducing lighting through the promulgation of new standards.

Promoting the introduction of solar heating through tax credits, low-cost loans, and so on.

Industrial

Introducing accelerated depreciation on energy-saving-related investments.

Promoting recycling and effective solid use of solid wastes in general.

Utilities

Reducing peak demand through the introduction of energy storage mechanisms.

Improving efficiency of generation and transmission.

Shaping and reducing load through the introduction of various rate structures. 38

[38] Project Independence Report.

The FEA, AEC, NSF, the Ford Foundation Energy Policy Study, and others have analyzed one or more aspects of the levels of energy savings which are attainable through such measures. The problem is quite complex because the effectiveness of price increases in reducing demand is not well known. Nevertheless, it is estimated that with petroleum selling for $7/ barrel, such policies could reduce consumption 7 percent in 1980 and as much as 12 percent in 1985. The most significant gains are to be made in the transportation sector (about half of the total). At higher petroleum prices, the indicated energy savings would be even larger.

The Outlook

All things considered, it would not be unreasonable to expect that conservation strategies could "save" 15 percent or so from a no-conservation case, and supply-stimulation policies (such as encouraging outer continental shelf drilling and improved tertiary recovery) could increase domestic supply by 15 percent over a no-action case, by the year 2000.[39] If no more than this could be achieved, complete energy independence would not be possible before the turn of the century, but the amount of imported oil would remain constant after 1985; about 10 x 10^{15} Btu/year.[39]

[39] U.S. Energy Development.

Some Potential Future Actions

Alternative Approaches. The classes of alternative actions available to reduce the country's dependence on imported energy include educational programs, directed at both suppliers and consumers; scientific and technological research and development aimed at increasing consumption efficiency, improving current supplies, and bringing new energy sources on-stream; and legislative initiatives ranging from allocation of energy and deregulation of various energy prices, to providing financial incentives for exploration and development of new energy supplies. A summary of such actions is presented in Figure 15.

Three time domains provide a convenient framework for discussing those steps necessary to alleviate energy constraints in the United States. Immediate results can be obtained through legislative actions such as rescinding selected environmental restrictions, providing a peak load primary schedule, etc. In the short-term (15 years or so), present actions directed at drawing on our domestic supplies by expanding current technologies are our major hope. Extensive coal mining and offshore drilling are examples. Our dependence on fossil resources can be diminished only when entirely new technologies are operational. Therefore, we must commit ourselves to a long technological endeavor which may extend into the next century in order to once again provide ourselves with secure energy sources.

Nuclear fission has been a growing energy resource; however, significant questions have been raised about waste heat and radiation as well as the dangers resulting from a possible engineering failure of a nuclear

FIGURE 15

ACTIONS THAT MAY AFFECT U.S. ENERGY DEMAND AND DOMESTIC SUPPLY

Education

° Programs for domestic and foreign suppliers on the socio-economic implications of energy availability and cost

° Programs for the public and private sectors on energy consumption and use

Science and Technology

° Development of more efficient means of electrical energy generation, storage, transmission, more efficient transmission lines, high efficiency storage devices, etc. (Also development of the hydrogen energy economy.)

° Development of more efficient energy consumption modes (e.g., improved mass transit, new automobile engines, improved insultation and construction, more efficient appliances, industrial machinery, etc.)

° Development of new supplies of energy (secondary/tertiary recovery of petroleum, geothermal systems, solar energy, oil shale recovery, underground and strip mining of coal, coal gasification, nuclear fission and fusion, improved geophysical exploration, etc.)

° Improvements in understanding of the relationships between energy consumption and economic growth

Legislation

° Rationing of energy

° Deregulation of energy prices

° Financial incentives (e.g., taxes, subsidies) for exploration, R&D and more efficient utilization and consumption of energy

° Relaxation or abolishment of pollution constraints on energy production and/or use plant.[40] The breeder reactor has been viewed as a means of overcoming this resource limitation. However, the breeder itself has been plagued with engineering difficulties and cost and schedule overruns. Recently, strong arguments also have been raised about the possibility that radioactive materials may easily be stolen by dissidents who might blackmail private institutions or even nations with bombs made from such material.[41] Concern about the safety of nuclear power generating stations has led to the introduction of significant constraints in the approval and construction cycle, to the point where it now takes about ten years from initial application to the point where a nuclear plant can begin supplying significant amounts of electrical energy for public consumption.

Thermo-nuclear fusion has been described as a potentially attractive long-term solution. 42 This technique employs the energy conversion process

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[40] Reactor Safety Study, An Assessment of Accident Risk in U.S. Commercial Nuclear Power Plants, Summary Report, WASH-1400 (Washington, D.C.: U.S. Atomic Energy Commission, 1974).

[41] John McPhee, The Curve of Binding Energy (New York: Farrar, Straus & Giroux, 1974).

[42] In this concept, very light atomic nuclei (i.e., hydrogen) combine to create highly energetic new nuclei, various sub-atomic particles, and energy in the form of radiation. Control of the fusion process involves many scientific principles which are not completely understood and which will require engineering capabilities not currently available. Stated simply, the most difficult problems are associated with maintaining an environment, typically in the form of a plasma, which is at sufficiently high temperature and is sufficiently stable so that the fusion process can be maintained. Recent developments using laser techniques have been applied to this problem. In this concept, a laser beam is focused on a pellet of deuterium to create the conditions necessary to sustain fusion. (Moshe J. Lubin and A. P. Fraas, "Fusion by Laser," Scientific American, Vol. 224, No. 6 [June 1971], pp. 21-23.) In any event, it is clear that even these recent breakthroughs cannot make fusion available in more than just laboratory, or at the most, engineering pilot plan demonstrations during the next several years.

in which hydrogen atoms combine to produce heavier atoms with an accompanying release of energy. Much remains to be done before this concept can be utilized to provide significant amounts of power.

The major thrust in making America energy independent, at least through the next 20 years, must necessarily focus on expanding America's ability to supply fossil fuels from domestic sources. Indeed, the recent crude petroleum price increases resulting from the oil embargo have made hitherto uneconomic petroleum deposits and other energy sources more attractive. Proposals have been made to produce oil from shale, gas from coal, hydrogen from water, and methane from growing plants and wastes. Several important impediments exist in many such plans; among them are water availability and capital availability. It has been estimated that shale oil plants (100,000 barrels/day and coal gasification plants (250 million cubic feet/day) may cost $700 million or more per plant.[43]

The potential use of America's enormous coal reserves as a means of providing energy independence was mentioned earlier. Work is underway to find economic means of converting coal to a methane-like natural gas or petroleum-like liquid. Serious consideration is already being given to ways of improving underground mining techniques to recover deep deposited coal and to develop means of land reclamation techniques for strip mining operations. The desire to exploit U.S. coal resources may moderate the influence, at least partially, of the arguments of the environmentalists.

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[43] Achieving Energy Independence, Research and Policy Committee of the CED, December 1974, p. 54. (Hereafter called Achieving Energy Independence.)

But approximately $300 billion in investments may be needed for the production of conventional oil, natural gas, coal, and uranium supplies equivalent to the 1985 demand. 44

Figures 17-20 present more detailed lists of potential technological and legislative programs which have been recently studies and proposed. 45,46

TECHNICAL PROGRAMS AFFECTING DEMAND
Technology
Emergence of a solar home heating industry
Significant agricultural and industrial uses for low grade heat
Advent of electric auto commercialization
Advent of fuel cells for substations, homes, buildings, etc.
Development of low flammability foam for high efficiency low-cost insulation
Development of lighting which essentially doubles efficiency in visible spectrum
Practical auto engine which is non-polluting and 20 percent more efficient than current
Greatly increased use of plastic in automobiles to reduce weight (less than 1800 lb. average) and improve MPG

Figure 17

[44] Achieving Energy Independence.

[45] Project Independence Report.

[46] U.S. Energy Development.

TECHNCIAL PROGRAMS AFFECTING SUPPLY

Technology

SO_2 scrubbers technically and economically proven.

Coal liquefaction and coal fasification implemented on large scale.

First large-scale oil shale plant on-line.

Hot dry rock geothermal proven feasible.

Combined cycle turbine.proven technically and economically.

Improved secondary and tertiary recovery.

Tar sand oil proven technically and economically sound.

Deeper water oil operations, and recovery.

New and improved uranium enrichment processes.

Nuclear breeder power plant demonstration.

EHV large long distance (more than 1500 miles) electricity transmission lines.

Utilization factor of light water reactors is high.

Effective solvent processes for sulfur removal from coal.

Figure 18

POTENTIAL LEGISLATIVE SUPPLY POLICIES
<u>Policies</u>
Natural gas wellhead prices removed.
Defeat of arguments for depletion allowance termination.
Geothermal exploration and use incentives.
Offshore oil leasing stimulated.
Very large-scale government R&D programs.
Coal mining environmental constraints eased.
SO_2 restrictions eased.
Nuclear power plants expedited.
Incentives for the development of oil shale established.
Obtaining favorable trade arrangements for oil.
Oil storage increased to one-year supply.

Figure 19

POTENTIAL LEGISLATIVE CONSERVATION POLICIES

Policies

Increase new car efficiency with an accelerated excise tax on low efficiency cars, or mandatory fuel efficiency standards.

Reduce vehicle miles traveled with a 30¢ per gallon conservation fee.

Additional capital and operating subsidies for public transit linked to auto disincentives.

25 percent tax credit for installation of insulation, etc., in existing homes.

Minimum efficiency standards for all new home construction.

15 percent investment credit for energy reduction investments in existing commercial buildings.

Minimum standards on new commercial buildings.

Minimum energy efficiency standards on new appliances.

Mandatory lighting standards for commercial buildings.

50 percent tax credit on solar appliances.

Accelerated depreciation on energy investments.

Subsidies for solid waste systems.

Reduce peak through changing of rate structure.

Reduce peak demand through regional and national interties.

Reduce peak demand through termal storage.

Increase generation and transmission efficiency by 5 percent in new plants.

Figure 20

Potential Effectiveness

A review of the programs suggested in Figure 17-20 indicates that energy independence would most effectively be promoted by:

- Diminished gasoline demand

  °increasing auto efficiency
  °limiting maximun auto weight
  °taxing gasoline or petroleum

- Improved methods of tertiary recovery

- Improved efficiency on industrial energy use

- Improved space heating efficiency through, for example, the use of higher performing insulation

- Incentives for the development of safe nuclear plants and geothermal energy resources

- Exploring and developing the outer continental shelf.

- Improved methods of coal extraction and processing.

- Although the "pay off" is not likely to be until the next century, fusion and solar energy research.

In essence, the question of energy production and use in the United States during the next several years resolves itself to ways in which we will be able to produce fossil fuels, make compromises in using these fuels, and implement more efficient conversion techniques. Large-scale transitions to non-fossil fuel energy sources are not likely to occur in the 1970's or 1980's.

WORLD CONCERN: INTERNATIONAL CONFLICT

The threat of nuclear holocaust dominates the course of the U.S. international relationships and U.S. foreign policy. The U.S., U.S.S.R., Great Britain, France, China, India, possibly Israel, and maybe in the near future Argentina, have nuclear capabilities, with the two major powers having staggeringly large delivery capabilities. The growth of the use of nuclear energy for electrical power throughout the world increases not only the numbers of nations with nuclear weapon capabilities, but the insidious potential for the hijacking of nuclear materials for acts of blackmail or terrorism by extremist groups. The possibility that a smaller nation will use its nuclear capability for blackmail of a neighboring or other nation for economic, resource or political concessions is and will, in all likelihood, become very real. A scenario wherein India, desperate for food for her hungry people and economically constrained from buying food would use her nuclear capabilities to force the rest of the world to bargain food in exchange for her signing of the non-proliferation agreement.

Even aside from the nuclear threats, the conflict potential is enormous, ranging from cartels such as that of the Organization of Petroleum Exporting Countries (OPEC) to individual acts of terrorism by small dissident groups. Armed conflict throughout the world has been almost continuous during the present century and shows no signs of abating. Since 1961 military expenditures around the world have doubled from an estimated $100 billion to over $200 billion (inflation accounts for 50% of the increase). Whereas in the U.S. and Western Europe military expenditures demand a smaller percentage - in the Near East, the percentage rose from 6 to 12% of GNP in the decade 1961 to 1971. The world is or is rapidly becoming an "armed camp" with the U.S. as the major supplier of arms.

Another source for disruption of peace in specific places throughout the world is an overt military, political or economic action by a major power in support of an ally or an intervention in the affairs of a satellite. The propensity to engage in such action may be enhanced by the growing international economic and resource interdependency. Despite the intensity of forces tending to fractionate the world, the view of the earth as a planet and the need for the nations to act in concert to preserve the environment, the resources and the civilization is present and possibly growing. International conferences on the Environment (Stockholm), Population (Budapest), Food (Rome), and the Law of the Sea (Caracas), although not reaching their stated objectives can be considered evidence of world-wide concern over the issues.

INTERNATIONAL CONFLICT: THE ISSUES

Widening Disparity Between the Wealthy and Poor Nations Leading to Militant Actions Among Groups of Nations (Such as Resource Cartels, Block Voting in the U.N., Covert Terrorism, Economic Warfare, and so Forth) to Achieve Political and Economic Objectives and Contributing to International Conflict

Lack of Agreement over the Use and Ownership of the Internationally Shared Resources (Such as Air Space, Outer Space and the Oceans) Leading to International Conflict

The Issue of War

WIDENING DISPARITY BETWEEN THE WEALTHY AND POOR NATIONS LEADING TO MILITANT ACTIONS AMONG GROUPS OF NATIONS (SUCH AS RESOURCE CARTELS, BLOCK VOTING IN THE U.N., COVERT TERRORISM, ECONOMIC WARFARE, AND SO FORTH) TO ACHIEVE POLITICAL AND ECONOMIC OBJECTIVES AND CONTRIBUTING TO INTERNATIONAL CONFLICT

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The Issue:

It has been argued that one of the greatest forces for international conflict in the world today is the inequitable allocation of *accumulated* wealth and the inequitable distribution of *potential* wealth and resources in the world. While inequity in the world is clearly not new, there is no question that the gap between the rich nations and the poor nations is widening. A larger percentage of the world's population is located in lesser developed countries than ever before, as shown in Figure 1. Seventy percent of the world's population lives in lesser developed countries, and the rate of change has been increasing over the past twenty years.[1] At the same time, the concentration of wealth is becoming increasingly inequitable. As Figure 2 shows, per capita incomes in the developed world grew 3.9 percent in 1960-68 period, but only grew at 2.7 percent in the less developed countries.[2] While real economic growth (measured in terms of GNP growth) may be increasing at greater annual rates in some of the lesser developed countries, population growth mutes these advantages. Additionally, the tremendous disparity in standards of living indicates that even if substantially higher rates of economic growth were sustained for lengthy periods of time (a situation most economists believe to be impossible), it would require centuries to narrow the gap.

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[1] U. N., The Determinants and Consequences of Population Trends: New Summary of Findings on Interaction of Demographic, Economic and Social Factors, Vol. 1 (United Nations: New York) 1973.

[2] Committee for Economic Development, Assisting Development in Low-Income Countries: Priorities for U. S. Government Policy (Committee for Economic Development: New York) 1969.

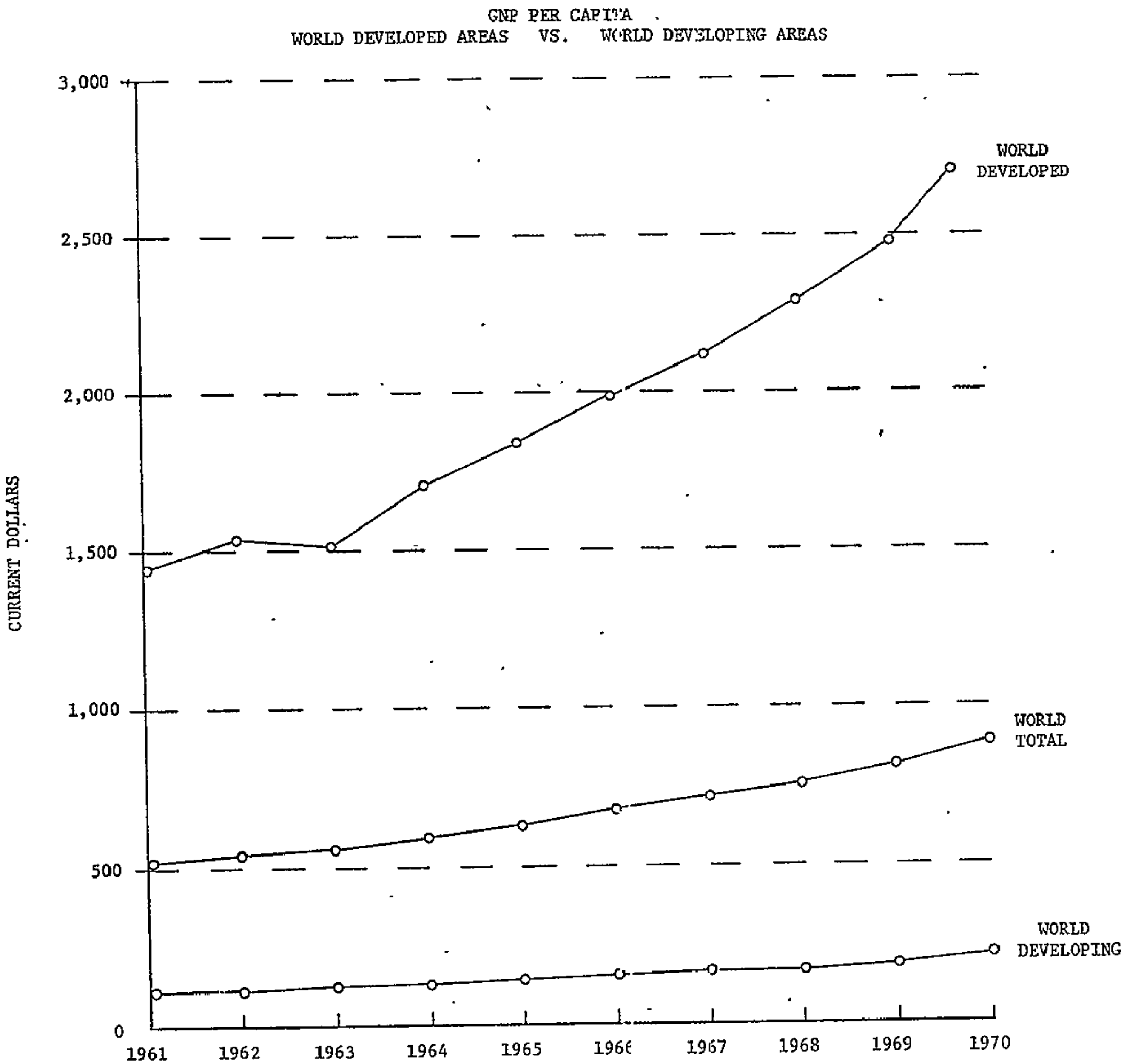
FIGURE 1

THE SPREAD OF UNDER-DEVELOPMENT

Year	Percentage of Total Population	
	More Developed Regions	Less Developed Nations
1920	36.2%	63.8
1930	36.7	63.3
1940	35.8	64.2
1950	34.5	65.5
1960	32.1	67.9
1970	30.0	70.0

Source: Department of Economic and Social Affairs, The Determinants and Consequence of Population Trends: New Summary on Findings on Interaction of Demographic, Economic and Social Factors, (United Nations: New York) 1973, p.529.

Figure 2



Source: United States Arm Control and Disarmament Agency, World Military Expenditures 1971 (Washington, D.C.: Government Printing Office).

This widening gap is increasingly becoming a source of international conflict among nations. The lesser developed countries are beginning to resort to group actions such as tacit and covert terrorism, resource cartels and political blackmail to achieve economic and political objectives. The recent economic and political success of the OPEC cartel is likely to encourage similar activities by other nations.

As Harrison Brown has noted, the basic sources of international conflict have not changed very much since the beginnings of history. He notes: "To be sure, the basic causes of war have not changed very much since urban civilization first appeared; they still closely resemble those which brought ancient empires into armed conflict. Wars are still fought to obtain or to keep markets and supplies of raw materials, to spread economic, social,and religious creeds, to pursue power and military security, and to combat threats to power in security."[3]

If this is an age old problem, then why are we so concerned with it? It is an especially frightening issue because the pressures for conflict have never been greater. Among the pressures aggravating the situation are the following:

(1) The tremendous technological advances in weaponry and the proliferation of nuclear weapons and nuclear materials among the nations of the world, both developed and underdeveloped alike greatly increases the likelihood of nuclear blackmail or nuclear war.

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[3] Harrison Brown, The Challenge of Man's Future, (Viking Press: New York, 1954, p.64.

(2) The proliferation of communications and increasing contact between the rich and poor nations has increased the awareness of this widening gap. Before the advent of widespread communications among countries the discrepancies in standards of living was only readily apparent through international travel, limited by an extremely small population. Such increasing awareness contributes to the level of expectation, frustration and eventually, militancy.

(3) The failure of traditional economic development approaches to stem the widening gap has generated frustration and encouraged new approaches to economic wealth, regardless of how radical, militant and threatening they may be.

(4) The realization by many of the lesser developed but resource rich nations that they have played an essential role in the economic development and concentration of wealth in other nations perhaps at a price of their own development, has generated fury, a sense of exploitation and a desire for expropriation.

(5) In those regions where it is occurring, economic development is essentially a disruptive, unstable, hostile and threatening process for the society experiencing it as traditional patterns are abandoned. "Development is apt to be characterized by a growing gap between expectations and achievements -- that is, by an increased awareness of insufficiency and a decreased tolerance of both poverty and privilege. For the underlying masses, development is apt to be a time of awakening hostilities, of newly

felt frustrations, of growing impatience and dissatisfaction."[4] Heilbroner further speculates that "it would be wise to anticipate . . .a rise of diversionary activities of a supernationalistic or military nature as a safety valve for frustration."[5]

(6) The combination of sophisticated weaponry with a national feeling of exploitation is an extremely volatile and dangerous mixture. In fact, Professor Heilbroner views it with a degree of inevitability. "Thus there seems little doubt that some nuclear capability will be in the hands of the major underdeveloped nations, certainly within the next few decades and perhaps much sooner. The difficult question must then be faced as to how these nations might be tempted to use this weaponry. I suggest that it may be used as an instrument of blackmail to force the developed world to undertake a massive transfer of wealth to the poverty-striken world. . .two considerations give a new credibility to nuclear terrorism: *nuclear weaponry for the first time makes such action possible;* and *'wars of redistribution' may be the only way by which the poor nations can hope to remedy their condition.*"[6]

Dimensions of the Problem:

It is clear that the wealth of the world is unevenly allocated among the member nations and this inequitable distribution is, in fact, increasing. By any measure, whether it be GNP per capita, health measures, educational

[4] Robert L. Heilbroner, The Great Ascent: The Struggles for Economic Development in Our Time (Harper & Row: New York) 1963, pp.18-19.

[5] Ibid, p.21.

[6] Robert L. Heilbroner, An Inquiry into the Human Prospect (W. W. Norton: New York) 1974, p.42-43.

measures, natural resource measures, food intake per capita or a host of other measures of industrial and economic development and achievement, there is an increasingly large portion of the world that is not receiving the benefits of industrialization and ecomomic development

The growing gap between the rich and poor nations is substantial. Some nations of the world subsist on per capita incomes amounting to but 1/80 of the U.S. per capita income. While the barriers to narrowing this gap are discussed elsewhere, it is becoming increasingly evident that except for a small portion of the world's population, the gap will not be closed in the foreseeable future. Examine, for example, the condition of Latin America, which economically is more viable than many other nations:

> "If we make the highly optimistic assumption that total Latin American output will. . .provide a 2.5% annual growth in output per capita, it would still be some forty years before Latin American per capital income reached one third the present U.S. per capital income. But if U.S. income continues to grow at around two percent per year, it would be over 250 years before Latin American income would reach one-third of the then-current United States income levels. Even if Latin American per capita income rose at four percent a year, more than fifty years would be required to reach one-third of the then prevailing U.S. levels."[7]

Aside from the pessimistic arithmetic of development, the issue is further aggravated by the increasingly dominant view that economic development is not the eventual fate of all countries. The Industrial Revolution of the 18 - 19th century was not at all either inevitable or random. In fact, there were many circumstances supporting the Industrial Revolution that

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[7] G. L. Bach, Economics, An Introduction To Analysis and Policy (New York) 1958, p. 806

made the situation unique. The inability of a large number of nations to duplicate the process of industrialization and economic development attests to the uniqueness of the process.

Until recently, economic development theorists thought that by merely putting the requisite pieces together in the proper order and combination (the proper order and combination remained elusive, however) economic development would result. Increasingly, this notion of the transferability and inevitability of industrialization and development is being questioned and gradually abandoned. Professor Heilbroner for one, after two decades of writing on the subject, has gradually moved from expressing fears about the consequences of widening disparity of wealth[8] to concluding most recently that not only is a large portion of the world unlikely to experience economic develop and as a result, nuclear blackmail and international conflict is inevitable, but also he concludes that the fate of the earth is so threatened, that it is the "inescapable need to limit industrial growth that emerges as the central challenge to the world."[9]

Others believe that while development may still be possible, it requires substantial, even radical, reform and institutional change in the lesser developed countries and greater concern, aid and massive sacrifice by the developed countries. Even these optimists conclude: "By far most important are the needed reform policies in the underdeveloped countries themselves.

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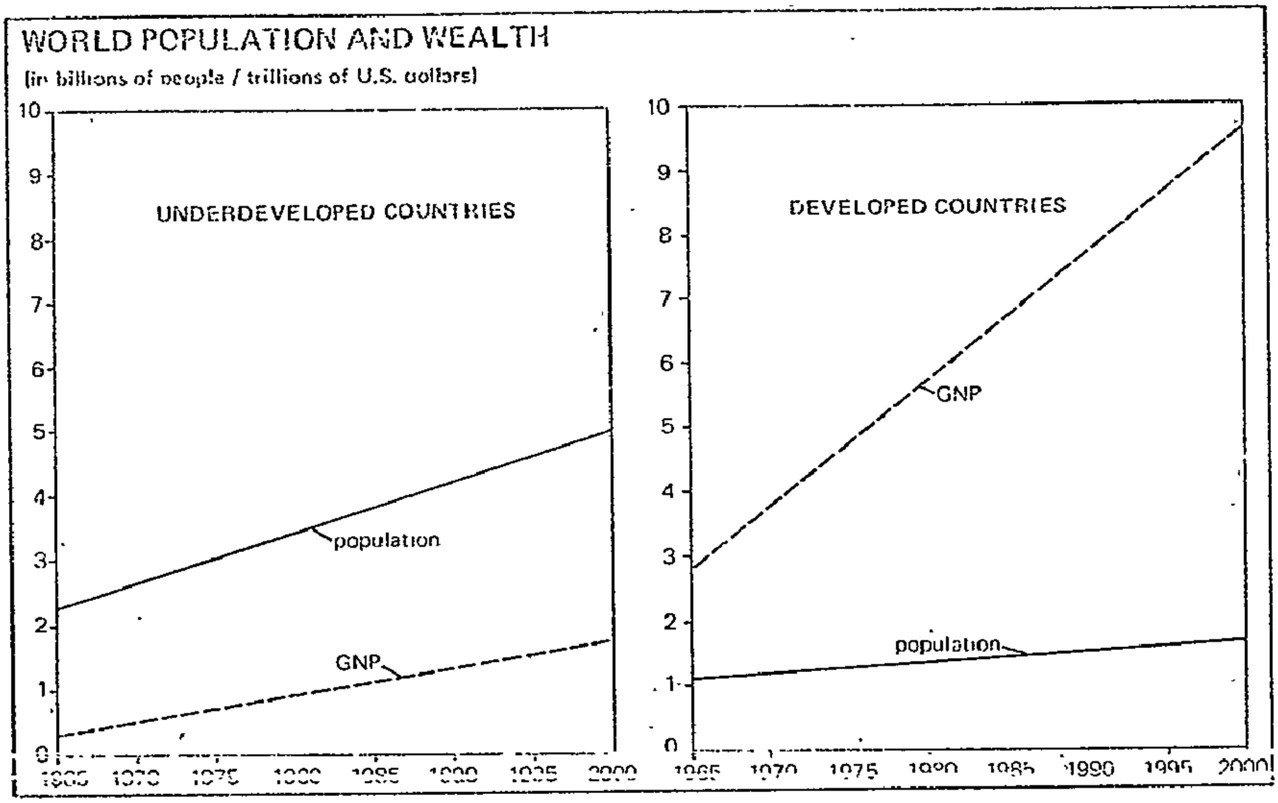
[8] Robert L. Heilbroner, The Future as History (Harper & Row: New York) 1959.
[9] Heilbroner, An Inquiry into the Human Prospect, op.cit., p. 54.

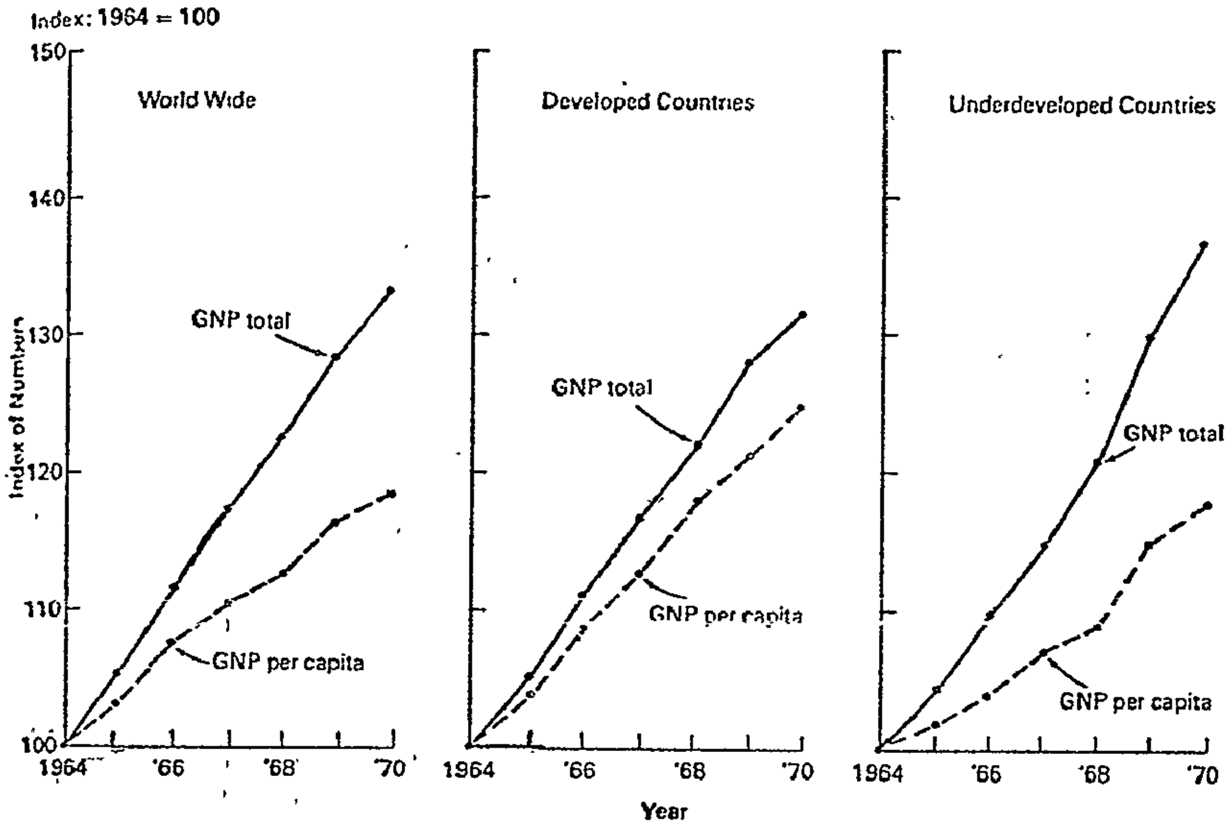
Figure 3



Source: John McHale, World Facts and Trends (Collier Books: New York) 1972

Figure 4

GNP AND GNP PER CAPITA



Source: Paul R. Erhlich, and Anne H. Erhlich, Population, Resources, Environment: Issues in Human Ecology (San Francisco, Calif.: W.H. Freeman & Co., 1972), p. 433.

But the difficulties they encounter are so great that most of them will have slight chance to succeed without more aid from the developed countries."[10]

Why this pessimism? Just how severe is the inequitable distribution of wealth? The inequitable allocation of wealth is so great with such profound and devastating impact upon the standards of living being experienced that it is difficult for anyone from the wealthy developed world to comprehend the magnitude. For example, the contrast between a per capita annual income of $5,000 (U.S. level) and $100 (Indonesia), strains the imagination.

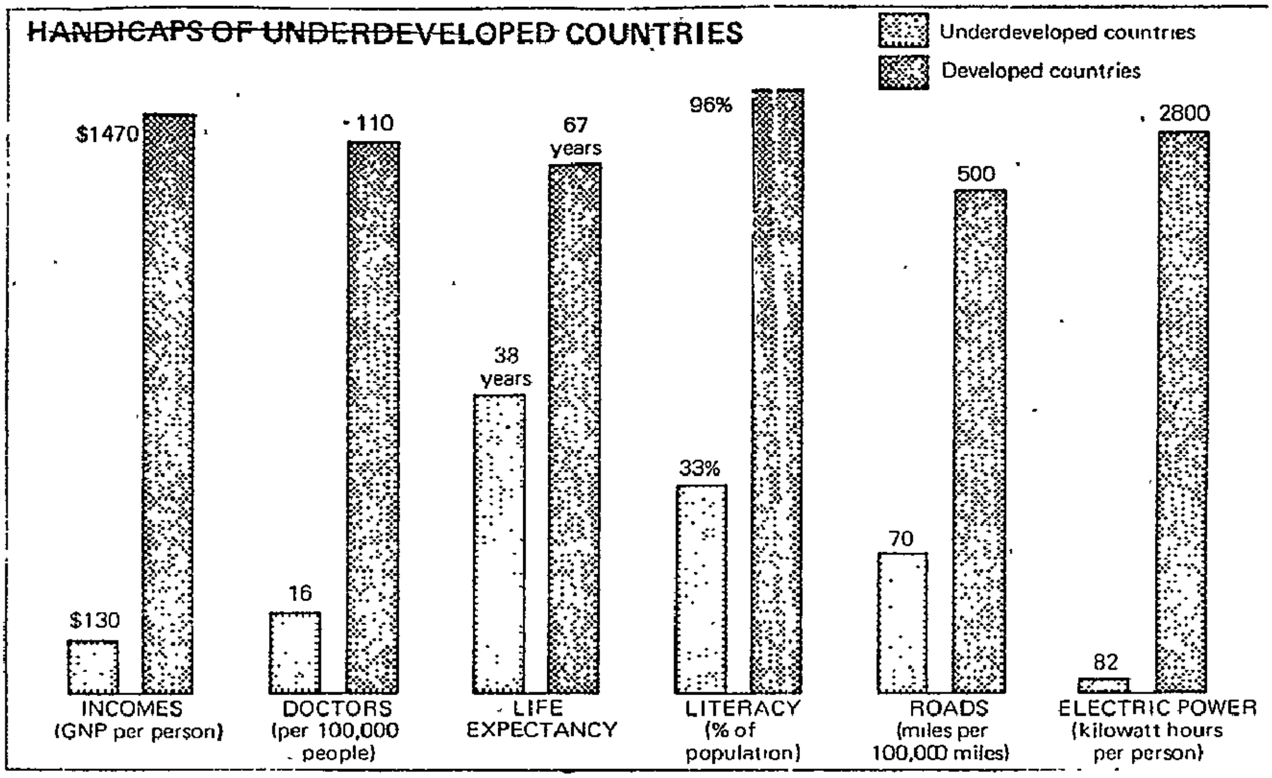
Measures of the Widening Income Gap:

The growing income gap is presented in Figures 3 and 4. In 1971 the average per capita GNP in the developing world is $229, while it is more than $2,900 in the developed world -- an order of magnitude greater than the developing world. It is difficult to understand what these levels of income mean, but as Figure 5 shows the lower incomes are related to widespread illiteracy and a sick and hungry population. The consumption of energy is another excellent indicator of economic development. The average per capita consumption internationally (in coal equivalents) is 4,400 pounds annually, yet in the United States it is almost 26,000 pounds per capita (see Figure 6). In such countries as Burma, it is less than 1/100th of this, in Ethopia it is 77 pounds, in Italy 6,000.

[10] Gunnar Myrdal, The Challenge of World Poverty: A World Anti-Poverty Program in Outline (Vintage Books: New York) 1970, p.45.

Figure 5

CONTRAST BETWEEN UNDERDEVELOPED & DEVELOPED COUNTRIES



Source: John McHale, World Facts and Trends (Collier Books: new York) 1972

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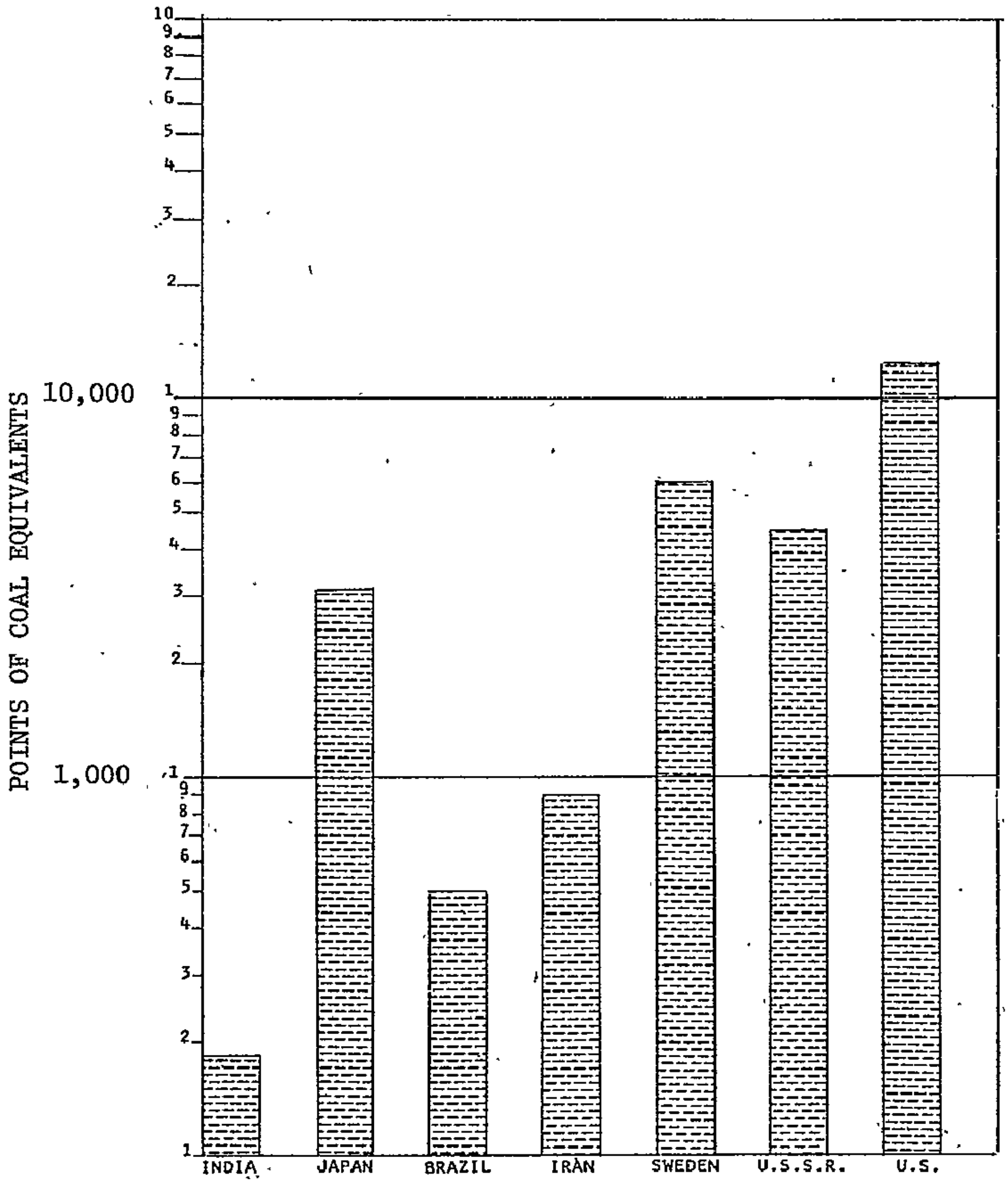
Figure 6

PER CAPITA ENERGY CONSUMPTION, 1971



Source: U.S. Bureau of the Census, Statistical Abstract of the United States, 1974, p820-821.

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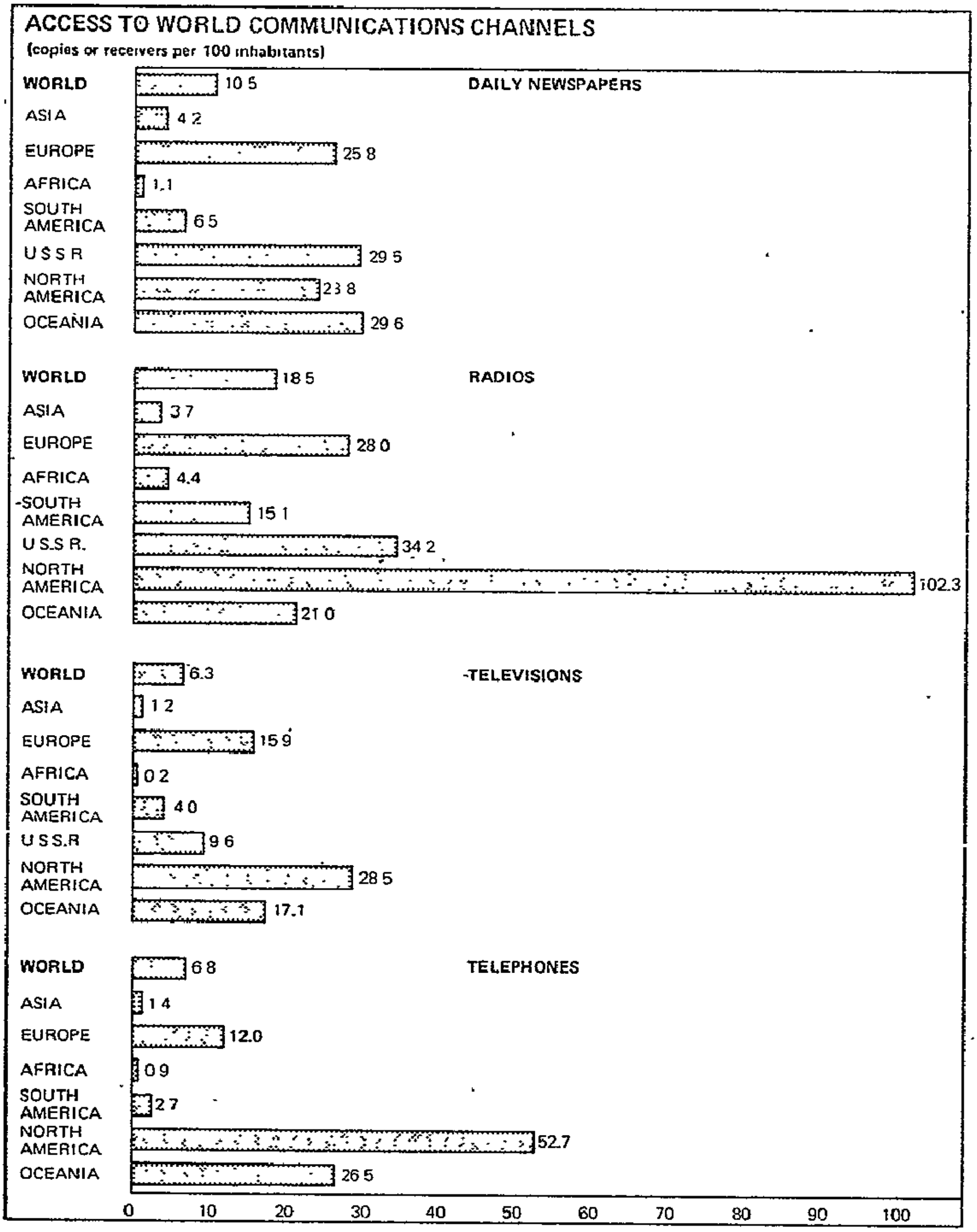
This level of energy consumption translates into a subsistence existence. Almost all (98%) housing units in this country have electricity and piped water but in Honduras less than 15% do, in Iran about 25%, even in Mexico, the number hovers only around 50%. Undoubtedly, in the poorest African and Asian countries, for which there is no data, the numbers would be precipitously lower.[11]

Another indicator of general well being is telephones. This is an indicator not only of consumer affluence but also of the country's ability to develop, manage and maintain a complicated communications infrastructure. It is probably also a measure of the nation's ability to utilize modern business procedures. In the United States there are 62 telephones per 100 population. The world total is almost seven. There are some countries in Africa that have less than one telephone per 100 population (as shown in Figure 7).

Another indicator of the implications of the widening income gap is the quality of health care and the kinds of illnesses. Birth rates and death rates differ as a function of wealth. The United States has an infant mortality rate of 18.5 (that is, the number of deaths of infants per 1,000 live births). Albania normally thought of as a relatively developed country, has an infant mortality rate at over 86 per 1000. Many countries are considerably higher yet.

11 U.S. Bureau of the Census, Statistical Abstract of the United States, 1974, 95th Edition (Washington, D.C.: Government Printing Office) p.819-820.

Figure 7



Source: John McHale, <u>World Facts and Trends</u> (Collier Books: New York) 1972

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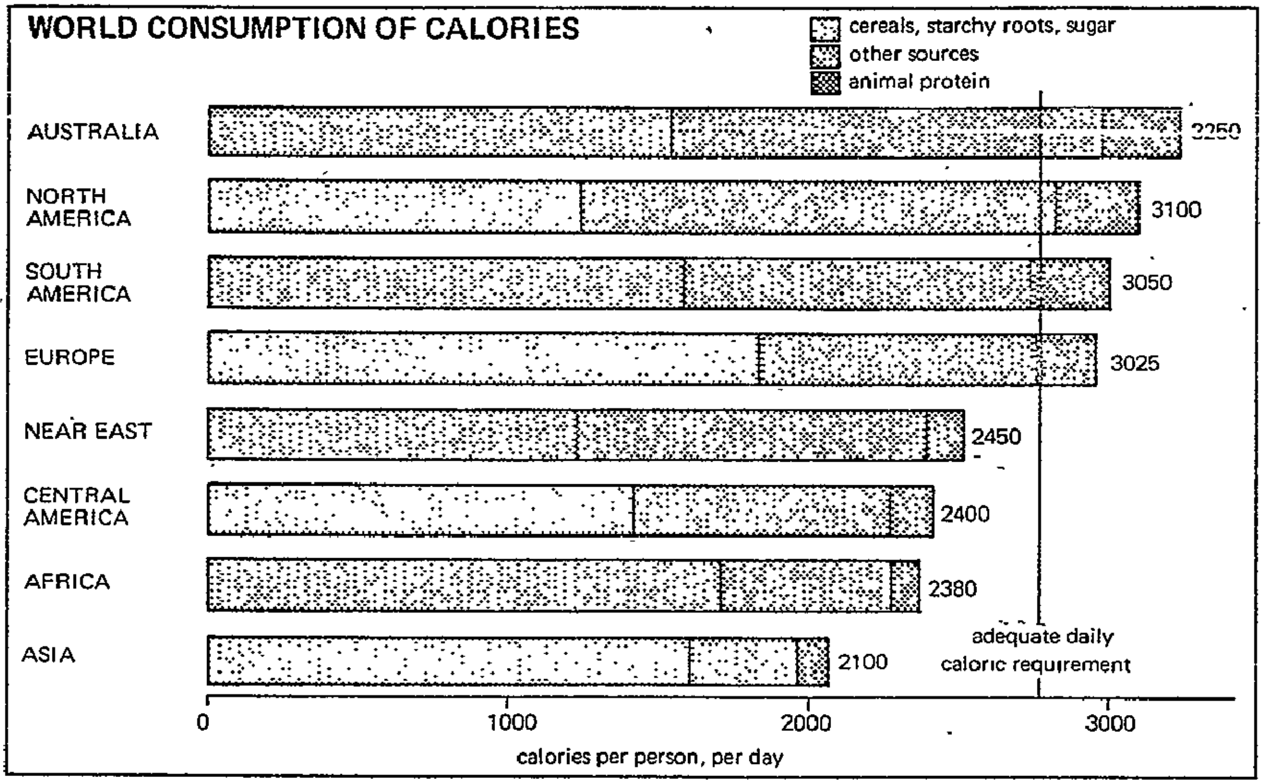
The kinds of illnesses that affect nations differ as a function of the state of their economic development and income. Developed nations are bothered by the diseases of industrialization: lung and respiratory diseases, cancer, heart diseases. Underdeveloped countries are more often subject to epidemics of insect and animal borne diseases caused by lack of sewage, sanitation and water purification systems. Tuberculosis and pneumonia are another two common diseases of poverty. Most of these diseases are easily preventable and well understood and it is the more complex diseases of the Western World that are awaiting scientific breakthroughs.

The lesser developed countries have essentially no preventative health care except for the small portion of wealthy; even therapeutic health care is available only to a select few. While it is not well understood, there is no question that generations of inadequate medical care and an equally long period of inadequate food has profound health and genetic effects upon a population. Malnutrition causes a host of physical problems, contributes to mental retardation and affects reproductive capacity. The vast majority of the underdeveloped nation's population (and hence, the vast majority of the world's population) exists on a caloric level that is substantially *below* the minimum requirement as shown in Figure 8.

Figure 8



Source: John McHale, World Facts and Trends, (Collier Books: New York) 1972.

Education and scientific and technological capability is another area in which the effects of the income disparity are immediately obvious and where long term economic development consequences are likely to be felt. Figure 9 displays the differences in educational achievement between developed and lesser developed countries. It has been estimated that over 40% of the world's population is illiterate, a number difficult for the universally literate United States to comprehend. But education is extraordinarily expensive. The United States Government spends 6.5% of its national income on education, a percentage exceeded only by Sweden and the Soviet Union. Public education expenditures per capita are even more startling. The average per capita expenditures by the lesser developed nations if $8.69 compared to $264.28 in the United States (see Figure 9). Even if the developing nations began to spend the same level on education it would do little to narrow the gap because of the large illiterate adult population, lack of teachers, and inadequate education plans and equipment. Strangely enough, the educational process is further complicated by the lack of students. In the lesser developed countries the children's labor is often an essential part of the family agricultural efforts.

The effect of this level of educational expenditures is that the lesser developed countries are far behind the developed nations in science and technology. Consider the simplest and least expensive means of transferring scientific and technological information -- books and magazines. The United States published over 81,000 new books (that is, new titles) in 1972, West Germany published over 40,000, the USSR over 80,000. Compare that to the few lesser developed nations about which we have data. Afghanistan published 83 titles, El Salvador 39, Iran over 3,000, and Nigeria over 1,000.[12]

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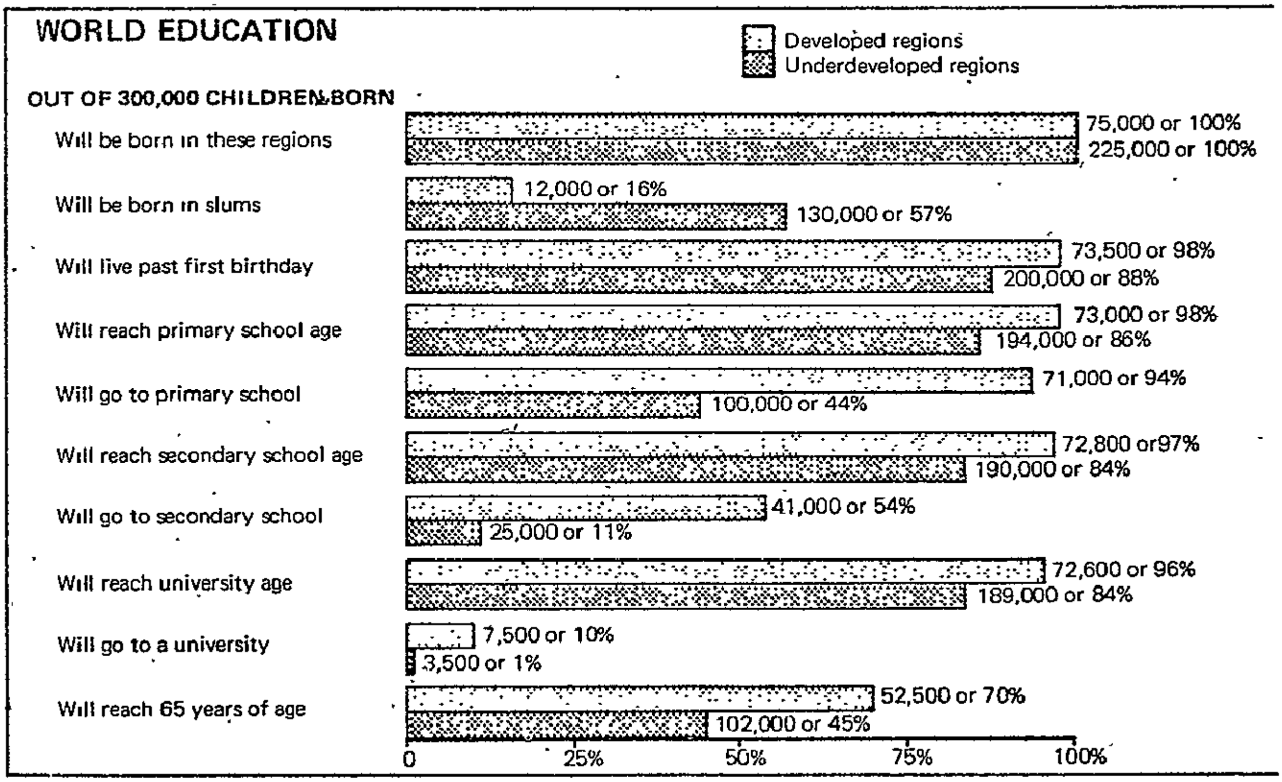
[12] Statistical Abstract of the U.S., op.cit., p. 821.

Figure 9



Source: John McHale, <u>World Facts and Trends</u> (Collier, New York) 1972

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ORIGINAL PAGE IS
OF POOR QUALITY

FIGURE 10

WORLD PUBLIC EDUCATION EXPENDITURES PER CAPITA, 1970

WORLD TOTAL	$ 41.13
Developed	149.86
Developing	8.69
NORTH AMERICA	270.03
EUROPE	107.83
Developed	124.23
Developing	21.84
LATIN AMERICA	14.85
FAR EAST	12.13
Developed	75.22
Developing	6.60
SOUTH EAST	2.25
NEAR EAST	15.62
AFRICA	7.82
Developed	2.38
Developing	8.23
OCEANIA	88.60

Source: Calculated from United States Arms Control and Disarmament Agency, World Military Expenditures, 1971 (Washington, D.C.: 1972).

The lack of an educational structure has fundamental impact upon the availability of scientists, engineers and technicians. The United States has almost 3 million people so employed; the Congo has less than 1,000, Iran has almost 100,000, Afghanistan 8,000.[13] The source of the disparity is obvious: in the developing world only about 1% of the population that reaches university age goes to college. Of those, it is likely that a large number of them are educated in foreign shores and leave their home country for employment opportunities elsewhere.

The dimensions of this disparity in wealth are becoming apparent. The problem is complex to solve: even if it were possible, a sudden equality of the per capita incomes between the developed and developing nations would have little impact. The long history of lack of social overhead capital, inadequate infrastructure and an uneducated population means that the lesser developed countries would have to spend substantially *more* per capita for sustained periods of time than the developed countries to recoup the past.

<u>The Role of the Lesser Developed Countries in the World Economy</u>: The above discussion is not to say that the lesser developed countries are without power, either economic or political. In fact, it is the increasing recognition of this power by the lesser developed nations that is contributing to international conflict. While only a moderate portion of the world is experiencing the benefits of economic development, the natural resource base of the world is globally, and inequitably, distributed.

The industrialized and developed world is becoming increasingly dependent upon the lesser developed countries for the natural resources necessary to sustain industrialized nation's economies. The United States

[13] United Nations, <u>Statistical Yearbook</u>, 1973 (New York) p.788.

Figure 11

U.S. DEPENDENCY ON FOREIGN MINERAL SUPPLIES, 1972

Mineral	Imports as Per cent of U.S. Consumption	Major Developed Country Suppliers, with Imports Supplied by Each	Total, Major Developed Country Suppliers	Major Developing Country Suppliers, with Imports Supplied by Each	Total, Major Developing Country Suppliers
Aluminium[a]	98				
Bauxite		Australia, 2.0%	2.0%	Jamaica, 53 5% Surinam, 27.4% Guyana, 7.3%	88.2%
Alumina		Australia, 40.9% Canada, 0.6%	41.5%	Jamaica, 26.0% Surinam, 19 8% Guyana, 0 6%	46.4%
Metal		Canada, 63.1% Norway, 7.6%	70.7%		
Chromium[b]	106	South Africa, 32.0% U.S S R., 27 8% Turkey, 25 6%	85.4%		
Cobalt[c]	98	Belgium-Luxembourg, 28 8% Finland, 10 0% Norway, 7.3%	46.1%	Zaire, 34.5% Zambia, 8.5%	43.0%
Copper[a]	18	Canada, 34.1%	34.1%	Peru, 23.2% Chile, 14.7%	37.9%
Iron/Steel[a] (iron ore)	28	Canada, 50.8%	50 8%	Venezuela, 30.6%	30.6%
Lead[a]	26	Canada, 33.1% Australia, 17.4%	50.5%	Peru, 22.0% Mexico, 9.7%	31.7%
Manganese[a]	95	South Africa, 14.6%	14.6%	Gabon, 26 3% Brazil, 18 8% Zaire, 10.4%	55.5%
Mercury[a]	58	Canada, 52.7%	52.7%	Mexico, 18.7%	18.7%
Nickel	74	Canada, 75.0% Norway, 10 6%	85 6%		
Sulfur[a]	13	Canada, 75.4%	75.4%	Mexico, 24 6%	24.6%
Tin[a]	77			Malaysia, 64 3% Thailand, 23.3% Bolivia, 8.9%	96.5%
Titanium[a]	72	Australia, 99 6%	99 6%		
Tungsten	44	Canada, 30 0% Australia, 11 0%	41.0%	Bolivia, 18.0% Peru, 12.0% Thailand, 9.0%	39.0%
Uranium[a]	12	Canada, 100%	100 0%		
Vanadium[a]	32	South Africa, 56.5%	56.5%		
Zinc[a]	52	Canada, 50 9% Australia, 5 6% Belgium-Luxembourg, 5 0% West Germany, 4.1% Japan, 3.8%	69.4%	Mexico, 8 3% Peru, 5.8%	14.1%

[a]Figures are preliminary.
[b]Chromite ore imports only.
[c]Estimate.

SOURCE: Based on Department of the Interior, *Second Annual Report of the Secretary of the Interior Under the Mining and Minerals Policy Act of 1970 Appendices*, June 1973.

is becoming increasingly dependent upon foreign sources of raw materials (as shown in Figure 11). It has been estimated that the United States with 5% of the world's population consumes 30% of the world's raw materials.[14] 14

This dependency on foreign sources of materials is never more evident than the international dependency of the developed nations upon the lesser developed nations for petroleum. Figure 12 dramatically illustrates the lesser developed nation's role in the developed world's industrialization. All evidence suggests that this dependency will, if allowed, continue, and probably increase, as by far the levels of the known and easily obtainable petroleum resources are located in the lesser developed nations. The United States has only about 5% of the proven oil reserves while the Mideast has more than 50% (see Figure 13). While the United States has a more assured supply of coal, the allocation of coal internationally is again inequitable. The extent of the metal and mineral reserves of the lesser developed countries is probably not adequately estimated.

The impact that a group of resource rich countries can have upon the U.S. and global economy is obviously substantial, witness, the disruptions caused by the OPEC cartel. While the possibility of other cartels is disputed widely, and the impending collapse of the OPEC cartel predicted daily, there is no doubt that the OPEC experience will provide a model for other lesser developed nations to emulate. Most economic development theorists argue that capital accumulation is the critical and essential step of economic development, never did forecast such an effective and rapid method. The OPEC nations increased their oil revenues by more than a factor of seven from 1971 to 1974, as shown in Figure 14.

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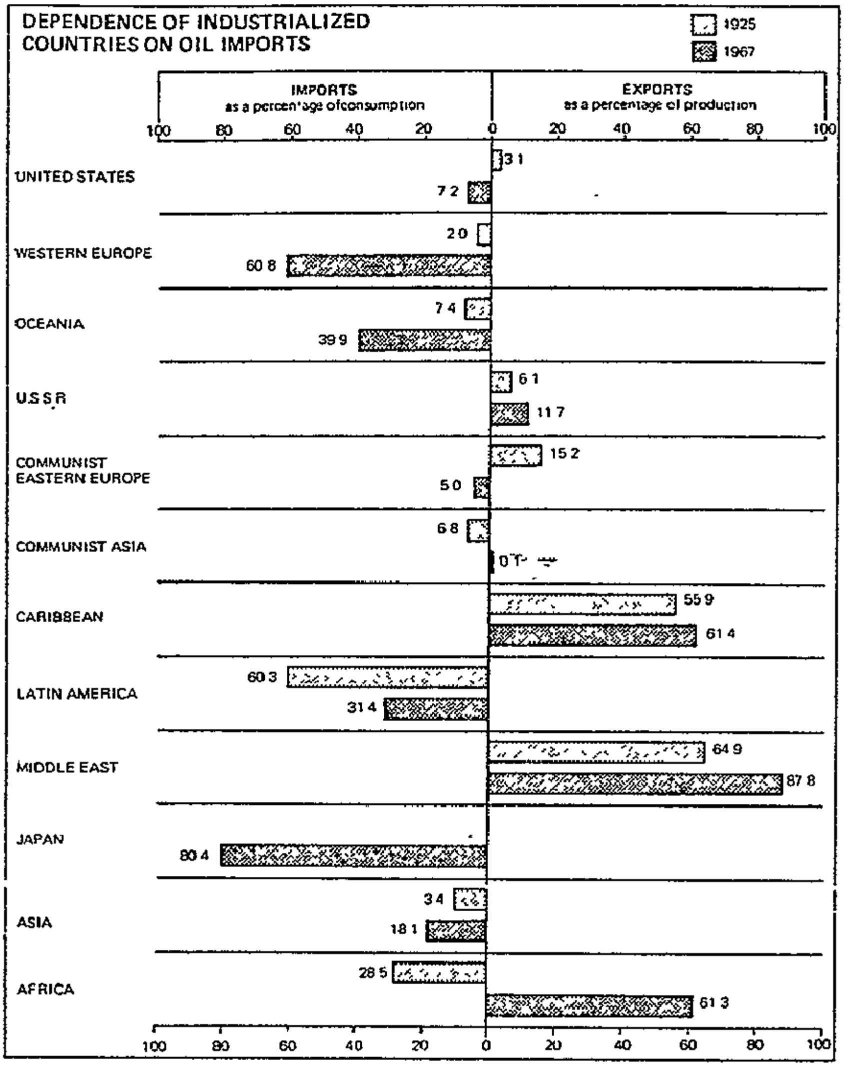
[14] Paul Ehrlich and Anne Ehrlich, Population, Resources, Environment (W. H. Freeman) 1970, p. 72.

Figure 12



Source: John McHale, <u>World Facts and Trends</u> (Collier Books: New York) 1972.

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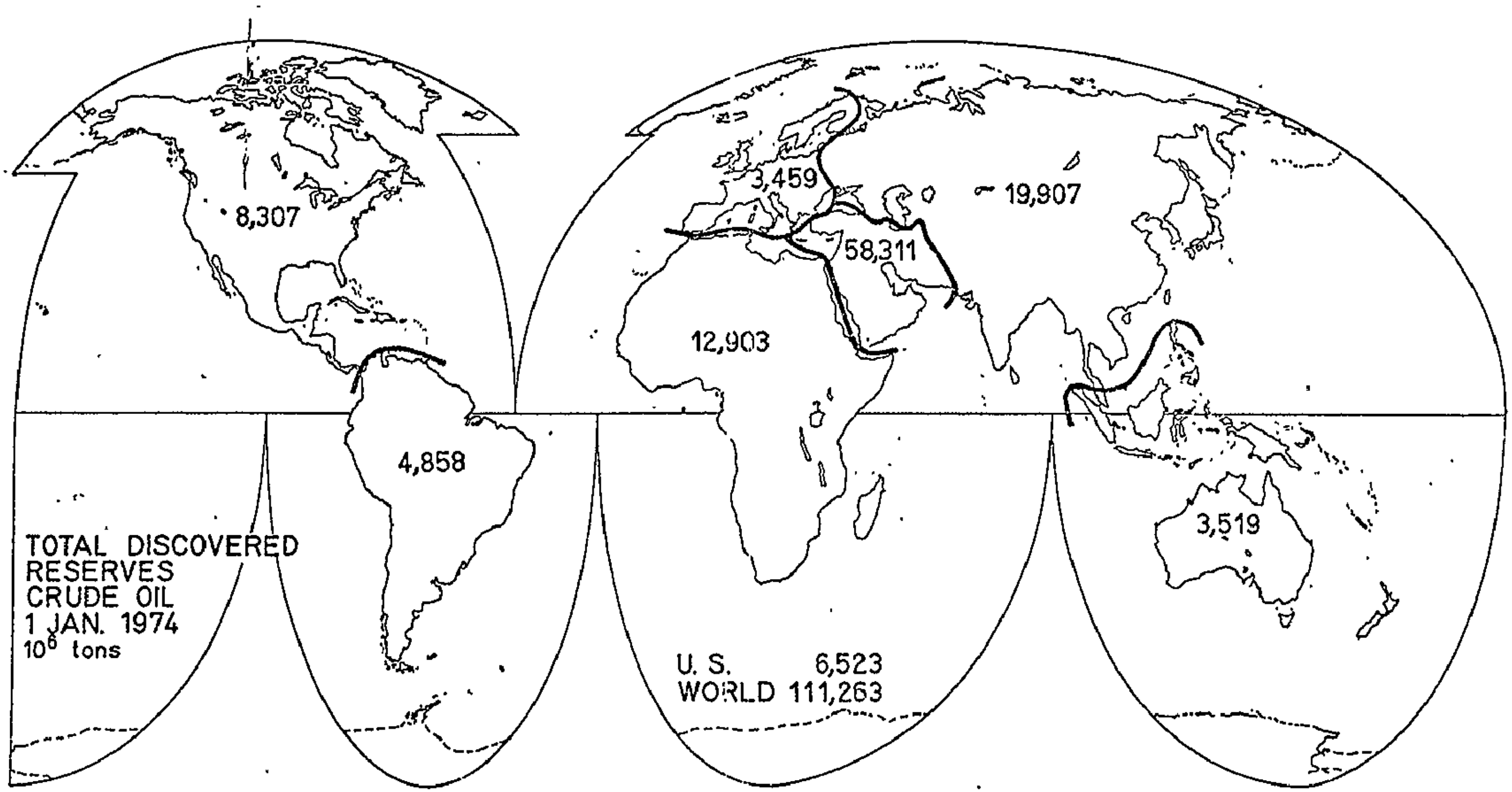
Figure 13

TOTAL DISCOVERED RESERVES OF CRUDE OIL



Source: National Academy of Sciencies, Mineral Resources and the Environment, (National Academy of Sciences: Washington, D.C.) 1975 p. 109.

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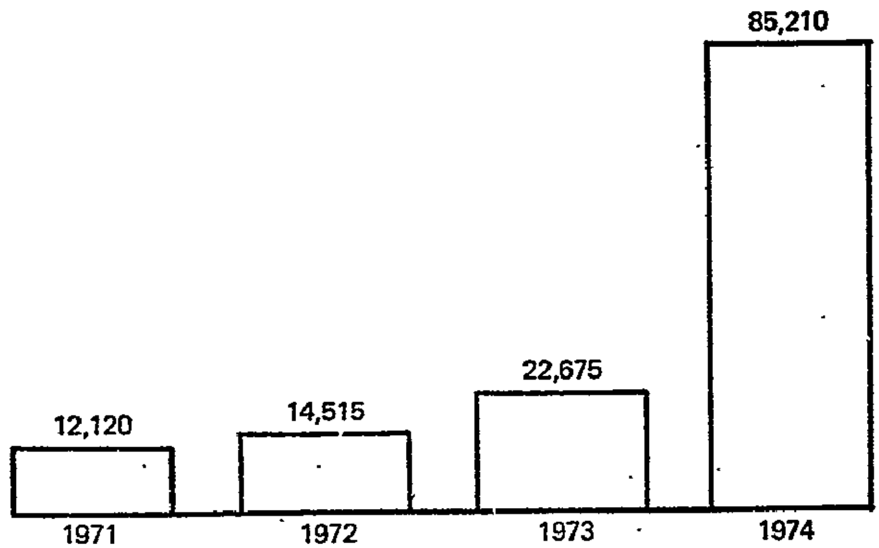
Estimated Total Oil Revenues of Eleven OPEC Governments,[a] 1971-1974 ($ millions)



[a]The eleven governments are: Saudi Arabia, Kuwait, Iran, Abu Dhabi, Qatar, Venezuela, Iraq, Algeria, Libya, Nigeria, Indonesia.

SOURCE: Figures are based on informal World Bank estimates.

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The potential for substantial impact upon the lesser developed nations by actions of the lesser developed is a fairly recent possibility and stems from two continuing phenomena: one, the rise of the one world economy and two, the changing international political relationships. The increasing economic interdependency of nations, irrespective of political boundaries, has been discussed at great length, but it is an important development of recent vintage and contradicts many analysts who argued for isolationist self-sufficiency as the effective approach to economic development and wealth (for example, the emphasis on import substitution industries by many countries). An increasing part of this interdependency is, at present, totally outside of the bounds of government as it is increasingly the role of multinational firms, a recent organizational form yet of such potential economic power that the parameters of its impact are not understood at all.[15] The second phenomena is the change in political relationships referring in general to the demise of colonialist relationships among nations. The increase in political independence has by definition changed the nature of the international economic relationships.

All of this adds up to continuing pressures for international conflict, and for group response on the part of the lesser developed nations. The OPEC experience is a good model for "militant" economic action, the EEC experience is a model for acceptable economic growth and development. In either case the conclusion to be drawn is the same: the need for cooperative group action for economic and political gain.

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[15] In fact, it is interesting to note that the 1968 edition of a classic economic development text (Benjamin Higgins, Economic Development: Problems, Principles and Policies, 1968) does not even use the word "multinational" in its otherwise extensive index, and the word "multinational" could not be found in the discussion on foreign investment.

<u>Forces for International Conflict</u>: There are many characteristics of the twentieth century world economy which support group and/or individual militant action against the developed "have nations." This section briefly discusses some of the current trends which contribute to this tension and conflict.

(1) <u>Regionalism versus Nationalism</u>:

While the heart of the argument presented here suggests that there are strong incentives for group action on the part of the lesser developed nations, there are equally strong motivations for isolated, nationalistic actions. This conflict between these two opposing approaches could aggravate the situation further. A precedent is clearly established demonstrating the success of group action and runs the gamut from the European Economic Community to the Palestine Liberation Front. However, nations which have only recently achieved political independence, whether freedom from a centuries old monarchy or freedom from the colonialist power of another nation, are not motivated to surrender any of that independence to a group, even to a group of its peers, and even for potential economic reward.

Aggravating the situation further is the instability of these political/economic relationships (witness the on and off quality of the Eqyptian/Syrian United Arab Republic). Partially exacerbated by the actions of the developed world and partially aggravated by the insecurity of the lesser developed nations themselves, the relationships will be tenuous at best. This probably resuls from their experience with colonialism, as well as resulting from economic and political insecurity.

In addition, maintenance of a successful group activity requires extensive diplomatic, bureaucratic, technical and managerial skills; skills that are often lacking in the lesser developed nations.

So what can the forces for group action possibly be? In a word: size. Despite all the pressures for nationalism, the underdeveloped world is cognizant of the political, economic, and perhaps most importantly, psychological impact of concerted group action, -- the bigger the better. Size in this context does not refer to population size; if it did, the underdeveloped nations would have long ago taken over the world. Size as used here refers more to political power in the context of control -- such as over a resource (i.e., OPEC), control over public opinion (i.e., block voting in the UN), or brief military control over an historical moment (i.e., PLF encounters). It is quite clear that irrespective of the pressures for nationalism among the lesser developed countries, of which there are many, the power that accrues from group action -- however, intermittent -- is increasingly recognized.

While the consensus, then, is for group militant action, there is no question that this will be a controversial alliance that will increasingly contribute to international conflict. The regionalism versus nationalism conflict will dominate any group interaction; and hence, the group structure itself will be fragile and prone to violent reaction within the group. Such in-fighting already has been threatening the unity of OPEC. Yet persistently, there has been adherence to the group goals. The New York Times has noted: "The oil producers relate their political and economic growth is that of the entire developing world; they were unwilling to bargain away their trump card, oil, except under conditions they considered favorable."[16]

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16 "The Early Oil Talks End in Disarray," The New York Times (April 20, 1975), Section 4, page 2.

In highly unstable political atmospheres one of the ways of attempting to ensure and consolidate a strong political base in the world is by overt action against other nations, especially those viewed as more powerful or more developed. Because of the perceived power balances these actions are likely to be most effective if done in cooperation with other nations. For example, look at the political power, prestige and international esteem that the Arabs have achieved through the OPEC actions. Unstable situations such as are found in the lesser developed countries where the administrations prone to frequent government upheavals and other domestic turmoil, contribute to the threat to international security. Because of this domestic instability, the frequent shifts in international political allegiances, and the disparity between political, economic and resource supply boundaries, group actions, however effective they are in the short run, are inherently unstable and will collapse soon after any success. The only exception to this is group action that is composed of nations that are cultural, economically, politically and historically similar and relatively equal, such as the European Economic Community.

The recency of political independence in many lesser developed countries further contributes to the intensity and propensity for conflict and unilateral action for two reasons. One is the need to establish, in a rapid and dramatic fashion, political credibility and political power, as discussed before. The second is the inexperience in international political processes and the most likely lack of an inadequate internal political bureaucracy.

(2) Population Growth:

While many of the direct implications of population growth are discussed elsewhere, it is important to note here the immense dichotomy between the population characteristics of the developed and underdeveloped world. More importantly than population growth *per sè* as a force for conflict is the population transition that is occurring internationally. This contributes substantially to social instability and, in turn, to political instability, domestic violence and eventually becomes incorporated into the world view of that nation. There are essentially three population configurations in the world: the developed, the undeveloped and by far the largest group--the intermediate lesser developed transitional nations. The conflict between a modern technological and highly urbanized population and a peasant, traditional agrarian culture contributes to social disruption. In fact, Harrison Brown suggests: "It appears most unlikely that these two greatly different ways of life can co-exist for long. A world containing two major patterns of existence is fundamentally unstable--either the agrarian regions of the world will industrialize or, in the long run, the industrial regions will revert to agrarian existence."[17]

(3) Political Instability:

While the problem of political instability is world wide, the lack of political stability in the lesser developed nations clearly contributes to both domestic and international conflict.

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[17]Harrison Brown, The Challenge of Man's Future (Viking Press: New York) 1954, p.225.

(4) Social Instability:

As previously discussed, the forces of population shifts from traditional peasant culture to a modern technological cultural, from rural to urban, from barter to money, and from economic underdevelopment to economic development all contribute to social instability. And any condition of instability aggravate tensions and produce conflict.

(5) Weaponry:

One of the fundamental shifts in the dynamics of international relations in the last several decades that makes it significantly different from other periods in history is the easy access to highly sophisticated armaments by all nations. Highly sophisticated armaments (often even nuclear arms) are available at low cost. Most horrifying, a recent study has indicated that the technical capability necessary to construct a small nuclear weapon is obtainable through the publicly available literature.[19]

It has been estimated by some experts that the intermediate transition countries which are the most unstable (i.e., Taiwan, Argentina, Brazil, South Africa, India, Pakistan, Iran) are likely to possess nuclear weapons by the end of the century.[20] Obviously, the greater the proliferation of nuclear weaponry, the likelier it is that terrorist groups will soon possess stolen nuclear weapons as well. It is also likely that within a decade, perhaps even sooner, terrorists will have access to homemade nuclear weapons. The proliferation of weaponry and the conclusion that even the least developed nations will soon have access to them presents

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[18] Mason Willrich and Theodore B. Taylor, Nuclear Theft: Risks and Safeguards, A Report to the Energy Policy Project of the Ford Foundation (Ballinger Publishing Company: Cambridge) 1974.

[19] The Hudson Institute, Trends Affecting U.S. Aeronautics R&D By the Year 2000.

an incredibly threathening situation, especially in the increasingly volatile world circumstances that we have suggested are likely to occur.

(6) Recognition of Underdeveloped Status:

As mentioned previously, the increasing awareness by the lesser developed countries of their economic predicament *vis a vis* the developed nations increases the level of frustration, expectation, anger, and sense of exploitation. All of this, of course, contributes to conflict situations.

(7) Successful Models:

It is probably the case that just one example of a successful joint venture, the OPEC cartel, will lead to a host of imitations. There is some concern that Venezuela is initiating a similar action in the coffee and tin markets in Latin America. It is quite likely that most lesser developed nations are evaluating their current position with respect to potential similarities to the OPEC example.

Faced with all of the characteristics of underdevelopment noted before (i.e., lack of population growth control, public health inadequacy, widespread illiteracy, political instability, social instability, lack of infrastructure development, lack of managerial and technical skills and capital shortages), the lesser developed countries have exhausted their options and must play the one trump-card that they might possibly have: scarce natural resources. Resources can be viewed as a means for capital accumulation, an essential step to industrial development. With the increasing dependency of the developed nations upon the lesser developed for scarce resources, it is quite likely that attempts at similar resource cartels and economic blackmail are inevitable before the end of the century.

Other nations may use blackmail and group action to achieve a political goal, apart from economic objectives. This kind of action may be even more dangerous than economically motivated actions. The solidification of a power base to achieve military and political security is likely to be most damaging to international peace. The rise of terrorism in the Middle East, for example, is not associated with the oil cartel action of the OPEC nations; rather that is associated with historical anomosities and the centuries-old fight for the Holy Land. There are other such ancient antagonisms brewing in the world today. What makes them especially dangerous, and the world especially vulnerable to them currently, is the widespread proliferation of armaments.

Some Positive Actions:

This section has identified four major contributing trends that increase the likelihood of group action by the lesser developed countries to achieve political and economic goals. These include: (1) the increasing disparity of wealth between the developed and lesser developed nations; (2) the increasing reliance of the industrialized world upon the resource base of the lesser developed nations; (3) the proliferation of easily available sophisticated weaponry in the world, and (4) wide-scale political and social instability in the world resulting from massive population transition. One approach to minimize vulnerability to blackmail, cartelization and other acts of international conflict is to respond to these causes of potential conflict. There are essentially two categories of strategies that can be undertaken to ameliorate the situation by the United States. One set of actions includes strategies to prevent the actual act of cartelization or blackmail from occurring, and the second includes strategies that would increase the capability of the United States to respond to these actions once they occur.

It seems unlikely in view of the long history of colonialism, imperialism and mercantilism by the developed world that there will be substantial success in actually preventing the majority of these activities from occurring. It does appear, however, that the probability of occurrence of these events could be reduced. A first set of strategies would have to do with reducing the inequitable allocation of wealth. It is quite clear that the developed nations will be called upon in increasing frequency to assist with such international disasters as starvation. It seems clear that it would be advantageous, not only for humanitarian purposes, but also to achieve political and military goals, to participate as fully as possible in these activities. A second method contributing to the potential narrowing of this gap is to share U.S. technology and educational experience with these nations.

Inferior managerial, technical and entrepreneurial skills are the major impediment the lesser developed nations face. The goal of the U.S. foreign aid effort should be to remedy this deficiency. If the United States is indeed part of the one-world economy; and if resource dependency does indeed increase, one way of ensuring international cooperation and reducing conflict would be to contribute in a substantial and real way to economic development by assisting in the development of human capital.

A second set of strategies would have to do with resources supplies. Obviously, the less dependent upon foreign sources for material and energy sources a nation is, then the less vulnerable it is to acts of blackmail by lesser developed countries. This is not to suggest an isolationist approach but merely to encourage further energy and material self-sufficiency.

This could occur through development of domestic sources or development of technological substitutes. Either would decrease the degree of economic and political vulnerability to these kinds of actions. If the potential for success of these blackmail actions decreases, they will also decrease in importance as a political tool.

A third area of strategies has to do with proliferation of weaponry in the world. While it may be axiomatic to state that the fewer the number of nuclear powers, the lower the probability of nuclear war or nuclear terrorism, it is also quite accurate. The Strategic Arms Limitation talks currently underway are addressing the question of weaponry for the super powers only. A fruitful source of future negotiation would appear to be the question of arming the lesser powers.

A final set of strategies has to do with international cooperation. The formation of anticartel cartels is likely to occur. In fact, they are beginning to develop in response to the OPEC oil cartel. It is not at all clear that this is a progressive step for the reduction of international tension. However, it is likely that these kinds of regional, special-purpose alliances will form to combat unique, and perhaps random, acts of the lesser developed countries. To the degree that these cooperative efforts reduce vulnerability to such random acts, they will, of course, reduce international conflict. Despite the short term, stop-gap efforts that the United States may take, it seems likely that the nation will be continually exposed and vulnerable to such actions by other nations. Unfortunately, these activities are largely unpredictable, but probably likely to increase in the future. The unfortunate success of the OPEC cartel encourages this kind of economic and political behavior. It is further likely that this kind of behavior will continue until such point that it actually provokes military response. Hence, one can anticipate increasing international tensions and conflict, periodically resulting in military skirmishes for-the next several decades.

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N76-18973

LACK OF AGREEMENT OVER THE USE AND OWNERSHIP OF THE INTERNATIONALLY SHARED RESOURCES (SUCH AS AIR SPACE, OUTER SPACE AND THE OCEANS) LEADING TO INTERNATIONAL CONFLICT

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ISSUE: LACK OF AGREEMENT OVER THE USE AND OWNERSHIP OF THE INTERNATIONALLY SHARED RESOURCES (SUCH AS AIR SPACE, OUTER SPACE AND THE OCEANS) LEADING TO INTERNATIONAL CONFLICT

The Issue:

The lack of adequate institutional mechanisms to regulate, monitor and govern the use of the commonly owned and shared resources of the world has been a problem for centuries, beginning with the origins of international trade and exploration. It is exacerbated today because of the growing dependency and international trade among nations and the impact of advanced technology.

There is no question that technology is one of the dominant factors affecting the exploration and management of commonly shared resources. Technology has made it possible to oversee a larger and larger portion of the shared resources. For instance, the three mile limit was established when it was technologically impossible to monitor any larger area. It is quite clear that technological advancement has made it possible to monitor larger segments of the oceans, and the atmosphere, as well as individual activities of nations.

This ability to monitor individual activities of nations from space has generated a sense of confidence in our efforts to control nuclear military devices but also provided a new source for international conflict. Not only can military activities be monitored, but location and extent of the natural resource base of a given country can be identified as well. Such identification by orbital satellites (as well as the resulting problem of ownership and dissemination of data) generates a central force for conflict. The fears are that a technologically superior nation may be able to identify and quantify the resource deposits of a less technologically sophisticated country. This could trigger conflict between the "haves" and "have nots."

There are essentially three major commonly owned resources over which there is lack of agreement governing their use. These include: (1) space, (2) the oceans, and (3) the biosphere. Increasingly sophisticated uses of these resources for a wide range of purposes provides a large arena for international conflict. These uses include transportation, communication, scientific research, material and food supply, waste disposal, and military security.

There are a host of pressures and events, such as new technologies; food and energy shortages; population pressures and economic strains, currently underway internationally which may further aggravate international conflict. These forces have not simultaneously come into play before, and the lack of agreement governing shared resources only places the world in a more vulnerable position then before. These pressures are discussed in some detail below.

Impact of Technology: Technological capability of the world has never been greater. The ability of nations to monitor the activities of each other through sophisticated listening devices and monitoring devices from space, the oceans or even from other remotely controlled areas has made it impossible for countries to conduct any kind of activities in secret for a sustained period of time. Hence, in times past, international conflict may have been prevented merely by lack of knowledge (albeit, just as it may have been caused by too much information as well as incorrect information).

This technological capability also means that some of the commonly shared resources can be more effectively used -- such as using the oceans for material and energy supplies. The ability to mine the oceans, still 183 not commercially feasible, is of such recent vintage that there are not adequate national mechanism, not to mention international mechanisms, to govern ocean mining. Estimates of the value of the riches in the oceans vary substantially and no figure can be relied upon. Quite clearly, the existence of such international riches is a source for international conflict. One can imagine that similar kinds of disagreements and conflict would have occurred had the United States found substantial material resources on the moon. In this era of resource scarcity, the oceans are being heralded as the solution to the supply problem, yet inevitably this will be a source of continuing conflict.

Technological capability also means that existing internationally shared resources can be put to new functional uses -- such as off-shore deep water ports. Technology has also made it possible to substantially alter climate and weather patterns, although at this point we do not fully understand the consequences.

Impact of Population: Population growth as well as population density is another set of factors which contribute indirectly to international conflict. The sheer density of the planet and the frequency with which the space and oceans are being used by the population necessitates some kind of international agreement to reduce conflict in the future. Secondly, population pressures decrease the ability of a given country to provide for its population. This population pressure, in the face of disagreements over allegedly "shared" resources, can only aggravate volatile conflict situations. Population pressures may force a nation to become increasingly dependent upon the oceans for food supplies, mineral resources, waste disposal, and so forth. Undoubtedly, this dependency will not be experienced equally by all countries; hence, another source of conflict.

Impact of Interdependency: The interdependency among nations of the world is another source of international conflict. More than in any other period of history, the nations of the world are dependent upon each other for supplies of scarce goods (materials, energy, technology and skilled manpower) as well as for markets for manufactured goods and services. No longer can a nation remain economically viable through isolationism. The result of such interdependency is to reduce the ability of a given nation to effectively control its own economic future, because its economy is affected by economic decisions and activities made by external organizations and by organizations over which it is likely to have minimal influence at best. The recent actions by the OPEC nations illustrate the vulnerability of the complex and interrelated world economy.

It is becoming increasingly clear that the arbitrary political boundaries achieved hundreds -- even tens of hundreds -- of years ago have very little to do with the boundaries of economic relationships that will dominate over the next few decades. Hence, political boundaries are becoming increasingly subordinate to economic boundaries; again, contributing to tension. The success of the OPEC grouping and the European Common Market are examples of such economic alliances.

Impact of Science: A final pressure that is contributing to international conflict is the increasing understanding of the impact of man's activities upon the globe and the interrelatedness of such activities. Activities in one country can have substantial climatic and environmental impact on countries miles away. International conflict may result from the indirect effects of such activities as massive industrial pollution, as well as, from the deliberate alteration of weather and climate for military purposes. While the threat of such climate and weather modification is clearly recognized, the lack of sufficient understanding of the climate and weather mechanisms precludes an adequate scientific solution, to some degree.

Dimensions of the Problem:

This section will briefly describe the status of agreements governing space, the oceans, and the biosphere.

1. Space: Since the airways were first used for transportation and communication, the issue of "air rights" has been of concern, and the advent of the space age only extended the range of argument to "space rights."

The first major issue associated with space is the delineation of sovereign "air space" and "outer space." This boundary dispute is analogous to the current dispute governing the world's oceans. According to the Outer Space Treaty of 1967 (The Treaty on Principles Governing the Activities of States in The Exploration and Use of Outer Space, Including The Moon and Other Celestial Bodies), "outer space" is defined as an open frontier for the exploration and use of all mankind. The treaty states: "Outer space, including the moon and other celestial bodies shall be free for exploration and use by all states without discrimination of any kind on the basis of equality and in accordance with international law and there shall be free access to all areas of celestial bodies."

This is in direct conflict with the fundamental tenet of international law which states that a nation exercises complete and exclusive sovereignty over its territorial air space. Because of the conflict that is resulting over these two legal concepts, a serious dispute has risen in recent years as to whether this delineation between "air space" and "outer space" is a reasonable objective. If it is a reasonable goal, the question of how the delineation should be determined then poses problems.

There are arguments pro and con about further definition and delineation of outer space. Some experts think that any further delineation will result in more international conflict, while others say that the current vagueness of international law generates conflict.

There are arguments for both sides of the controversy. Arguments supporting the view that formal delineation of outer space is necessary for international peace include: (1) such an agreement would preclude states from making unjustified claims in the future to large areas of space; (2) under certain interpretation of the existing treaties, there is the possibility that some nations will abuse space activities as a violation of their sovereignty; (3) disputes regarding the extent of air space will inevitably lead to international conflict; (4) the resolution of this fundamental legal question would establish a precedent for cooperative international attitudes towards the governance of other shared resources and would establish an effective model for progress towards reducing international conflict.

At the same time various writers on space laws have also argued that this issue should remain unresolved at least for the time being for equally substantial reasons which include: (1) the absence of this delineation has not led to international disagreements and conflict; (2) attempts to reach an agreement may lead to immoderate demands and may actually lead to international conflict (similar to the boundaries negotiations of the Law of the Sea Conference); (3) any boundary that is established in the definition of air space versus outer space may, in fact hamper future space activity; (4) any arbitrary line would, in fact, encourage disputes and complaints on minor technological violations and would be a force for international conflict.[2]

Currently, however, there is substantial consensus among experts regarding the need for international agreement governing this boundary issue because of the changing nature of space exploration. Because of the current emphasis of the American space program upon resource, climate and geological monitoring satellites (such as ERTS) and other orbiting observatories designed specifically for monitoring natural environment and natural resources required by man, it is quite clear that the countries being observed are much more directly affected by space activities than they have been in the past. Hence, the issue of air space versus rights is becoming increasingly important to prevent international conflict on the basis of the dissemination of this information so gathered.

[2] The Law Relating to Activities of Man in Space by Lay and Taubenfield, 1970.

Several alternative ways to delineate air space from outer space have been proposed:

(1) Establishing a boundary line between the two environments merely on a physical or geophysical basis. This would define the upper limit of the atmosphere as air space. Obviously the technical problems of precisely defining the atmosphere, troposphere, stratosphere, ionosphere, and so forth are immense.

(2) Relying on the structure and methods of vehicular propulsion as the demarcation line. Hence the demarcation line would be the difference between aeronautics and astronautics.

(3) Using the notion of national control over the expanse above its territory as a position of demarcation. This, of course, has a serious ethical deficiency as it implies that air space should be defined by technological competence of an individual country. There is no question that this would be a force for international conflict rather than against it.

(4) Viewing space in terms of its functional characteristics. This is the most widely accepted approach and places less emphasis on the location of the lines to be drawn and more on the character of the activities that are to be conducted in space. This approach has led to the suggestion for the establishment of different frontiers for different types of activities.[3,4]

A second major issue concerning regulation of space is the question of the liabilities in space and responsibility for space related injury and damages. Concern over this issue led to the Convention on International Liability for Damage Caused by Space Objects. This was signed and ratified simultaneously by Washington, London and Moscow in early 1972 to cover the resolution of international conflicts over the liability with respect to damages, loss of life, personal injury, impairment of health, property damages that may result from space activity.[5] Despite the existence of this convention, it is quite likely that were there to be any damage either from the re-entry of a vehicle or the misfiring of a vehicle, international conflict would inevitably result.

[3] "The Boundary Question and Space Law: A Balance Sheet," 6 Ottawa Law Review 266.

[4] J.D. Cooper, "The Legal Problems of Outer Space," Proceedings of the American Society of International Law, 1956, pp. 85-94.

[5] Conference on International Liability Analysis and Background Data, prepared for use of the Committee on Aeronautical and Space Sciences, U.S. Senate, May 1972.

Those actions which result in pollution are a third major problem. The problem of space debris, in particular, is one of the major issues in the environmental law. As Figure 2 shows, the level of accumulated debris in space is substantial. While the vast majority of space objects completely burn up upon re-entry into the earth's atmosphere, there have been instances where space debris has actually been recovered. With the increasing numbers of objects being launched into space (most of which are operating within 100-400 miles of the earth's surface), there is concern that space activity may be threatened by congestion. These problems would include collisions, overcrowding of the national defense communications systems, and interferences with optical astronomy.[6]

Another potential source of pollution is biological or chemical contamination of the earth by space probes as well as of external celestial bodies that are explored. Currently, there is no international agreement governing these kinds of considerations. However, the issue is so threatening that individual countries are devoting a great deal of attention to it.

One of the major concerns associated with the use of communications satellites is privacy for the individuals as well as for respect for national sovereignty. With the development of ERTS, there has been an increased interest in the right of privacy both internationally and domestically. To date, ERTS have been used primarily to gather environmental, resource and pollution related data and to identify major geological features of the earth. But in order to gather this kind of information about the earth's resources and agriculture, it also gathers substantial other information without technological restrictions.

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[6] Paul Dembling and Swadish Kalsi, "Pollution of Man's Last Frontier: Adequacy of Present Space Environmental Law in Preserving the Resource of Outer Space," 10 Netherlands International Law Review 125 (1973)

Figure 2

ACCUMULATION OF SPACE DEBRIS

Census of Satellites: Cumulative Statistics

Year of Launch	1957	1962	1967	1972
Launchings	2	150	649	1,218
Total Resulting Pieces	5	572	2,994	4,859
Of Which:				
A) Still in Orbit	2	303	1,178	1,810
B) Decayed*	3	269	1,816	3,049

*i.e. burnt up on earth re-entry, impacted on earth or other celestial bodies and unoperational

Compiled from U.K. Ministry of Aviation Supply's Royal Aircraft Establishment Technical Report 68124 (1968), data supplied by Royal Aircraft Establishment by letter of March 6, 1973, and NASA's Goddard Space Flight Center Satellite Situation Report for April 30, 1973. Since compilation is from multiple sources, there may be a small degree of error.

While there is nothing in international law which specifically prohibits these activities of ERTS, it is quite possible that nations will view the gathering of this information as a threat to their economic, political and military security. Some countries have already objected to being surveyed by ERTS as an invasion of their privacy. They have argued that the gathering of this information is a violation of their sovereign rights over their air space. As mentioned earlier, no agreement has been made as to the delineation of air space and outer space. The ERTS satellite's orbit is approximately 560 miles high -- far beyond any delineation which is seriously being considered. Hence, the orbit is located in "outer space" which under the Outer Space Treaty is free for exploration by all states. Under the interpretation, the ERTS satellite is free to collect any information. Despite this interpretation of current international law, it is quite likely that this activity will be a substantial area of international conflict in the future. It may mean that those nations which are technologically superior and have the capability of establishing earth resources satellites have greater access to information regarding the location of scarce natural resources than even those countries possessing the resources.

A further source of conflict may result from the need to interpret The Outer Space Treaty. There is no agency so designated to interpret the treaty and regulate its use. Hence, even if there is any international conflict over the treaty and the use of air space versus outer space, any resolution must await the creation of an agency to interpret it and enforce any decision.

A national security argument has also been made against such remote sensing satellites -- the argument being that this information can be used for military purposes against a state. Information concerning weather patterns, resource locations, and geography can be useful for military purposes and may constitute espionage. However, the right of a state to protect its national security is not synonymous with the total right to privacy in international law. It does not give a state immunity from observation. However, it does protect a state from acts which threaten the stability and existence of its government and economy, and unless this threat can be shown,no violations of national security have occurred under the tenents of international law. There does appear to be a precedent for the right to privacy argument in international law. It has always been permissible to gather information about another state so long as there is no violation of the sovereignty of that state. Thus, gathering information from beyond the territorial sea has always been legal. Unless there has been a violation of a nation's air space (such as the U-2 incident) or a violation of its territorial waters (such as the Pueblo incident), a state has no legal basis under current interpretation of international law for prohibiting the gathering of information.

There has still been some conflict regarding the dissemination of the information. Assuming that international law continues to allow remote sensing data to be gathered, the question then reverts to what is to be done with it. To date, there has not been an international procedure established for the dissemination and use of data gathered from outer space.

The NASA practice of allowing any and all parties access to the information gathered by the satellites has precluded any international friction to date. NASA contends that the information is gathered for the benefit of mankind, and the availability of this information to all who want it proves there is no attempt to gather information for military purposes or economic blackmail. However, this still may become a source of of international conflict. Many of the lesser developed countries being surveyed have access to the data but they often do not have the technological and scientific infrastructure necessary to analyze and effectively make use of this data. Hence, once again, the technologically superior nations are in a dominant position and the lesser developed nations may view this as a means to exploit their resources.

Under the current regulations, any party conducting activities in outer space is to inform the Secretary General of the United Nations of the nature, conduct, locations, and results of activities. The Secretary General is then to disseminate this information immediately and effectively.

Some countries have objected to this policy and have argued that the information should be made available only to that nation that is the subject of the survey and from whom the data was gathered. Others have argued that the information and data should be made available to other nations with the express consent of the observed country in question. These arguments are partly based on a Resolution of Natural Resources adopted by the United Nations General Assembly which provides that "the right of peoples and nations of permanent sovereignty of their natural wealth and resources must be exercised in the interest of their national development and of the well-being of the people of the State concerned."[7] It can be argued that the dissemination of natural resource data could be detrimental to the national interest of a state and, therefore, the state itself should govern the dissemination of the data to any third parties. This article could be interpreted as requiring the consent of state before any information on their natural resources is acquired, used or disclosed.

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[7]United Nations General Assembly Resolution 1803 XVII (1962)

The possibility of misuse of this information is substantial. Information could be disclosed for political purposes. It could also be used for industrial purposes giving individual firms an advantage in dealing and bidding for mining or land rights in foreign countries. The possibilities that the information might be withheld from one party and disclosed to another is sufficient to cause international conflict. International agreement on the rules governing the acquisition, dissemination, distribution and use of this remote sensing data is absolutely necessary to prevent such abuses. The existing treaties do not provide adequately for the kinds of problems caused by remote sensing systems. It is quite likely that ERTS data will have an impact on individual nations which will be economic, political and legal in nature, totally unlike any other space venture. The existing Outer Space Treaty is a very general agreement and its purpose was to provide general guiding principles for space activities.

In 1971 the United Nations General Assembly established the Working Group on Remote Sensing of the Earth by Satellites. The objectives of this Working Group are to promote the optimum utilization of a remote sensing by satellites for the benefit of individual nations. The goal of the Working Group was to formulate a treaty to control the activities of remote sensing satellites. Various proposals have been offered ranging from the establishment of an international data bank, regulations governing a nation's authority over the dissemination of the resource data, and finally, a free dissemination policy.

In sum, it is likely that the lack of a regulatory mechanism to govern the uses of space, especially governing remote sensing data, will be a continual source of international tension.

2. The Oceans: The second major area of dispute leading to international conflict is the lack of agreement over the world's oceans. The conflict generally revolves around four major issues:

1. The ownership of the riches of the seas.
2. The regulation over the uses of the seas.
3. The management and environmental protection of the seas.
4. The military role that the seas play in international security.

Each one of these issues is causing substantial international controversy. The controversies over the use of the seas probably originated when man first began sailing upon the seas. Recognizing the conflict, the United Nations General Assembly in 1970 called for a conference that would "establish an equitable international regime including an international machinery for the area and the resources of the seabed and the ocean floor and the subsoil beyond the limits of national jurisdiction."[8] This resulted in the establishment of the Committee on the Peaceful Uses of the Seabed and the Ocean Floor Beyond the Limits of National Jurisdiction. The Seabed Committee has been working since its inception in 1972 to explore such issues as the regulation of the high seas, the continental shelf, the territorial sea and continuous zone, fishing and conversation of living resources of the seas, and the preservation of the marine environment. This was the first effort to re-evaluate the issues that were originally

[8]United Nations General Assembly Resolution 2750, 1972.

raised in the First Law of the Seas Conference in 1958. The Fourth Law of the Seas Conference was recently held in Geneva and many of the issues which were first raised in 1958 have yet to be resolved. It is likely that the seas will become a growing source of international conflict because of the rising importance and use of the sea and the scarcity of resources now available from the sea. The following sections explore the pressures upon the ocean and that are likely to result in international conflict.

The delineation of the line of ownership over which a nation can exert sovereignty beyond its shores has been a source of controversy for some period of time. Originally, international laws recognized sovereignty to three miles beyond the shoreline. However, unilaterally nations are now claiming anywhere from three miles to two hundred miles. This claim refers to exclusive control over the *uses* of these territorial waters as well as to the *resources* that exist within these territorial waters. There appears to be an emerging consensus among the developed and developing countries alike that a twelve mile territorial sea is advantageous.[9] The United States has let it be known that it will accept, for the first time, new rules governing the national sovereignty of the oceans. At the recent conference in Geneva, agreement on the 12-mile limit was reached but the difficult problem of rights and responsibilities has not been defined so as to adequately meet new environmental and economic issues arising.

A second agreement was reached at the conference regarding the merits of establishing two stage jurisdiction over the seas. The first jurisdiction, perhaps twelve miles, would grant total sovereignty to the host country (except that ships could pass through narrow straits). A second zone would constitute "economic jurisdiction" and could extend up to 200 miles beyond the coastal shores.

[9] Much of the discussion is based on John A. Knouss, "Marine Science, 1974 Law of the Sea Conference," Science, 28 June 1974, Vol. 184, No. 4144, p. 1335. and Richard A. Frank's article on "The Law at Sea" in The New York Times Magazine, May 18, 1975.

While total sovereignty would not be granted in the economic jurisdiction (such as control over transportation and scientific uses of the seas), it remains unclear exactly what the economic zone would imply. Several South American countries, including Brazil, unilaterally have declared sovereignty over 200 miles of the ocean. It is quite likely that the United States and countries not bordering the sea will not tolerate sovereignty construed this broadly, as it would be economically disadvantageous. For instance, essentially it would wipe out the United States tuna fish industry. In 1973, the United States tuna canneries sold more than $1 billion worth of tuna fish, most of which was caught off the shores of Mexico, South America and Africa and would be unavailable to American fishermen under a 200 mile boundary.[10]

There is agreement among nations that there should be some delineation of territorial responsibility over which countries are granted total sovereignty, including total control not only over the *use* of these waters but total control over the *riches* of these waters as well. Obviously, one basis for disagreement may be the inequitable allocation of resources in coastal waters. Before the "territorial" zone (that is, the total sovereign region of three to twelve miles) can be agreed upon, it is likely that agreement of the size, dimension and meaning of the economic zone will be necessary first. The definition of the economic zone may be *geographic*, (that is, go many miles from shore) or *functional* (such as the off-shore range of a particular fish). If a functional definition is chose, it will mean that the economic area would be defined variously for different reasons. This approach is analogous to the definitional problems of "air space" and "outer space" previously discussed.

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[10]"Deciding Who Rules How Much of the Sea," Business Week, March 31, 1975, p.26.

A major problem in the definition of both the territorial sea and the economic sea is what to do about archipelago nations, islands adjacent to nations, and narrow straits. There are at least 116 straits which are greater than 6 miles in width but less than 24 miles -- passage through which would be substantially affected by a change from the 3 to 12 mile territorial sea. Fortunately, both the United States and the Soviet Union (among other major countries) are insistent that any agreement on the 12 mile territorial sea be coupled with free passage through the straits. This may be a point of contention with the lesser developed nations. The application of the territorial sovereignty delineation and the economic area delineation to offshore islands are particularly cumbersome.

There will still remain a substantial amount of open seas that would be available for the common use of the world. It is informally well agreed that this common territory should be shared by all members of the world, although there is no treaty governing this. One suggestion is the establishment of an international fund for the open seas in which all member countries would participate. Individual countries mining from the open, commonly owned seas would pay a set percentage of the value of whatever is mined into the fund which would then be available for distribution among member nations on the basis of a yet to be determined formula. This may offer a way of providing economic development assistance to the lesser developed countries. However, undoubtedly this will require some time to resolve. Several American firms are already attempting to implement ocean mining operations in advance of any established domestic or international policy. In anticipation of these efforts, the Ocean Mining Administration has been established within the Department of the Interior and will issue licenses to American ocean mining firms and provide other incentives to encourage ocean mining. It is quite likely that these licenses will be granted before any international law or agreement is reached. Should the United States initiate an aggressive policy in the absence of international agreement governing the oceans, it may well be viewed unfavorably by the rest of the world and contribute to conflict.

The less developed countries feel particularly threatened by these activities. Currently, the natural resource base of the lesser developed countries is their only foundation for economic viability and method for capital formation, and any actions which they perceive as threatening may aggravate the tension between the "have" and "have not" nations.

Another stumbling block to achievement of an international agreement over the use and regulation of the oceans is concern for the rights of land locked countries who will feel increasingly threatened by the expansion of the territorial waters and creation of the economic zone.

Any agreement must account for use of the *surface* of the seas apart from ownership of the *contents* of the seas. The increasing reliance upon the oceans for transport of bulk cargo, especially petroleum necessitates the free passage of these ships.

Another source of controversy is likely to be the management of environmental protection and prevention of pollution. Much of the negotiation of the Law of the Sea Conference has revolved around regulations of the territorial seas and coastal economic zone. However, the Stockholm Conference, the 1972 United Nations Conference on the Human Environment, did address some of the questions of environmental protection. It is quite clear that any effort to reduce environmental degradation in this country alone, or in any country alone, will be unsuccessful by itself and, in fact, could even become a source of international conflict. Imagine, for example, the grounding of a supertanker and massive oil spill upon the shores of its political enemy. The political implications of such an accident could be profound indeed. The fourth conference was unable to establish any new guidelines for pollution control and Canada's effort to establish a 100-mile pollution jurisdiction was not accepted. In short, the growing problem of ocean pollution has been left for another year to solve.

A final consideration is the role that the oceans play in military and political security. Some have expressed concern that a 200 mile limit could trigger an escalation in the arms race. These commentators have noted that in South American countries where a unilateral 200 mile delineation has been established, it was immediately followed by an escalation in armament expenditures and the establishment of fleets of patrol boats to monitor the 200 mile limit. This could further antagonize an extremely volatile situation. At the same time, it is quite clear that if nations are granted an increase in territorial sovereignty, they will, in fact, make efforts to protect it and guard their resources especially since the ocean riches are inequitably allocated. The bulk of the ocean riches are located in the continental shelf adjacent to land masses and the open seas are essentially barren. The open seas have few fish resources and the mineral resources of the ocean depth are currently beyond the reach of even anticipated technology.

3. The Biosphere and Climate: A final concern is the lack of agreement governing the protection of the biosphere and the need for regulations to protect the climatic and weather patterns. This category refers to the effects

of direct actions (such as intentional weather modification) as well as inadvertent biosphere modification. Another section of this report discusses in some detail the role industrial pollution may play in modification of the climate. Here, it is important to note in particular, the "greenhouse effect," caused by an increase in the carbon dioxide content of the atmosphere (resulting from the combustion of fossil fuels, primarily coal) and causing substantial warming of the globe. Recently, this has been counteracted by the increasing concentration of dust and particulate pollution in the atmosphere which increases the amount of solar radiation reflected off the earth -- hence, substantially cooling the globe. Both of these activities are largely influenced by the level and kind of industrial activities on the globe. It becomes quite clear that if the industrial revolution spreads to other countries or the level of industrial activity increases substantially in the developed countries, the negative impacts upon the global ecosystem could be severe indeed. Hence, the need for internationally agreed upon pollution standards, environmental quality indices, and pollution abatement strategies may become of paramount importance.

The protection of the biosphere is hampered by a frequently mentioned problem: lack of knowledge. The relationship of the oceans, climate and weather patterns, industrialization and atmospheric physics, and the impact of man's activities are not at all well understood. Increasingly, scientists are experimenting with different ways of modifying the weather with little insight into the short or long term consequences of such activities. Even such humanitarian efforts as increasing the precipitation of the drought plagued areas may be dangerous. The National Academy of Sciences has discovered that efforts to increase the precipitation in any given area may, in fact, result in an increase in precipitation in some areas, while in others a decrease in precipitation may occur and in still others the experiment will have no impact whatsoever. However, so little is understood that the results cannot be predicted in advance with any accuracy.[11]

The implication is that individual countries pursuing weather modification schemes to improve their particular geographic and environmental problems (such as localized floods, droughts, hurricanes, tornados) may profoundly, and perhaps, permanently change the climate and weather relationships of their region or another region without any insight into the outcome of their efforts or the implications of their activities over the long run.

At the same time, there is the legitimate fear that such climate and weather modification programs could be used as a military weapon. This is a legitimate fear, somewhat muted by the inferior state of the art. In any event, this is another area requiring international mechanisms for solution.

<u>Some Barriers to International Agreements:</u>

Regardless of the area of lack of agreement, there are substantial problems that prevent the implementation of any international agreement. First, there is no institution that is currently perceived internationally as adequate to regulate, oversee, monitor, interpret, and enforce any international agreement that may come into existence. This is true of both the Outer Space Treaty as well as any resulting treaty of the Law of the Seas Conference. Apparently, The United Nations currently is taking a dominant role in the search for an international agreement; however, The United Nations does not currently demand sufficient international respect to fill this role effectively.

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[11] National Academy of Sciences, <u>Weather & Climate Modification: Problems and Progress</u> (Washington, D.C.) 1973

National Academy of Sciences, <u>Understanding Climate Change: A Program for Action</u> (Washington, D.C.) 1975

A second problem is that the biological, chemical, geological and physical relationships of the commonly owned resources are not well understood. Repeatedly, it has been noted that climatic processes are not well understood. Similarly, very little is known about the science of the oceans. In fact, it is essential that any kind of agreement governing the use of the oceans must not in any way interfere with such research into the fundamental dynamics of the oceans. This lack of understanding means that any kind of agreement that is reached must be sufficiently flexible to accommodate future increases in understanding of these mechanisms.

A final problem refers to inequitable technological achievement among nations which results in technological dominance. While the international consensus is that the open seas and their riches are the common property of the world and therefore available for sharing by all nations of the world; it is also quite clear that the relative technological differences among nations make an equitable sharing highly unlikely. The lesser developed countries who may view these resources as their ticket to economic development or at least temporary accumulation of wealth may not have the technological competence necessary to take advantage of these marine resources in a competitive fashion. Hence, any kind of international agreement that will benefit the most developed and the most technologically sophisticated countries will *increase* rather than decrease international conflict. Yet, it appears almost impossible to prevent this kind of discrimination. The suggested international fund may make it more equitable. The notion is that a fund would be established from the proceeds of the commonly owned resources of the ocean for the use of the developing countries as a source of capital for development.

Some Potential Actions:

Quite clearly the first step is the establishment of an international agency which will command sufficient worldwide respect to interpret and enforce existing international laws governing the use of shared resources and would be a forum for future interpretation of any treaties, laws, or regulations. While a necessary step, it is recognized that this would be overwhelmingly difficult. This entity should have the power to levy penalties against nations that violate the agreements. It should also have resources for research, loans for lessor developed countries and monitoring capabilities. As the one world economy intensifies, the importance of international law substantially increases as a means of maintaining, preserving and increasing international peace and reducing international conflict. It will be the function and role of this agency to establish the trust fund previously described as well.

Any institutional mechanism created to fill this void must be able to interpret and enforce an agreement. First, the agreement must be made among a host of widely disparate nations. Preliminary efforts are underway currently, witness the Law of the Seas Conference and the Stockholm Conference. Secondly, there must be a body to interpret this treaty or agreement. It is quite clear that existence of the agreement by itself is insufficent. Inevitably events will occur which demand an interpretation and ruling on the agreement; perhaps even the levying of a fine or penalty. Finally, there must be an administrative mechanism that can oversee necessary research and support the compliance with these treaties. The institutional mechanism must be flexible enough so that the agreements can move forward as scientific understanding and international law move forward.

There have been many recommendations and suggestions for the institutional mechanism. In 1970, the United States Senate passed Resolution 399, recommending its support for the creation of a World Environmental Institute that could act as a global research center to disseminate knowledge of environmental problems and their solutions to all nations in the world. It was viewed as an exchange reference center -- a clearing house on environmental information. Close in agreement with this, the ad hoc Committee of the International Council of Scientific Unions and Problems of the Human Environment recommended the establishment of an International Center for the Environment which would serve as both a research center as well as a center for disseminating environmental information. Simultaneously, UN Secretary General General U Thant called for a global authority which would centralize the piecemeal environmental efforts now being done. Currently, international environmental efforts are conducted in bits and pieces resulting in overlap, omissions and a lack of centralized authority, decision making and responsibility.

It is the consensus of most experts that a fundamental requirement is a mechanism for the collection, storage, retrieval processing, analyzing, and dissimination of environmental monitoring data as well as environmental research results. The lack of such an international clearing house serves as a barrier to scientific understanding and progress. A central information resource and data bank is viewed as essential to provide policymakers, legislators, and industry with sufficient scientific data and understanding for informed decision making. Such an institution would also establish an enviable precedent for international cooperation.

Figure 3 indicates the piecemeal efforts of international organizations towards environmental regulations and displays the similarity of the piecemeal approach taken towards environmental problems in the United States prior to the establishment of the Environmental Protection Agency. The state of international environmental protection is similar to that of the United States two decades ago.[12]

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[12] 1972 Survey of Environmental Activities of International Organizations, Prepared by Warren G. Magnuson for the use of the Committee on The Commerce, United States Senate, February 1972.

In sum, the use, ownership and protection of the commonly shared resources are likely to be continuing sources of considerable international tension and conflict and will be extremely difficult to remedy. The international conference on The Law of the Sea reflects the present status of international attempts to create "ideal" solutions for the protection of the future environment: such efforts appear to expand into years while pollution and economic problems reach crises levels and individual countries primarily concentrate on rights which are economically advantageous.

Figure 3

INTERNATIONAL ENVIRONMENTAL ORGANIZATIONS

ENVIRONMENTAL ACTIVITIES AND CONCERNS OF INTERNATIONAL ORGANIZATIONS

	Agriculture, forestry, soil, and plant sciences	Air pollution	Climate	Education	Energy	Fisheries and wildlife	Health and medicine	Information exchange and research coordination	Legal research and reference	Marine pollution	Marine science	Measurements and standards	Minerals and mining	Monitoring	Noise	Pesticides	Population	Radioactivity/atomic wastes	Recreation, natural, historic, and cultural sites preservation	Regional, land, and economic planning	Solid wastes	Transportation	Urban affairs	Water pollution	Water resource development and management
UNITED NATIONS																									
General Assembly and Economic and Social Council				X	X			X		X	X						X		X	X		X	X	X	X
U.N. Conference on the Human Environment	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Advisory Committee on the Application of Science and Technology to Development	X			X				X									X								
U.N. Secretariat				X	X			X		X			X				X		X	X		X	X	X	X
U.N. Development Program	X	X	X	X	X	X	X			X	X		X	X		X	X			X			X	X	X
U.N. Industrial Development Organization	X	X											X			X				X				X	
U.N. Scientific Committee on the Effects of Atomic Radiation	X	X					X	X		X	X							X							
The Economic Commission for Europe	X	X			X			X	X		X		X	X			X		X	X	X	X	X	X	X
The Economic Commission for Asia and the Far East	X	X			X															X			X	X	
The Economic Commission for Africa	X			X	X				X				X				X			X	X	X	X	X	X
The Economic Commission for Latin America	X	X																						X	X
U.N. Research Institute for Social Development								X												X					
U.N. Institute for Training and Research		X		X				X		X	X	X				X								X	
U.N. Educational, Scientific and Cultural Organization	X	X		X		X	X	X	X	X	X	X		X			X		X				X	X	
International Atomic Energy Agency	X	X		X	X			X		X	X	X	X	X		X		X			X	X		X	X
International Civil Aviation Organization		X					X		X			X		X	X					X		X			
International Bank for Reconstruction and Development	X	X		X	X	X	X	X		X			X			X	X		X	X	X	X	X	X	X
International Labor Organization		X						X		X			X		X		X	X		X			X		
Inter Governmental Maritime Consultative Organization		X						X		X	X	X		X		X		X	X		X	X		X	
Food and Agriculture Organization	X			X		X	X	X		X	X	X				X		X		X	X	X	X	X	X
World Health Organization	X	X		X			X	X			X	X		X	X	X		X			X			X	X
World Meteorological Organization	X	X	X	X				X		X	X	X		X				X				X	X	X	X
North Atlantic Treaty Organization		X						X												X		X	X	X	X
Organization for Economic Cooperation and Development	X	X			X	X		X				X		X	X	X		X		X	X	X	X	X	X
Organization of American States	X	X		X	X	X	X	X		X	X		X					X		X	X	X	X	X	X
Council of Europe	X	X		X	X	X	X		X			X	X	X	X	X	X		X	X	X	X	X	X	X
The European Community	X	X						X	X			X	X		X	X		X				X		X	X
Council for Mutual Economic Assistance	X	X			X			X	X	X	X	X	X			X		X	X	X	X	X	X	X	X
Asian-Pacific Weed Science Society	X															X									X
Association for the Taxonomic Study of Tropical African Flora	X							X																	
Association of African Geological Surveys								X					X												
Charles Darwin Foundation for the Galapagos Isles	X					X		X			X														
Committee on Space Research								X						X											
Commonwealth Agricultural Bureaux	X		X				X	X								X	X	X		X					
Danube Commission							X	X				X										X			
David Davies Memorial Institute of International Studies		X	X						X	X	X					X		X						X	

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Figure 3 (cont.)

INTERNATIONAL ENVIRONMENTAL ORGANIZATIONS

ENVIRONMENTAL ACTIVITIES AND CONCERNS OF INTERNATIONAL ORGANIZATIONS—Continued

	Agriculture, forestry, soil and plant sciences	Air pollution	Climate	Education	Energy	Fisheries and wildlife	Health and medicine	Information exchange and research coordination	Legal research and reference	Marine pollution	Marine science	Measurements and standards	Minerals and mining	Monitoring	Noise	Pesticides	Population	Radioactivity/atomic wastes	Recreation; natural, historic and cultural sites preservation	Regional, land and economic planning	Solid wastes	Transportation	Urban affairs	Water pollution	Water resource development and management
Eastern Regional Organizat on for Planning and Housing								X									X			X			X		
Europa Nostra Associations for the Protection of Europe's Natural and Cultural Heritage									X										X				X		
European and Mediterranean Plant Protection Organization	X							X	X																
European Atomic Energy Society					X													X			X				
European Atom Forum					X			X										X							
European Center for Population Studies								X									X								
European Committee for the Protection of the Population Against the Hazards of Chronic Toxicity							X		X																
General Fisheries Council for the Mediterranean				X		X		X																X	
Indo Pacific Fisheries Council				X		X		X																	
Inter-American Association of Sanitary Engineering							X					X													
Inter-American Committee for Agricultural Development	X			X				X												X					
Institute of Ecology				X				X																	
Inter-American Nuclear Energy Commission				X	X		X	X										X							
Inter-American Planning Society				X																X					
International Association Against Noise								X	X			X			X										
International Association for Earthquake Engineering								X																	
International Association for Ecology								X																	
International Association for Hydraulic Research								X		X	X	X										X		X	
International Association for the Physical Sciences of the Ocean								X		X	X	X													
International Association of Geodesy								X				X													
International Association of Geomagnetism and Aeronomy								X				X													
International Association of Meteorolgy Atmospheric Physics		X	X	X	X			X				X		X				X							
International Association of Microbiological Societies				X			X	X				X													
International Association of Scientific Hydrology	X						X			X	X													X	
International Association of Seismology and Physics of the Earth's Interior			X					X			X														
International Association of Theoretical and Applied Limnology																								X	
International Association of Volcanology and Chemistry of the Earth s Interior			X		X			X			X														
International Association on Water Pollution Research				X		X	X	X	X	X	X			X		X		X	X	X	X			X	
International Botanical Congress	X							X				X													
International Castles Institute								X											X						
International Center for the Study of the Preservation and the Restoratin of Cultural Property				X				X											X						
International Commission for the Northwest Atlantic Fisheries						X					X														

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Figure 3 (cont.)

INTERNATIONAL ENVIRONMENTAL ORGANIZATIONS

International Commission for the Scientific Exploration of the Mediterranean Sea								X			X														
International Commission of Agricultural Engineering	X			X			X	X								X			X	X				X	
International Commission on Irrigation and Drainage	X			X		X	X	X											X	X	X			X	
International Commission on Large Dams								X																	
International Commission on Radiological Protection							X	X				X		X				X							
International Council for Bird Preservation			X		X			X	X	X														X	
International Council for Local Development				X				X												X					
International Council for the Exploration of the Sea						X		X			X	X													
International Council of Environmental Law								X	X											X			X		
International Council of Scientific Unions	X	X	X	X	X		X	X			X	X		X	X		X	X	X					X	X
International Federation for Housing and Planning																				X			X		
International Federation of Agricultural Producers	X	X						X									X			X	X			X	
International Geographical Union	X	X	X	X			X	X					X				X			X					X
International Institute for Conservation of Historic and Artistic Works																			X						
International Institute for Environmental Affairs								X																	
International Law Association								X		X			X												X
International Mineralogical Association													X												
International Office of Epizootics		X					X	X	X																
International Organization for Biological Control of Noxious Animals and Plants	X							X								X									
International Organization for Standardization								X				X													
International Planned Parenthood Federation				X				X											X						
International Radiation Protection Association							X	X				X							X						
International Society for Plant Geography and Ecology	X							X				X													
International Society for Research on Civilization Diseases and Vital Substances	X	X					X	X								X		X						X	
International Society for Tropical Ecology	X		X																						
International Society of Biometeorology	X		X				X					X						X							
International Society of City and Regional Planners				X				X												X		X	X		
International Society of Soil Science	X																								
International Union for the Conservation of Nature and Natural Resources	X	X		X		X		X	X								X		X	X			X	X	X
International Union for the Scientific Study of Population								X									X								
International Union of Biological Sciences	X			X		X		X			X					X	X								
International Union of Forestry Research Organizations	X							X				X													
International Union of Geodesy and Geophysics								X																	
International Union of Geological Sciences	X		X	X				X			X		X												
International Union of Pure and Applied Chemistry	X						X	X				X				X								X	
International Union of Pure and Applied Physics								X				X			X										
International Water Supply Association								X																X	X
Inter-Parliamentary Union		X	X			X			X	X						X	X			X	X			X	X
North-East Atlantic Fisheries Commission						X		X				X													
Organization for Coordination in the Control of Endemic Diseases in Central Africa							X	X																	
Pan Indian Ocean Science Association								X			X														
Piccard Foundation for the Study and Preservation of the Environment				X				X																	
Society for International Development		X						X																X	
Woodrow Wilson International Center for Scholars				X				X																	
World Energy Conference		X			X							X	X									X		X	X
World Medical Association				X			X	X																	
World Peace Through Law Center		X		X				X	X				X									X		X	

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Source: 1972 Survey of Environmental Activities of International Organizations, Prepared by Warren G. Magnuson for the Use of the Committee on The Commerce, United States Senate, February 1972).

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THE ISSUE OF WAR

The Issue. One of the most important dilemmas of our age is that nuclear war is feasible from a technical viewpoint, occasionally impending from a political viewpoint, and unthinkable from a moral, ethical, and genetic viewpoint. Furthermore, almost all of the socio-economic-political issues which appear on the horizon seem to be politically destabilizing--overpopulation, shortages of food, cartelism, terrorism, pressures to redistribute wealth to developing countries. War is possible. War is conceivable. Even nuclear war.

In striving for a definition of war, Clausewitz, the 19th century military theoretician, said, "War is not merely a political act, but also a political instrument, a continuation of political relationships, a carrying out of the same by other means." As long as the world's political powers maintain the view that war is ultimately "a political instrument" there will be a finite probability of war, large scale or small.

The issue, unique in our times, is clearly among the most difficult and dangerous that nations of the world have ever faced. It is unique because of the high level of the killing potential now stored in weapons; it is difficult because disarming, even arms limitation in some instances, is seen as counter to national interests; it is increasingly dangerous for three reasons; first because more nations, and even groups within nations, are going to have vastly increased killing potential in the very near future. Second, new, inexpensive, easy to conceal weapons are at hand. Finally, the danger stems from the apparently inevitable clashes between nations over food, minerals, energy, and the distribution of wealth in the world.

Dimensions of the Problem. How can the capacity and propensity to wage war and its potential consequences be measured? Certainly the extent of armaments and military-related expenditures can be listed; they are extensive. The number of military personnel, domestic and foreign installations, numbers of warheads of various types, countries in conflict or thought likely to be in conflict can be named and counted. These are the statistics of the issue but they only serve to describe it superficially. This description is needed, nevertheless, so that the dimensions of the issue are clear; however, this quantitative enumeration should not be confused with the issue itself which eludes quantification. The issue is a human problem, a problem as old and ephemeral as the concept of nationality, tribe, and belonging. Because the issue is so fundamental to the organization of human affairs, the statistics presented in this section are inevitably the trees of some atavistic forest. But the trees must be described because the forest cannot yet be seen.

There is, of course, great difficulty in assembling reliable figures on military expenditures throughout the world. Nevertheless, various organizations within the United Nations and peace institutes throughout the world have gleaned enough data to form an idea of the massive world scope of military spending which now exists:

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- On a worldwide basis, military expenditures have been increasing about 6 percent per year, in constant dollars, since 1950.

- The level of military budgets for 1970 totaled 200 billion dollars.

- Since military expenditures, on the average, are growing faster than either world GNP or world population, the absolute burden and per capita burden are both increasing.

- As an example of the size of the military enterprise, in 1967 military costs were seven percent of the world GNP—equal to the total annual income of one billion people living in Latin America, Southeast Asia, and the Middle East. The manpower in military service totals some 50 million people.

- World military expenditures exceed expenditures for public education, public health, and foreign aid; public education amounted to about 70 percent of military expenditures, public health about 30 percent, and foreign economic aid, about six percent.

- In the United States, somewhat less than 10 percent of the gross national product has been devoted to military spending.

- In the late 1960's the developing countries accounted for only 11 percent of the world's total military expenditures; $8 per capita versus $170 per capita in the developed countries. In absolute terms their spending averaged four percent of gross national product versus eight percent in the developed countries.

- Yet even in the developing countries, military expenditures far exceed expenditures for public education and public health (in 1966, $17 billion for the armed forces, $11 billion for public education, and $5 billion for public health).[1]

- In real terms, military expenditures in developed countries peaked in 1968, but the growth rate of military spending in developing countries has increased sharply. Since 1961, military spending in 93 developing nations has more than doubled.[2]

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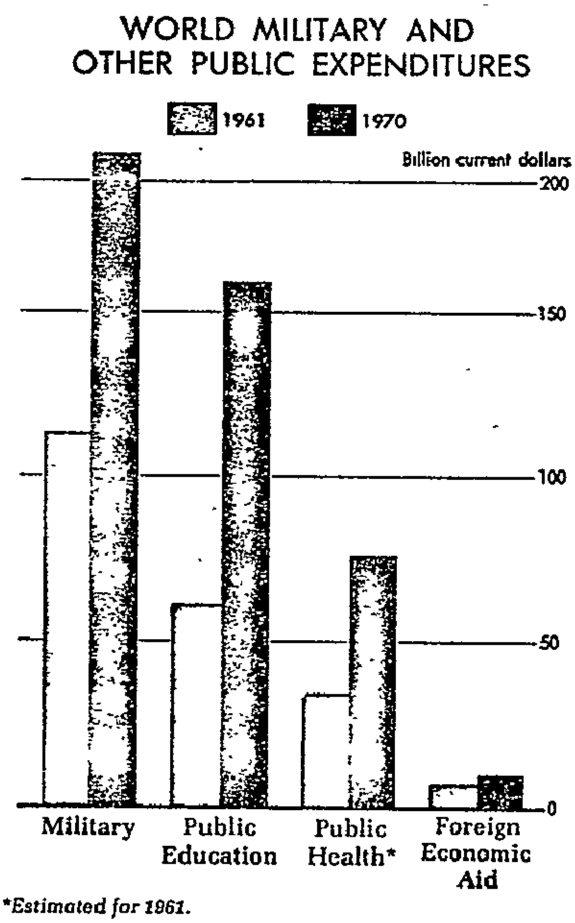
[1] Archibald S. Alexander, "The Cost of World Armaments," Scientific American (October 1969), pp. 21-27.

[2] World Military Expenditures; 1971, U.S. Arms Control and Disarmamemt Agency, July 1972.

Figure 1 illustrates world expenditures for military and other public purposes for the years 1961 and 1970.



SOURCE: World Military Expenditures; 1971, U.S. Arms Control and Disarmament Agency, July 1972.

Figure 1. World military and other public expenditures

Some nations are carrying an incredible per capita burden to support their military expenditures. Figure 2 shows military expenditures as a percentage of GNP versus gross national product per capita. In countries

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RELATIVE BURDEN OF MILITARY EXPENDITURES, 1970

MILITARY EXPENDITURES AS % OF GNP	GROSS NATIONAL PRODUCT PER CAPITA							
	UNDER $100	$100-199	$200-299	$300-499	$500-999	$1,000-1,999	$2,000-2,999	OVER $3,000
OVER 10%	Laos Vietnam, North	Cambodia Vietnam, Republic of	Iraq Jordan Syrian Arab Republic	Albania Korea, North	Saudi Arabia	Israel		
5-10%	Burma Somali Republic	China, People's Republic of Egypt Sudan		China (Taiwan) Iran Malaysia	Cuba Portugal	Germany, East Greece Poland	Czechoslovakia Soviet Union United Kingdom	United States
2-4.9%	Chad Ethiopia Guinea India Indonesia	Central African Republic Mauritania Nigeria Pakistan Senegal Thailand Yemen Zaire	Congo (Brazzaville) Ghana Korea, Republic of Morocco Turkey	Algeria Brazil Dominican Republic Peru	Argentina Chile Lebanon Mongolia South Africa, Republic of Spain Uruguay Venezuela Yugoslavia	Bulgaria Hungary Italy New Zealand Romania	Australia Belgium France Netherlands Norway	Canada Denmark Germany, West Kuwait Sweden Switzerland
1-1.9%	Afghanistan Dahomey Haiti Niger Upper Volta	Cameroon Kenya Malagasy Republic Mali Tanzania Togo Uganda	Bolivia Ecuador El Salvador Honduras Paraguay Philippines Rhodesia, Southern Tunisia	Colombia Guatemala Guyana Ivory Coast Nicaragua Zambia	Cyprus Gabon Trinidad & Tobago	Austria Libya	Finland	
BELOW 1%	Malawi Nepal	Ceylon Sierra Leone	Liberia		Costa Rica Jamaica Mexico Panama	Ireland Japan	Iceland	Luxembourg

SOURCE: World Military Expenditures: 1971, U.S. Arms Control and Disarmament Agency, July 1972.

Figure 2. Relative burden of military expenditures, 1970

like Laos and North Vietnam, GNP per capita is under $100, yet military expenditures amount to over 10 percent of the GNP of these countries. At the other extreme, Luxembourg has a per capita GNP of over $3000 and yet its military expenditures are below one percent of the GNP of that country.

On an absolute basis, the military expenditures of the United States and the Soviet Union far outweigh other countries in the world. This situation is illustrated in Figure 3.

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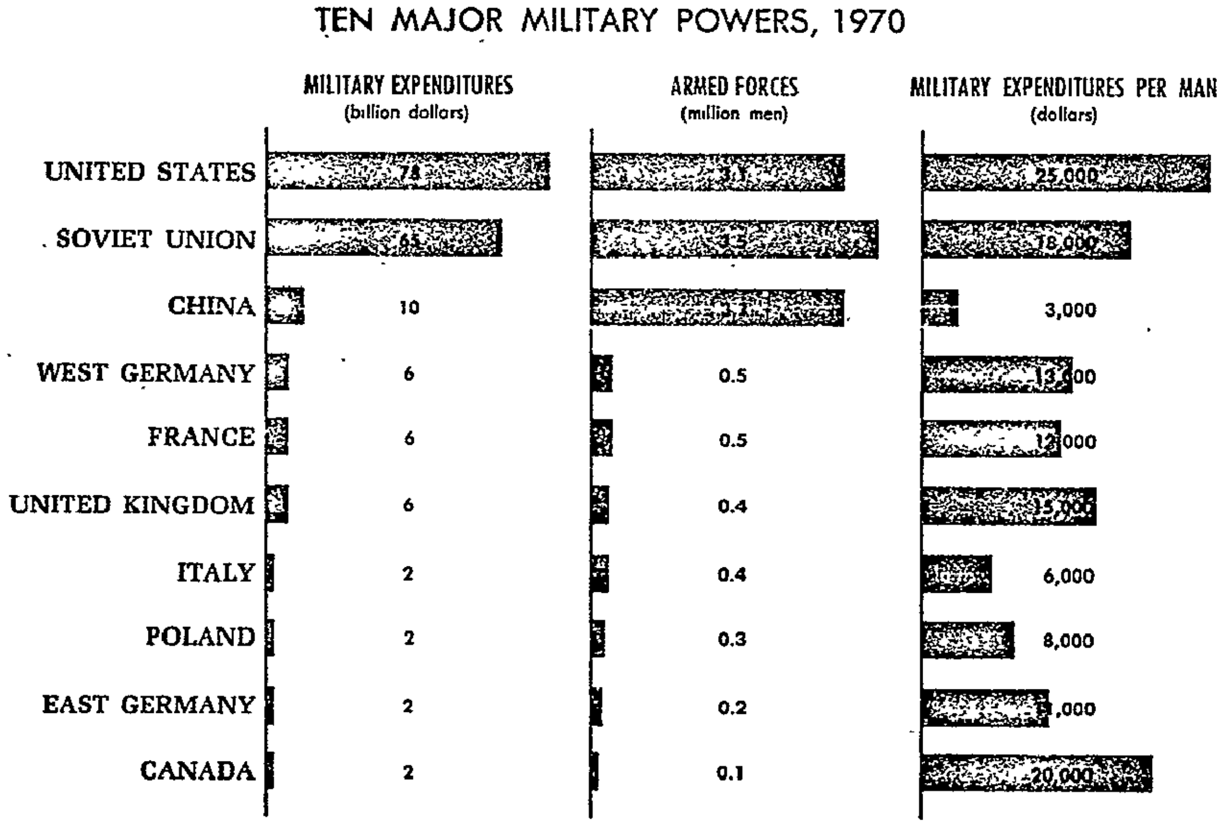

SOURCE: World Military Expenditures: 1971, U.S. Arms Control and Disarmament Agency, July 1972

Figure 3. Ten major military powers, 1970

The number of nuclear weapons around the world is huge. The United States has over 30,000 located within the United States, at sea, and in foreign countries. Of these, 8,500 are strategic and 22,000 tactical.[3] The Soviet Union has approximately 5,500 nuclear weapons, of which 3,000

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[3] Barry Schneider, "Big Bangs from Little Bombs," The Bulletin of Atomic Scientists, May 1975.

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are tactical.[4] The strategic weapons include those capable of being delivered by land based Minuteman and Titan missiles, submarine launched Polaris and Poseiden missiles located on 41 U.S. ballistic missile submarines, and bombs which can be carried on SAC bombers. The tactical weapons include surface-to-surface missiles such as Lance, Sargeant, HonestJohn, and Pershing, artillery shells (155mm and 203mm) and fighter bombers which can carry air-to-surface missiles and bombs. The tactical weapons carried on ships include bombs, depth charges, torpedos, and missiles. The Soviet Union has also developed considerable tactical power, but its size is about half the U.S. tactical nuclear capacity.

The smaller nuclear weapons are deployed in Europe, the Philippines, South Korea, Guam, and Wake Island. Figure 4 summarizes the deployment of U.S. nuclear weapons outside of the continental United States.

What is the total explosive force available in nuclear weapons throughout the world? Apparently somewhat more than 50,000 megatons. This is equivalent to 15 tons of TNT for each person in the world.[5]

War might next appear in many different places in the world. Figure 5 attempts to summarize some of the more important potential conflicts of the next ten years.

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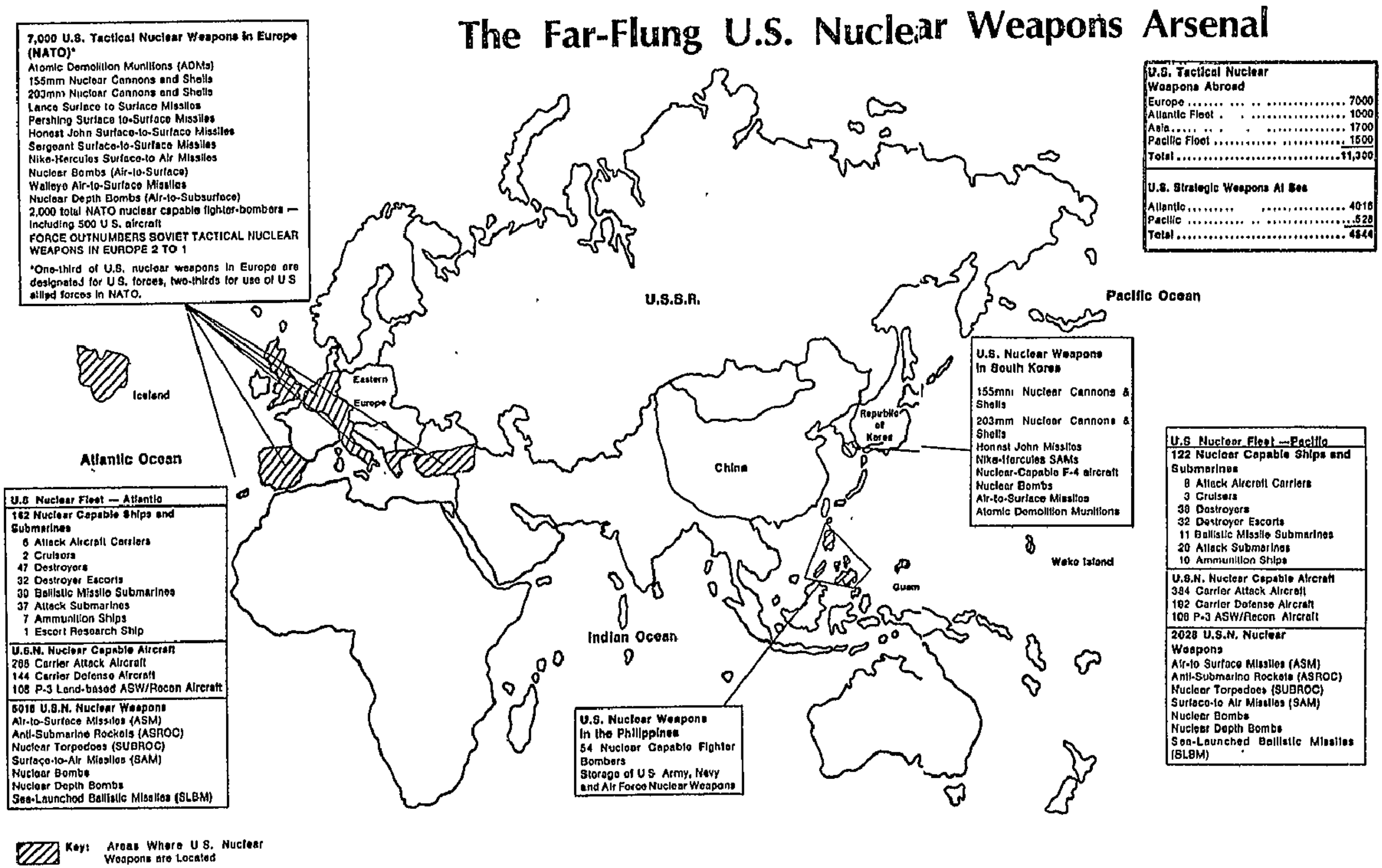
4 Larry Carder,"Nuclear Strategy and Nuclear Weapons," Scientific American, May 1974; and Barry Schneider, "Big Bangs from Little Bombs," The Bulletin of Atomic Scientists, May 1975.

5 Data on the Human Crisis: A Handbook for Inquiry, The University of the State of New York, The State Education Department, Albany, New York 1972.



SOURCE: Center for Defense Information, Defense Monitor. 4:2 (February 1975), 6-7, and Barry Schneider, "Big Bangs from Little Bombs," The Bulletin of Atomic Scientists, May 1975

Figure 4. The far-flung U.S. nuclear weapons arsonal

POTENTIAL MILITARY CRISIS SITUATIONS IN THE WORLD			
COUNTRY	ANTAGONISTS	STATUS QUO	OUTLOOK
NORTHERN IRELAND	I.R.A./U.K. U.D.L./U.K. I.R.A./U.D.L.	TERRORISM CUM RESIDENT BRITISH MILITARY POLICE FORCE.	LITTLE CHANGE IN THE STATUS QUO, POLITICAL RESOLUTION UNLIKELY; LONG TERM BRITISH ARMY PRESENCE LIKELY.
MIDDLE EAST	ISRAEL/ARAB NATIONS ISRAEL/P.L.O. LEBANON/P.L.O.	TEMPORARY TRUCE WITH PRESENCE OF U.N. FORCES; PEACE ACTIVITY BEING SOUGHT ON SEVERAL FRONTS, TERRORISM MAINLY PERPETRATED BY PALESTINIANS.	POSSIBILITY OF OPEN WAR WITHIN THE YEAR, AND A POSSIBILITY OF OPEN PEACE, PALESTINIAN TERRORISM LIKELY TO CONTINUE FOR DURATION OF ISRAELI OCCUPATION OF THE WEST BANK AND THE GAZA STRIP.
CYPRUS	TURKISH CYPRIOTS/ GREEK CYPRIOTS	UNEASY TRUCE WITH THE DEMARKATION OF THE ISLAND.	CONTINUING UNEASYNESS OVER A DIVIDED CYPRUS AND ATTEMPTS AT RUNIFICATION BY MAKARIOS/GREEK FACTIONS.
KOREA	SOUTH KOREANS/ NORTH KOREANS	AMERICAN PRESENCE SEEMS TO THE MAIN FORCE KEEPING COMMUNISTS FROM ATTEMPTING TO OVERTHROW THE PARK REGIME.	CONTINUING AMERICAN PRESENCE LIKELY; THERE IS SOME SPECULATION THAT CHINESE ARE RESTRAINING THE NORTH KOREANS, WISHING U.S. FORCE TO REMAIN TO MAINTAIN THE THREE-POWER BALANCE IN ASIA.
TAIWAN	REPUBLIC OF CHINA/ PEOPLE'S REPUBLIC OF CHINA	STALEMATE BETWEEN THE CLAIMS OF THE TWO STATES TO THE RIGHTS OF OTHER'S TERRITORY.	DEATH OF CHIANG MAY MEAN THE END OF PRC'S RESTRAINT IN TAKING MILITARY ACTION TO GAIN CONTROL OF TAIWAN.
SOVIET UNION	U.S.S.R./PEOPLE'S REPUBLIC OF CHINA	CONTINUING TENSION OVER COMMON BORDER, EXACERBATED BY IDEOLOGICAL DISPUTE OVER "RIGHT" PATH FOR THE WORLD COMMUNIST MOVEMENT.	CONTINUANCE OF THE STATUS QUO, NO OPEN WAR IN THE NEAR FUTURE.
PORTUGAL	COMMUNITST/SOCIALISTS	UNEASY POLITICAL SITUATION WITH THE CONTROLLING MILITARY LEADERS SUPPORTING THE COMMUNISTS AND THE POPULACE SUPPORTING THE SOCIALISTS.	CIVIL WAR POSSIBLE BUT NOT LIKELY, PORTUGESE WITHDRAWAL FROM NATO IS VERY POSSIBLE IF THE COMMUNIST PARTY GAINS FULL CONTROL;SPANISH/ PORTUGESE SITUATION COULD DEVELOP.
INDIA	INDIA/PAKISTAN	PERENNIAL TENSION HEIGHTENED BY THE RECENT INDIAN AGGRANDIZEMENT OF SIKKIM.	OPEN WAR UNLIKELY.
BRAZIL	BRAZIL/ARGENTINA	SUBTLE RIVALRY OVER LEADERSHIP IN S.A.; BOTH NATIONS CONTINUING TO BUILD MAJOR MILITARY ESTABLISHMENTS.	NO OPEN HOSTILITIES PROBABLE IN THE NEAR FUTURE.
CHILE	BOLIVIA/CHILE	CONTINUING DISCUSSION OVER BOLIVIAN ACCESS TO A SEAPORT; TENSIONS LESSENED WITH THE ADVENT OF A RIGHTEST REGIME IN CHILE.	OPEN CONFLICT ONLY LIKELY IF THE POLITICAL SITUATION DETERIORATES IN EITHER COUNTRY.
EL SALVADOR	EL SALVADOR/HONDURAS	THE BORDER BETWEEN THE TWO NATIONS IS STILL CLOSED AS A RESULT OF THE "SOCCER WAR"; TENSIONS STILL EXIST.	NEGOTIATIONS IN PROGRESS MAY RE-OPEN BORDER, BUT THE POSSIBILITY OF THE RESUMATION OF HOSTILITIES STILL EXITS.
PANAMA	PANAMA/U.S.	PANAMANIANS WISH TO TAKE OVER POSSESSION OF THE CANAL ZONE/ NEGOTIATING WITH THE U.S.	FURTHER TENSIONS DEVELOPING IN THE NEAR FUTURE

Figure 5. Potential military crisis situations in the world

Discussion of the Issue. The issue of our proximity and propensity to war encompasses most dimensions of national experience: foreign policy, national aspirations, history, self images, diplomacy, social and economic development, industrial capacity, technology and science, institutions and groups which see conflicts in their interests or against their interests. All of these interact, reinforce or cancel to form the complex structure which while balanced precariously, leans nations of the world toward peace or war. This discussion of the issue is divided into the following elements:

- Classical roads to nuclear war.
- Proliferation of nuclear weapons.
- Verification, the key to weapons treaties.
- SALT results.
- Changing U.S. Military doctrine.
- Two modern problems: terrorism and guerrilla warfare.
- Some ugly weapons: CBW
- New forms of warfare.

"Classical" Roads to Nuclear War. Escalation describes the gradual expansion of a limited or confined conflict into a full-scale war, in terms of both geography and weaponry. The United States and the Soviet Union have developed small battlefield atomic weapons. These tactical systems are designed for use in the field by troops engaged in close combat. Since our nuclear arsenal consists of a continuum of warhead sizes, it is easy to envision a situation which starts as a limited action in which small nuclear weapons are used. These include bombs carried by fighter planes, short-range missiles, torpedos, mines, cannon, and tactical rocket launchers like the "Davy Crockett."

As the fighting grows in intensity, larger and larger weapons would be used until finally the biggest were employed. This type of escalation does not require the initial use of nuclear weapons; a conventional war can also grow by steps until a level of conflict results which neither side anticipated or wanted originally.

Of course, major war by escalation can also be the result of minor wars occurring between smaller nations aligned with major powers. First France, and then the United States went to war over issues in Vietman; throughout the world there are patterns of alliances and commitments which could bring this kind of conflict again. Certainly, the United States would be less likely to become involved in a Vietnam type situation again without adequate provocation; nevertheless, in the coming decades, provocations may abound.

We have no way of knowing how many times we have come close to war through inadvertence. In 1958, at the height of the cold war, Frank H. Bartholomew, then President of United Press, wrote in a wire service story:

> ...You are airborne in six minutes; you have been flying for eight minutes. You believe enemy missiles that must have passed you in flight would be due to strike North America in one minute. Other U.S. bombers are in the air all over the world with reprisal bombs.
>
> But this one thing you alone do not know; since your takeoff, foreign objects picked up on the radar scopes turned out to be a shower of meterorites.
>
> Other aircraft in your sortie have been turned back by radio. ...there has been a failure; you did not receive a turn-back signal.
>
> Do you proceed to your target...no go. You are saved, you and many others, by a powerfully simple plan called "Fail Safe". It is proof against errors, human or mechanical.
>
> "Fail Safe,"...instructs you to proceed to your target for a fixed number of nautical miles and then turn back if for any

reason you do not at that point and at that moment receive coded orders to continue.

This has actually happened many times. (Emphasis added.)[6]

As weapons systems become more complex chances for human and mechanical failure increase.

The list below recounts some accidents involving nuclear weapons. In the past, the Department of Defense has acknowledged eleven such accidents; some details are known about five of them:

- Air crash over Palomares, Spain. On January 17, 1966 an American B-52 bomber collided with a KC-135 refueling tanker causing the death of 5 crew men and the dropping of 4 hydrogen bomb which were recovered after an intensive ground and sea search. Radioactive leakage and conventional explosion occurred in the area.

- Bomb accidently dropped over South Carolina. On March 11, 1958, a B-47 bomber accidently dropped a nuclear weapon in the megaton range over Mars Bluff, South Carolina. The conventional explosive "trigger" of the nuclear bomb detonated leaving a crater seventy feet wide and thirty-five feet deep. A new farmhouse was obliterated. No radiation leakage was detected, no nuclear explosion occurred and noone was killed.

- Bomark missile burned in fire. On June 7, 1960, a fire at McGuire Air Force Base led to a series of explosions and the destruction of one of 56 nuclear armed Bomark missiles. No nuclear explosion occurred but there was a small amount of radioactive leakage creating a temporary health hazard.

- 24 megaton bomb safety devices sprung. In 1961, a near catastrophe occurred at Goldsboro, North Carolina when a B-52 bomber had to jettison a 24 megaton bomb. Five of the six interlocking safety devices were set off by the fall. The single switch prevented the bomb from exploding, an explosion which would have been over 1800 times more powerful than the Hiroshima bomb.

- Greenland air crash scatters plutonium. On January 21, 1968, a B-52 attempting an emergency landing at Thule Air Force Base, Greenland, crashed and burned on the ice of North Starr Bay. The high explosive components of all 4 nuclear weapons aboard detonated, producing a plutonium-contaminated area of at least 300-400 feet wide and 2200 feet long.[7]

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[6] Frank H. Bartholomew, UPI, The New York Times (April 19, 1958.)

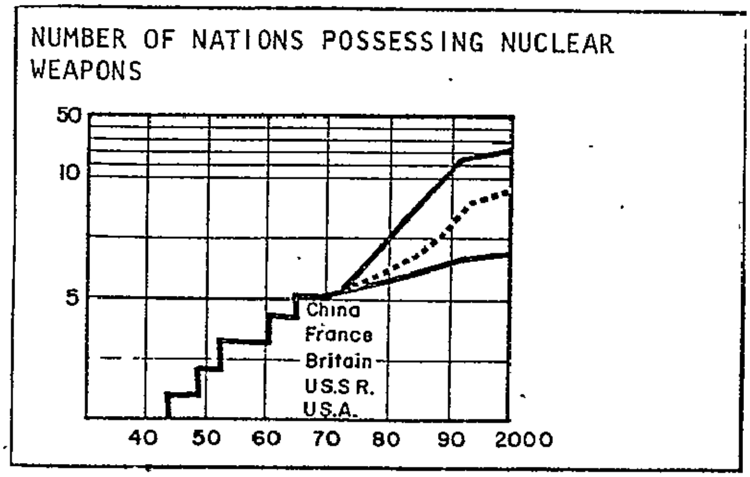
[7] Barry Schneider, "Big Bangs from Little Bombs," The Bulletin of the Atomic Scientists (May 1975).

The pre-emptive strike scenario deals with a situation in which one nuclear country launches the first attack itself while it is still able to do so. It is this scenario which has led to the long standing military doctrine of the United States and the Soviet Union of mutual assured destruction: Country A will not launch a pre-emptive attack on Country B if enough of Country B's missiles would survive that attack. Therefore, it is politically stabilizing to harden and protect missile launching sites. Such hardening lends credibility to the threat of significant retaliation.

This situation is stable enough as long as the world is essentially "bi-polar"--that is, only two nuclear powers are present. When there are several powers, however, the retaliatory threat must be made real for all possible enemies. This becomes increasingly difficult as the number of nuclear nations increases. Thus, proliferation of weapons is destabilizing, not only because chances for inadvertness or escalation of an on-going conflict increase, but because the precarious stability built on mutual deterence is challenged as well.

Proliferation of Nuclear Weapons. In 1970, the Institute for the Future conducted a Delphi study dealing with important societal changes. Among other questions, they asked a group of political scientists, social scientists, natural scientists, politicians, and others, how many nations they believed would possess nuclear weapons by the year 2000. The median opinion was that nine nations would have such weapons by the turn of the century, but the interquartile estimates ranged from seven to thirty-five.[8] Today, barely five years after the study was completed, there are

[8] Raul de Brigard and Olaf Helmer, Some Potential Societal Developments--1970-2000. Report R-7 (Menlo Park, Calif.: Institute for the Future, April 1970), p. 113



Source: Raul de Brigard and Olaf Helmer, Some Potential Societal Developments--1970-2000 (Institute for the Future, Middletown, Conn.: April 1970), Report R-7, p. 113

six: The United States, Great Britain, France, the USSR, China, and India have nuclear weapons. All but India have a strategic delivery capability.

Eighty-three nations have become parties to the 1970 Treaty on the Non-Proliferation of Weapons (NPT). China, France, and India are the only non-parties to the NPT which have nuclear capability. There are many non-party nations which apparently have the technical capability to build nuclear weapons and maybe under political pressure to do so. These include: Argentina, Brazil, Egypt (Egypt has signed the NPT but not ratified it), Israel, Pakistan, South Africa, and Spain.[9] There are other countries which could probably, if they wished, develop nuclear weapons but appear to be under no particular political pressure to do so. These nations include:

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[9] Thomas A. Halsted, "The Spread of Nuclear Weapons-Is the Dam About to Burst?" Bulletin of the Atomic Scientists, May 1975, p.11.

Belgium, Federal Republic of Germany, Italy, Japan, Netherlands, and Switzerland.[10]

By means of the non-proliferation treaty, nuclear powers agreed to work toward nuclear disarmament and to help end the spread of nuclear weapons throughout the world. Non-nuclear nations would be recipients of the benefits of the peaceful uses of nuclear energy supplied by the nuclear powers themselves. While the treaty has not fallen apart, it clearly has not produced the results that its authors had hoped for. India became the sixth nuclear power May 18, 1974 when a 15-kiloton explosive set off underground in the Rajasthan Desert in northwestern India. The purpose of nuclear development in India, was ostensibly to pursue peaceful applications. Within India there was almost universal acclaim for the development; China and the Soviet Union did not voice disapproval and the United States' was quite mild. Major criticism came from Japan, Sweden, and Canada. The criticism from Canada is particularly interesting in view of the fact that Canada had provided the nuclear reactors which generated the nuclear fuel for the Indian explosion.

Today, according to Thomas A. Halsted, Director of the Arms Controls Association, there are three major factors which favor proliferation. First, most nations of the world apparently believe that nuclear weapons can be equated with greater security. Second, there is a general expectation that nuclear explosives will prove useful for peaceful purposes. Finally, the expanding use of nuclear generated electric power facilities makes available, through the reprocessing cycle, enriched uranium which can be used in weapons.

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[10] Thomas A. Halsted, "The Spread of Nuclear Weapons-Is the Dam About to Burst?" Bulletin of the Atomic Scientists, May 1975, p. 11.

This latter point must cause appreciable concern. By 1980 at least 30 countries will build nuclear power reactors. These include in order of the amount of 1980 installed capacity: the United States, Japan, West Germany, United Kingdom, USSR, Sweden, France, South Africa, Canada, Switzerland, Taiwan, Korea, Italy, East Germany, Czechoslovakia, Belgium, India, Argentina, Finland, Mexico, Netherlands, Spain, Rumania, Bulgaria, Austria, Brazil, Yugoslavia, Thailand, Philippines, and Pakistan.

In June 1974, the United States offered to sell both Egypt and Israel a 600-megawatt reactor to produce electric power. The offer required acceptance by Egypt and Israel of stringent safeguards--including, apparently, the requirement that spent fuel be returned to the United States for reprocessing to prevent the possibility of accumulation of weapons-grade material within the using countries. Despite this feature of the agreement, many critics see the introduction of such nuclear technology into the volatile Middle East as dangerous and not in keeping with the spirit of the NPT.

The United States is, of course, not the only nation engaged in the sale of nuclear reactors to foreign countries. For example, France recently announced that it will sell five large reactors to Iran.

<u>Verification, the Key to Weapons Treaties</u>. Weapons have been limited by a number of treaties including:

- The Antartic Treaty of 1959.
- The Limited Test Ban Treaty of 1963, banning nuclear testing underseas, and outer space, and in the atmosphere.
- The Outer Space Treaty of 1967.
- The SEATO Arms Treaty of 1972.
- SALT I, signed in Moscow in 1972, which established a five year interim agreement on offensive weapons.

All of these treaties depend on verification. On-site inspection (except for the Antarctic Treaty) has been, and continues to be, a difficult requirement. What has made prior agreements possible at all is the advent of a very sophisticated orbital reconnaissance capability in both the USSR and the United States. The current generation of reconnaissance satellites is known as "Big Bird" which first flew in the early 1970's.

> "Big Bird" is capable of performing in rapid sequence, both wide-area surveillance and close-look inspection. Data from the relatively low reduction area--surveillance photographs are relayed from orbit more than one hundred miles above the earth to ground stations by a high capacity transmitter. Film from close-look inspections which reveal objects as small as one foot or so in dimension, is recovered in special capsules which are picked up as they parachute earthward." [11]

Orbital surveillance is augmented by other means of intelligence gathering including over-the-horizon radars and ferret aircraft.

In treaty negotiations the United States has taken the position that on-site inspection to investigate uncertain seismological events would be required. Most countries now agree that seismological detection is sensitive enough to make a complete test ban practical. The detection threshold with current equipment is about one kiloton. The identification threshold is about 5-10 kilotons in hard rock, but about an order of magnitude higher for testing in large cavities which have been designed to decouple the shock from the earth's crust. An interesting note: Since the test ban treaty went into effect in 1963, more tests have been conducted underground than were conducted in the atmosphere prior to that date--the number is well over 1000.[12]

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[11] Strategic Weapons: Verification Keeps Ahead of Arms Control", Science, March 14, 1975.

[12] Steven Rowe, "No Halt in the Nuclear Arms Race," New Scientist (February 15, 1973), p. 374.

SALT I talks began in November 1969. Although many hoped that these talks would result in nuclear disarmament, much less was achieved. When the talks began neither multiple independently targetable re-entry vehicles (MIRV) nor defensive anti-ballistic missile systems (ABM's) had been deployed (except for a single small ABM system protecting Moscow). MIRV's and ABM's are reciprocal steps in the process of nuclear escalation: MIRV systems are a threat to hardened ICBM enplacements and therefore upset the balance of land-based deterents. Effective ABM's, on the other hand, would imply that the country in which they were enplaced could survive a retaliatory attack--therefore, a pre-emptory attack could be seen as plausible. Instead of proposing a joint ban on further MIRV and ABM development, SALT I limited both nations to a single ABM installation (around each capital), and the MIRV issue was essentially removed from the agenda. A freeze was set on the number of ICBM's (USSR was allowed a total of 2358 missiles and the United States 1710). No more ICBM launchers or silos could be constructed and "light" ICBM's could not be converted to "heavy" delivery vehicles.

SALT II began in late 1972; in its first phase a futile search was made for an agreement which would have resulted in permanent arms limitation. At the Nixon-Brezhnev meeting of June 1974, the leaders sought to have SALT II extend the interim agreements for two to three years and to add a limitation on MIRV's. However:

> "A simple freeze on MIRV's, which was discussed, would have meant no more MIRV deployment by the United States and no further MIRV testing by the Soviet Union. From the Soviet standpoint, this was unacceptable because the United States already had many MIRV's where the Soviets had none. What the Soviets wanted was to stop or slow down the U.S. deployment while they carried on the largest deployment program the Soviet Union could mount. So the MIRV issue brought this phase of the negotiation to an impasse." [13]

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[13] Strategic Arms Limitation (II): "Leveling Up Dissymmetry," Science. (February 21, 1975), p. 627.

Before SALT II began, Congress approved a resolution calling for the President to seek equality in strategic forces for the United States during the talks. Equality has turned out to mean an upward adjustment in the number of delivery vehicles which either the United States or the Soviet Union can have. Within this ceiling of 2400 delivery vehicles, either side may have whatever force mix they desire--except new ICBM silos and heavy ICBM's are still proscribed. Within the 2400 delivery vehicle total, 1320 missiles may currently have MIRV's. According to Science, this commits the USSR to deploy "an average of at least two additional warheads everyday for the next ten years." 14

Thus, SALT has not produced arms reduction--rather it has sanctioned an increase in the level of armaments. Furthermore, new weapons not covered by the agreement can be deployed as additions to the existing forces. A submarine launched cruise missile is an example. Clearly, despite SALT, the arms race is still moving ahead full tilt.

Changing U.S. Military Doctrine. In greatly simplified terms, our nuclear strategy, as stated publicly, has been one of "mutual assured destruction" (MAD). The size of the U.S. nuclear force has been based on a worst case scenario of a massive Russian all-out attack. Mutual assured destruction holds that the U.S. response to a first strike would be a retaliation of sufficient size to wipe out the attacker at sufficient levels of destruction to inhibit any rational government from initiating a first strike. Only a relatively small portion of our missile arsenal could inflict massive

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14 Strategic Arms Limitation (II): "Leveling Up Dissymmetry," Science (February 21, 1975), p. 627.

damage on the USSR: for example, the delivered warheads of 220 Minuteman III ICBM's could "kill about 21 percent of the Russian population from immediate effects alone, and destroy 72 percent of the Russian industrial capacity."[15] We actually have more than 550 Minuteman III missiles. Poseidon missiles--could achieve a similar result. Our fleet currently includes some 500 Poseidon missiles; only about 170 of these missiles would be required. Finally, our 400 B-52's and 65 FB-111's could also inflict heavy damage. The nuclear arsenals of both the United States and the USSR are summarized in Figure 6. This figure illustrates that both the United States and the USSR have secure retalitory capability--most strategists believe enough force to absorb an <u>all-out</u> nuclear attack and mount a massive retaliatory strike.

Within this posture of mutual assured destruction, a new strategy is taking shape. In the Department of Defense's annual report for 1975, Secretary of Defense James Schlessinger said that we are seeking "a wider set of much more selected targeting options" and greater "flexibility" in responding to "any kind of nuclear attack." Secretary Schlessinger enumerated "principal features of the proposed posture" as follows:

1. "A capability sufficiently large, diversified, and survivable so that it will provide us at all times with high confidence of riding out even a massive surprise attack and of penetrating enemy defenses, and with the ability to withhold an assured destruction reserve for an extended period of time."

2. "Sufficient warning to ensure the survival of our heavy bombers together with the bomb alarm systems and command-control capabilities required by our National Command Authorities to direct the employment of the strategic forces in a controlled, selective, and restrained fashion."

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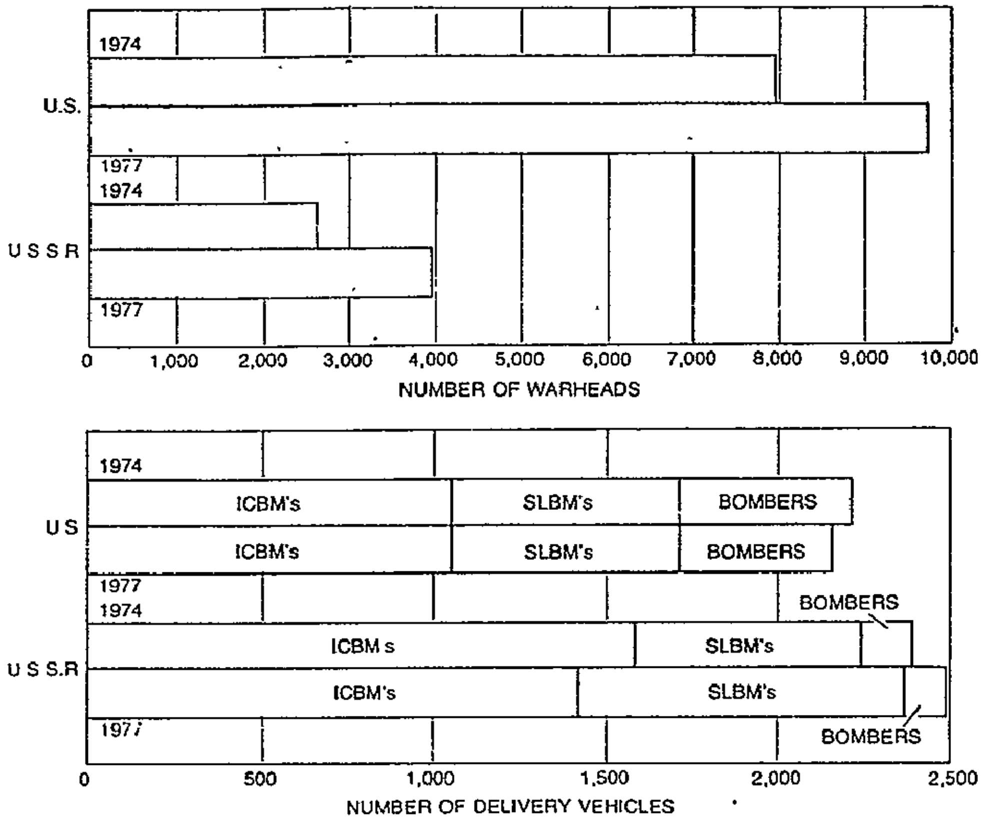
15 Larry Carter, "Nuclear Strategy and Nuclear Weapons," Scientific American (May 1974).



Source: Larry Carter, "Nuclear Strategy and Nuclear Weapons," Scientific American, (May 1974).

Figure 6. Strategic nuclear arsenals of the United States and USSR. This figure presents a numerical representation of the military balance between the United States and USSR and does not take into account qualitative differences in the nuclear weapons: for example, the larger size of Russian ICBM's.

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3. "The forces to execute a wide range of options in response to potential actions by an enemy, including a capability for precise attacks on both soft and hard targets, while at the same time minimizing unintended collateral damage."

4. "The avoidance of any combination of forces that could be taken as an effort to acquire the ability to execute a first-strike disarming attack against the USSR."

5. "An offensive capability of such size and composition that all will perceive it as an overall balance with the strategic forces of any potential opponent."

6. "Offensive and defensive capabilities and programs that conform with the provisions of current arms control aggrements and at the same time facilitate the conclusion of more permanent treaties to control and, if possible, reduce the main nuclear arsenals."

The third criterion relates to the new doctrine of flexible response. It implies that an escalating nuclear war scenario becomes much more plausible than before. One can imagine an all-out nuclear war beginning with the use of tactical nuclear weapons located in Europe and then escalating to threats or actual exchanges of nuclear weapons designed to incapacitate certain industries, military installations, or to destroy selected cities. Murmansk for Groton, for example.

Such a possibility is more "thinkable" than an exchange based on mutual assured destruction. Therefore, flexibility in response, when equated to flexibility in attack, is inevitably threatening and dangerous.

<u>Two Modern Problems: Terrorism and Guerrilla Warfare.</u> <u>Terrorism</u> is a violent fact of political life. Terrorists groups in different countries have apparently formed international linkages and arms, ammunition, and

personnel flow among them.[16] With increasing presence of fissionable material throughout the world, the possibility of amateur made, nuclear terror weapons is becoming more plausible and threatening. Nuclear bombs require only a few kilograms of plutonium-enriched uranium 235 or uranium 233. Furthermore, the design and construction of a crude but workable explosive device is apparently not difficult. To test this hypothesis, the Public Broadcasting System recently challenged a physics graduate student to design a workable bomb using only publicly available materials.[17] Once the student had completed the design, it was submitted to nuclear physicists associated with the U.S. Weapons Program. Their judgment was, given adequate construction and fissionable material, the design would have produced a weapon capable of exploding.

Despite the fact that terrorist weapons would be of extremely low yield, when compared to weapons currently in the arsenal of the nuclear powers, even inefficient devices would be capable of killing tens of thousands of people and causing enormous damage. When amateur nuclear bombs become plausible, some aspects of our way of life may have to change. For example, joint sessions of Congress may become obsolete; video communications might be used to replace this kind of assembly. Urban centers are vulnerable to terrorist attack; disruptions of communications, water supply, transportation, becomes much easier for small groups to accomplish when nuclear explosive power becomes available to them.

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[16] Mason Willrich, "Terrorist Keep Out", The Bulletin of the Atomic Scientists, (May 1975), p. 12. (Hereafter called M. Willrich, "Terrorist Keep Out".

[17] "Nova Series: The Plutonium Connection", (Boston, Mass.: WGBH TV), March 9, 1975.

The key question is whether or not terrorist groups could conceivably obtain an adequate amount of fissionable material to construct a bomb. The fuel used in conventional reactors is not suitable for the construction of weapons. However, during fuel reprocessing, high-grade uranium is produced which could be used in an explosive. Furthermore, high temperature gas-cooled reactors, which are now being introduced, utilize enriched uranium which, contrary to the light water reactors, can be used in explosives. The liquid metal fast breeder reactor (LMFBR) which is now under construction, produces more plutonium than it consumes. The reason for the introduction of the LMFBR is to extend our supplies of fissionable material. However, when viewed from the standpoint of the prospects of terrorism, the LMFBR must be regarded as a potential source of illicit explosives. The Atomic Energy Commission has forecasted that by 1980 the U.S. nuclear power industry will use 19,000 kilograms of materials that are of quality high enough to be used in nuclear explosives.[18]

Before December 1973, the Atomic Energy Commission requirements for safeguarding plutonium were incredibly lax. Plutonium enriched uranium was shipped in unescorted trucks around the country, driven by single, unarmed drivers. The material itself could be stored in locked buildings checked once every four hours by an unarmed guard. In November 1973 the General Accounting Office issued a report describing the laxity of the system and recommending changes be immediately introduced.[19] Shortly thereafter, in April 1974, the Ford Foundation Energy Project released a report which was

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[18] The Atomic Energy Commission, Office of Planning and Policy Analysis, 1974 Forecast, Washing.-1139 (Washington, D.C., 1974).

[19] Comptrollor General of the United States, <u>Improvements Needed in the Program for the Protection of Special Nuclear Material</u>. Report to the Congress (Washington, D.C.: November 7, 1973).

also very critical of the Atomic Energy Commission procedures.[20] The report found that even the strengthened safeguards were inadequate but that a satisfactory system could be developed to reduce the risk of theft of nuclear materials. The Atomic Energy Commission reviewed this report before its publication, and completed an in-house study which was made public through Senator Ribacoff, in April 1974.[21] This report agreed with the Ford Foundation Report; the Atomic Energy Commission author said:

> "Urban terrorist groups in this country,,,likely to have available to them the sort of technical knowledge needed to use the now widely disseminated instructions for processing fissile materials in for building a nuclear weapon. There are also liable to carry out reasonbly sophisticated attacks on installations and transportation...The new regulations are inadequate and...immediate steps should be taken to greatly strengthen the protection of special nuclear materials."

The General Accounting Office Study, the Ford Foundation Study, and the Atomic Energy Commission in-house study have apparently produced a new attitude toward the safeguarding of nuclear material within the United States. However, the funds requested by the Atomic Energy Commission for strengthening the program during the fiscal year 1975 were cut by about 80 percent by the Office of Management and Budget. Thus, while awareness is growing, the safeguard problem still exists.

The international aspects of the problem are most disturbing. While the level of discussion has increased in the United States, little discussion has taken place on a world basis. The plutonium used in India's nuclear

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[20] Mason Willrich and Theodore B. Tayler, Nuclear Theft: Risks and Safeguards, Cambridge, Mass.: Ballinger Publication Company, 1974.

[21] D.M. Rosenbaum, et al, Special Safeguards Study, Atomic Energy Commission, (April 30, 1974.

explosion was produced in a reactor provided India by Canada under a "peaceful uses" guarantee.[22]

Mason Willrich, Professor of Law at the University of Virginia, and former Assisstant General Council of the U.S. Arms Control and Disarmament Agency, had suggested some possible means for reducing the risk of theft.** He believes that safeguards should concentrate on the prevention of theft rather than on detection and discovery of stolen material. Storage areas must be strong enough to withstand attack; co-location of nuclear fuel cycle support facilities such as enrichment fuel fabrication and reprocessing, would reduce the need for transportation of fissionable material; spiking plutonium so that its handling would be extremely dangerous would be another possibility; guarding of nuclear facilities should be taken over by a nuclear materials security service; and finally, the U.S. Government should pursue the establishment of safeguard standards with other nations employing nuclear materials. Willrich believes that the problem is basically a human problem--not technological:

> Safeguards against nuclear theft and sabotage are intended to deal with the risk of malfunctioning humans. The possibility of nuclear violence using material diverted from civilian industry is fundamentally a human problem for which there is no technological fix. There is no final solution. Nor is there any alternative to dealing with it effectively until the last fissionable atom has been split.*

Guerrilla warfare, of course, is not new. U.S. Marines were sent to Nicaragua in 1912 to impose what the United States considered to be a desirable domestic order. There was no opposition to them. When they were sent again in 1926, resistance was offered by the Nicaraguan forces under

22 M. Willrich, "Terrorist Keep Out".

General Augustino Sandino. The encounter was protracted and irresolvable. It aroused widespread cirticism within the United States and anti-Americanism in Latin America. The Marines were withdrawn in 1933.[23]

Since the end of the Second World War, guerrilla wars have been in progress in one part of the world or another--more or less continously. This form of warfare grew out of the resistance movements which formed against German rule in occupied countries during the Second World War. Guerrilla movements have surfaced in Africa, Southeast Asia, Cuba, Malaysia, and South America. A basic reality of this form of warfare is that:

> "Technical superiority in arms and logistic support possessed by the forces opposing the guerrillas is quite unimportant in determining the outcome of the war...military commanders tend to be blind to the true character of the guerrilla movement that they are fighting, and they make the same political, psychological, and tactical mistakes over and over again.
>
> "From a military point of view, the art of guerrilla warfare is largely a matter of improvisation and opportunism...the greater importance attaching to conserving manpower than to holding ground...the guerrilla is always ready to run away and hide. Consequently, when regular ground or air forces attack with powerful modern weapons, the guerrilla makes it his business not to be present.
>
> "If the guerrilla movement is supported by a large section of the population, it has a reservoir of manpower on which to draw. Clumsy, destructive, and impatient action by regular forces will always tend to drive civilians into the guerrilla camps....If some highly, lethal new weapon, such as a nerve gas or an infectious micro organism, were used effectively against the guerrillas, that local military victory of the regular forces would be bought at a price of moral catastrophe that would make political victory utterly impossible." [24]

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23 Lewis J. Halle, "Does War Have a Future?" Foreign Affairs, (October 1973), p. 22.

24 Vladimir Dedijer, "The Poor Man's Power," a chapter in Unless Peace Comes, Nigel Corder (ed.), (Viking Press, New York: March 1970).

Some Ugly Weapons: CBW. Chemical weapons include nerve agents, blister agents, incapacitants, vomiting agents, and riot control agents.

Nerve gases originated during research on insecticides. During the second world war, the Germans manufactured but did not use the toxic chemical known as Pabun which goes under the military symbol GA. This German plant was moved to Russia. The United States has manufactured the related chemical Sarin which is known as GB. It is thought to be four times more lethal than Pabun. Death from this chemical can occur in from one minute to two hours, depending on the amount and means of absorption. VX is the second nerve gas, which has the same kind of effect as GB, but is longer lasting.

The blister agent, HB, is a purified version of mustard gas which was used in World War I.

The incapacitants include BZ which produces both physical and mental effects, such as slowing of physical and mental activity, headaches, giddiness, disorientation, hallucinations, drowsiness, and increase in body temperature.

The three riot control drugs developed by the United States are DM, a vomiting agent; CS, tear gas; and CN, which is similar to CS but also causes burning and itching. All three riot control drugs were authorized for use in Vietnam.

The United States has developed binary chemical weapons in which comparatively innocuous intermediate chemicals are separated from one another by a small explosive device. When the explosive device is detonated, the chemicals mix forming a poison such as nerve gas. Using this approach, stockpiles of the separate chemical agents can be stored safely. This technology has caused some difficulty in the chemical disarmament talks currently being conducted in Geneva. Binary weapons are exceedingly difficult to describe; in the limit all precursors which are sitting on the laboratory shelf are potential weapons.[25]

The Arms Control and Disarmament Agency has stated that the ease of production of the chemicals used in binary weapons puts this approach easily within the capability of developing nations.[26]

Biological weapons are now banned, by international treaty. Work on such weapons has ceased in the United States; however, this review of war and weaponry would be incomplete if this field were not at least mentioned. There are a number of reasons why military strategists feel that biological weapons offer very significant offensive potential:

- The possibility of choosing micro organisms or toxins tailored to specific military needs--from temporary incapacitation of large segments of the population with certain viruses--to attacks on agriculture.
- High levels of the effects on human, animal, or plant targets with respect to weight and costs of the weapons.
- A significant psychological effect.
- Extremely difficult defense because of the large number of delivery methods.
- Absence of physical damage to industry and other structures.[27]

Before the convention banning production and stockpiling of biological and toxic weapons, the biological arsenal is thought to have included the

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25 Dr. Robert Jones, "Chemical Warfare--The Peacetime Legacy," New Scientist (April 24, 1975), p. 202

26 New York Times (March 24, 1974).

27 Carl-Gorin, "The Infectious Dust Cloud," Unless Peace Comes, Nigel Croder (ed.), (Viking Press, New York: March 1970).

following diseases: Rabbit Fever, which brings with it mortality of untreated victims as high as 30 percent; Rocky Mountain spotted fever, in which mortality can run as high as 80 percent in untreated cases; Psitpacosis, parrot fever, which carries 10 percent mortality; Ciccodioidomycosis, a disabling disease which may affect any or all organs--mortality about 50 percent; and Botulism, in which death occurs in about 65 percent of the cases.[28]

The micro organisms with which experimental work was being conducted before the ban was extremely potent. A single inhaled particle of Burneti is sufficient to cause infection--three grams of embryonic chicken tissue innocculated with Q fever is thought to hold enough infectious doses for the entire human population of the world.[29] Delivery of such micro organisms is relatively simple--in the form of aerosols or as additives to water or food supplies. Biological agents could be disseminated on a small scale by introducing them into central ventilation systems in key buildings or vehicles. With this weapon, very small groups could upset the strategic balance.

Perhaps most disturbing of all, means have now been developed to create artificial viruses through genetic mutations of natural viruses. In effect, these mutations cause new diseases for which no cures or antidotes have been developed.

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[28] Chemical and Biological Warfare (II): The Weapons and the Policies," Science (January 20, 1967).

[29] Carl-Gorin, "The Infectious Dust Cloud," Unless Peace Comes, Nigel Corder (ed.), (Viking Press, New York: March 1970).

Turmoil in Biological Research

At a symposium on biological researchers held in Davos, Switzerland in October 1974, Carl Scherrer of the Swiss Institute for Cancer Research said, "we are in the same place as nuclear physicists were in 1938."[30] The progress in the field which led to this statement has indeed been impressive. For example:

- Nils Ringertz of the Swedish Institute for Medical Cell Research and Genetics and others have reported crossing genes of different species to obtain live hybrid cells; in particular, he and his colleagues have combined human cells with chromosmes of rats, mice, and insects.

- Har Khorana of the Massachusetts Institute of Technology has synthesized a 126-unit artificial gene which has the potential of directing the production of transfer RNA within a bacterial cell.[31]

At the Davos meeting, Paul Berg of Stanford University warned that these same techniques might result in the creation of bacteria which could not be cured by any known medical treatment. These artificial genes could be used as a short cut to genetic manipulation and achieve very desirable consequences, such as the introduction of nitrogen fixation capability into various grains, but clearly this capability could also lead to widespread suffering if a bacteria capable of reproducing and causing an uncurable disease were to escape into the environment, or if this technology were to be used as a biological agent in warfare.

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30 "Genetic Engineering: Clashing Views," Science News (November 2, 1974).

31 "On the Brink of a Functioning Artificial Gene," Science News (September 21, 1974).

In July 1974, Berg called for a moratorium on research involving the formation of bacteria resistant to antibiotics and research which linked DNA molecules with tumor-causing viruses. In late February 1974, 140 scientists involved in genetic experiments gathered at Asilomar, California, to discuss how the scientific community might manage this two-edged sword.[32] After intense and dramatic discussions, the group agreed to initiate a policy in which certain experiments on the transplantation of foreign genes into bacteria would be deliberately renounced. This decision came about despite concern that any specific document the conference produced might be codified into law; that police powers did not exist among scientists and cheating might go on; that any such restriction diluted academic freedom; that the issue was more than just scientific--it also hinged on moral and ethical considerations. Yet the judgments were made on the basis of perceived benefits versus perceived risks. How the future consequences of these judgments will fare remains to be seen.

One can only hope that the current ban is real, effective, and lasting; inspection is clearly impractical since the manufacturing of viruses is so simple and easy to camouflage. Therefore, the continued effectiveness of the ban depends on good will of all nations.

The United States has been criticized as establishing a very hypocritical policy with respect to the use of CBW. For example:

> "President Nixon's announcement of the U.S. renunciation of biological weapons was essentially deflective. Biological weapons constitute less than 10 percent of the U.S. CB arsenal, and are so poorly understood and indiscriminatory

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32. Janet H. Weinberg, "Decision at Asilomar," Science News (March 22, 1975); and Science News (March 7, 1975).

> that their use was never seriously contemplated. In the same announcement, the President confirmed the U.S. renunciation of the first use of lethal chemical weapons and extended the renunciation to the first use of incapacitating chemicals. However, early in 1970, the Nixon Administration came up with a new definition of chemical warfare that would permit the use of agents "whose effects are not lasting." Under this definition, American use of tear gas and herbicides in Vietnam is not chemical warfare. Thus, in making his announcement, the President renounced the militarily unreliable part of the U.S. CB arsenal and redefined the useful chemical agents out of it." [33]

New Forms of Warfare. In past times, international political power was essentially proportional to military strength. This is no longer the case. First of all, when a country has the capability to over-kill its enemy many times, a further increase in force will not necessarily increase political power. Secondly, a small country which gains nuclear weapons may reach a high level of power at a time when its economic conditions, conventional military forces, and population would normally relegate it to a secondary role. Thirdly, in open societies, public pressures militate against conventional military engagements, thus reducing the ability of such nations to employ force or the threat of force to execute policy. Finally, the use of guerrilla tactics apparently provides military strength which is disproportionate to the political power of guerrillas. For all these reasons, many developed countries in the world find conventional warfare of all types much less a viable option that it was as recently as twenty years ago.

Against this background, a new kind of weapon might well come on the scene: the covert weapon, which has the characteristic that only one side

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[33] Kevin J. Kinsella, "Disarmament: The Current State of the Fraud," Science Journal (November 1970), pp. 42-43.

knows when it's being used. Wars could be waged in times of ostensible peace without overt military force. Technology is currently being developed which could provide the basis for covert weaponry. [34]

Some possible covert weapons are:

- Fertility control drugs which can be added to staples or water supplies to lower the fertility rate of a population to some predetermined level.

- A fertility inducer or twinning drug which would suddenly increase population growth rates in enemy nations.

- Mass administered drugs which control the level of amine in the brain and thus modulate aggressiveness or will to resist.

- Hallucingens with precisely controlled characteristics, or personality control drugs.

- Drugs which control the sex of babies.

Weather control, of course, also fits this pattern. Making it rain on command, by seeding certain kinds of clouds is a technology already in hand. For the future, the perfection of this technique could lead to increasing the number and types of clouds which could be manipulated, dissipating or redirecting hurricanes, lightning dissipation, and fog dispersal.

In an age of covert weapons, every unusual drought would be suspected of being artifically induced. When floods occur, will retaliatory hurricanes be launched? This is not an accademic issue: between 1967 and 1972 the Department of Defense ran Operation Popeye, attempting to create rainfall over the Ho Chi Minh Trail in order to make it so muddy that the North Vietnamese could not move supplies into the South.[35]

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34 The Future as a Pattern of Coincidence," prepared for the Institute of Life Insurance, T. Gordon, The Futures Group Report 22-14-01 (Glastonbury, Conn.: October 1971).

35 Phil Stanford, "Is the Pentagon Tinkering Too Much With the Weather?" Parade, May 3, 1975.

Control of the environment goes beyond weather control: it also might include climate modification through the introduction of carbon dioxide or particulate matter in the atmosphere, movement of the polar ice caps, or spraying the polar ice caps with heat absorbant material; creating a "hole" in the ozone layer to permit ultraviolet radiation to penetrate to the surface of the earth; creating earthquakes through the injection of fluids into faults in the earth's crust; and triggering tsunamis, tidal waves, through the use of directed earthquakes.[36] Add to this unholy list, the possibility of orbiting mirrors which can concentrate solar energy at particular points on the earth in order to raise the temperature beyond the point of survival.

Because of the serious implications of weather control used as a weapon, some members of Congress have been considering placing restrictions on the development of weather weapons. In 1973, Senator Claiborne Pell initiated a resolution requesting that the Administration begin negotiations with the USSR to ban weather modification. Representatives Donald Fraser and Gilbert Gude have introduced a similar resolution in the House in the current session.[37]

The age of covert warfare would be the golden age of paranoia. Countries would always wonder who was attacking or whether there was an attack. In this time, the computer would be the only measure of peace, and nations would judge whether peace or war existed on the basis of how far demographic, economic, meteorlogical and behaviorial factors seem to be from normal expectations.

* * * *

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[36] Gordon J.F. MacDonald, "How to Wreck the Environment," A chapter in Unless Peace Comes, Nigel Corder (ed.) (New York: Viking Press, March 1970).

[37] Phil Stanford, "Is the Pentagon Tinkering Too Much With the Weather?" Parade, May 3, 1975

The Preamble to the Charter of the United Nations reads in part:

> "We the peoples of the United Nations, determined to save succeeding generations from the scourge of war, which twice in our lifetime has brought untold sorrow to mankind, and to reaffirm faith in fundamental human rights, in the dignity and worth of the human person,...and of nations large and small...to promote social progress...to practice tolerance...to maintain international peace...and resolve to combine our efforts to accomplish these aims."

We are enormously distant from this ideal.

The 8,000 year history of civilization is a continuum of war. This unending record of battles and ascendancy of one nation over another suggests that war somehow may be intrinsic in man, or at least in groups of men, derived from the primal instinct for self-preservation. War has elements of group psychoses, chauvanism, pride, glory, and mysticism. If such elements are intrinsic, then the successful elimination of war must be based on a solution that satisfies these intrinsic drives. In other words, the solution to war must necessarily be a human, rather than a technological or legal problem, and control must be found in terms of a human solution.

If a human solution is possible, it will have its birth in psychology, which is not fully a science today. It will have its adolescence in the development of the sciences of government, economics, and group dynamics. These sciences will provide understanding of group needs and drives, and methods for satisfying them. The human solution will realize maturity in world law which, newly codified, will embody the principles of these sciences of the people. To avoid the catastrophy of war, we must come to work with men of good will and peace throughout the world, limit armaments, and disarm if at all possible, stabilize and defuse the issue which can lead to war, and seek with all possible speed, the sciences which will divine insight into the underlying causes for war.

WORLD CONCERN: POPULATION AND FOOD

With only a few reversals because of massive famine or incidence of disease, the world's population since the agricultural revolution has grown steadily; the rate of growth becoming exponential in the last 200 years. At the birth of Christ, estimates place world population at 200 million, by 1750 the number had grown to 800 million; by 1975, to 4,000 million and the 2000 constant fertility, no global disaster extrapolation is that more than 7,000 million humans will occupy this planet. It is not a question of *will* population growth cease, it is a question of *how*: will it be voluntarily accomplished through control of fertility or will it be involuntarily through famine, environmental degradation, and biosphere contamination.

While world population growth averages 2%, it is essentially a regional problem. The growth rates vary from 0.6% for the U.S. and Europe to 2.5 to 3.0% for the underdeveloped nations - Africa, Latin America, Southern Asia. Many nations do not perceive their population growth as a problem; but as a means to ensure economic growth and political equality.

The immediate threat of world population growth is famine. Again, this is a regional problem, but on a global scale the most striking fact has been the relentless decrease in world grain reserves since 1961. These reserves have fallen from 60 days at actual consumption rates to about 20 days in 1974. And the import-export distribution reveals that only North America is a major surplus producing region; however, in the U.S. and elsewhere, the reserves of idle cropland have steadily shrunk in that 1961-1974 time period until they are essentially zero in the U.S.

The "Green Revolution" brought about by the introduction of new strains has stretched the reserves only a few years, but now has been slowed by the limitations (and sharp price increase) on the availability of fertilizers. The margins are so small and the inelasticity in the demand for food so strong that small changes in weather, and all the other factors contributing to food production, including distribution, produce very large fluctuations in the availability of food, and at times, great potential for massive starvation and disease in India, Bangladesh and the Sahel region. Of significant concern in the agriculture picture is the evidence for adverse climatic change in the Northern Hemisphere, particularly over the Great Plains in the U.S.

Food production throughout the world has kept pace in the long term with population growth; available calories per person have risen in the developed nations and remained essential constant in developing countries. The crucial problems are two: how to effect the global management of the world's grain supplies so that regional variations in production can be avoided and how to increase the productivity of the small farmer in the developing nations.

In the United States the primary issues associated with population are the changing age distribution and the changing demography as urbanization increases. Growth in total numbers is expected to be modest, from 210 million in 1975 to between 280 to 300 million in 2000 depending on net reproductive rate.

Because of the reduced birth rate, the U.S. population is aging; it is projected that the age group of over 45 will rise from about 24% in 1975 to 33% in 2000 and the age group 25-44 will increase from 22% to almost 30%. The implications of this are largely economic; shifts in demands for goods, services and government expenditures for health care and social security. But society's values (and priorities) may be expected to shift too, because of the different values of different age groups and the observed persistence of values among age cohorts as they age.

By 2000 over 80% of the U.S. population will be living in urban areas; the trends in the disruption due to congestion, the pollution, crime, violence and alienation of the individual have all been unfavorable, and show little sign of abating.

POPULATION AND FOOD: THE ISSUES

Rapid Population Growth in the Fourth World Leads to Massive Deaths Due to Starvation, Malnutrition, and Disease

Inadequate Food Supplies in the Fourth World May Lead to Massive Starvation

Population Growth in the Lesser Developed Nations Inhibits Economic Growth and Development, Leading to a Growing Disparity of Living Conditions between Developed and Underdeveloped Countries

Continued Urbanization of the United States is Causing the Deterioration of the Central City; Costly Suburban Developments; and Increases in Congestion, Pollution, Crime, Violence and Alienation

Changing Age Distribution of the U.S. Population Creates Fundamental Attitudinal and Social Changes which Markedly Affect the Demands for Goods, Services, and Resource Expenditures

RAPID POPULATION GROWTH IN THE FOURTH WORLD LEADS TO MASSIVE DEATHS DUE TO STARVATION, MALNUTRITION, AND DISEASE

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ISSUE: RAPID POPULATION GROWTH IN THE FOURTH WORLD* LEADS TO MASSIVE DEATHS DUE TO STARVATION, MALNUTRITION, AND DISEASE

The Issue:

World population growth is currently over 2 percent per year.[1] Population growth throughout the world is not homogeneous, however; the growth rate in developing countries is substantially greater than in developed countries. Recent statistics estimate that, on the whole, developing countries are growing at the rate of 2.5% annually, while developed countries are growing at 1.0% per year. Within the developing countries themselves there is also an appreciable difference in population growth rate. Figure 1 presents UN population growth rate estimates for Fourth World and 10 developed countries and demonstrates that these Fourth World countries, which are growing the fastest are also the poorest.

The continued disparity in growth rate between the developed and the developing countries will have several significant consequences:

> The median age in the developed countries will increase while the median age in developing countries will decrease.
>
> By the year 2000 only 22% of the world's population will reside in developed countries (versus 30% currently).[2]
>
> World population will be between 5.9 and 6.7 billion by the year 2000, an increase of 62-83% over current world population.[3]

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*Taken here to include Bangladesh, Central African Republic, Chad, Ethiopia, Gambia, India, Mali, Mauretania, Niger, Pakistan, Senegal, Sri Lanka, and Upper Volta; these countries are either experiencing malnutrition or significant food shortages, or seem likely to have such problems in the future.

[1] UNESCO Statistical Yearbook 1973 (Paris; UNESCO Press, 1974), pp. 32-33.

[2] United Nations Department of Economic and Social Affairs, Population Studies, No. 49, The World Population Situation in 1970 (New York: United Nations, 1971), p.46 (Hereafter called World Population Situation 1970).

[3] World Bank Sector Working Paper, Population Planning, Washington, D.C., March 1972, p.45, (Hereafter called Population Planning).

FIGURE 1

POPULATION PER CAPITA PRODUCT AND GROWTH RATES

FOURTH WORLD COUNTRY	GNP/CAPITA (U.S. DOLLARS) 1972	POPULATION GROWTH RATE 1960-72	1965-72	PERCENTAGE OF FOOD REQUIREMENTS*
Bangladesh	70	2.6	2.5	80
Central African Republic	160	2.2	2.2	98
Chad	80	1.8	1.8	89
Ethiopia	80	2.2	2.4	93
Gambia	140	2.0	1.9	104
India	110	2.3	2.3	94
Mali	80	2.1	2.1	88
Mauritania	180	1.9	1.9	85
Niger	90	2.9	2.8	89
Pakistan	130	3.2	4.1	93
Senegal	260	2.1	2.2	100
Sri Lanka	110	2.4	2.3	98
Upper Volta	70	2.1	2.1	72
DEVELOPED COUNTRY (10 top countries in GNP/capita)				
United States	5590	1.2	1.0	126
Sweden	4480	0.7	0.7	104
Canada	4440	1.7	1.5	129
Switzerland	3940	1.2	1.0	119
Denmark	3670	0.7	0.7	120
France	3620	1.0	0.8	127
West Germany	3390	0.9	0.6	121
Norway	3340	0.8	0.8	110
Belgium	3210	0.5	0.3	128
Australia	2980	2.0	1.9	123

SOURCE: World Bank Atlas, (Washington, D.C.: The World Bank, 1974), pp. 6-7 and The World Food Conference, Selected Materials for the use of the U.S. Congressional Delegation to the World Food Conference, Committee on Agricultural Forestry, U.S. Senate (October 30, 1974), pp. 37-39.

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*Revised standards of average requirements (physiological requirements plus 10 percent for waste at household level).

Even if stringent birth control measures were to result in rapid fertility decreases per female of childbearing age, population growth rate would not be curtailed substantially since the future childbearing sector is already born. Even if birth rates could be brought down to replacement level immediately, a most unlikely situation, world population would grow to 6.5 billion within the next 75 years. But it is much more likely that birth rates will not diminish appreciably within the next few decades; for example, assuming that they drop to replacement level by 1980, world population will reach 8.2 billion by 2050. The world would have added 4 billion people of whom more than 90 percent would be in the underdeveloped countries.[4] As Figure 2 shows, the countries which comprise the Fourth World are likely to grow from 1 billion people in 1970 to between 2 and 2.5 billion in the year 2000, depending on the assumptions made about birth rate.[5]

Ironically, the population growth problem is aggravated by improvements in the quality of life, efforts at improved sanitation, nutrition, control of epidemics and insect borne diseases, and improved vaccination and public health programs all reduce infant mortality rates and improves childhood survival rates. Some small improvement in adult life expectancy occurs as well. These two concurrent forces -- high birth rates and reduced infant mortality -- doom these nations to sustained rates of rapid population growth for some time to come. Figure 3 below shows the disparity between declining mortality rates and rising birth rates. This, then, is the heart of the population problem of the Fourth World.

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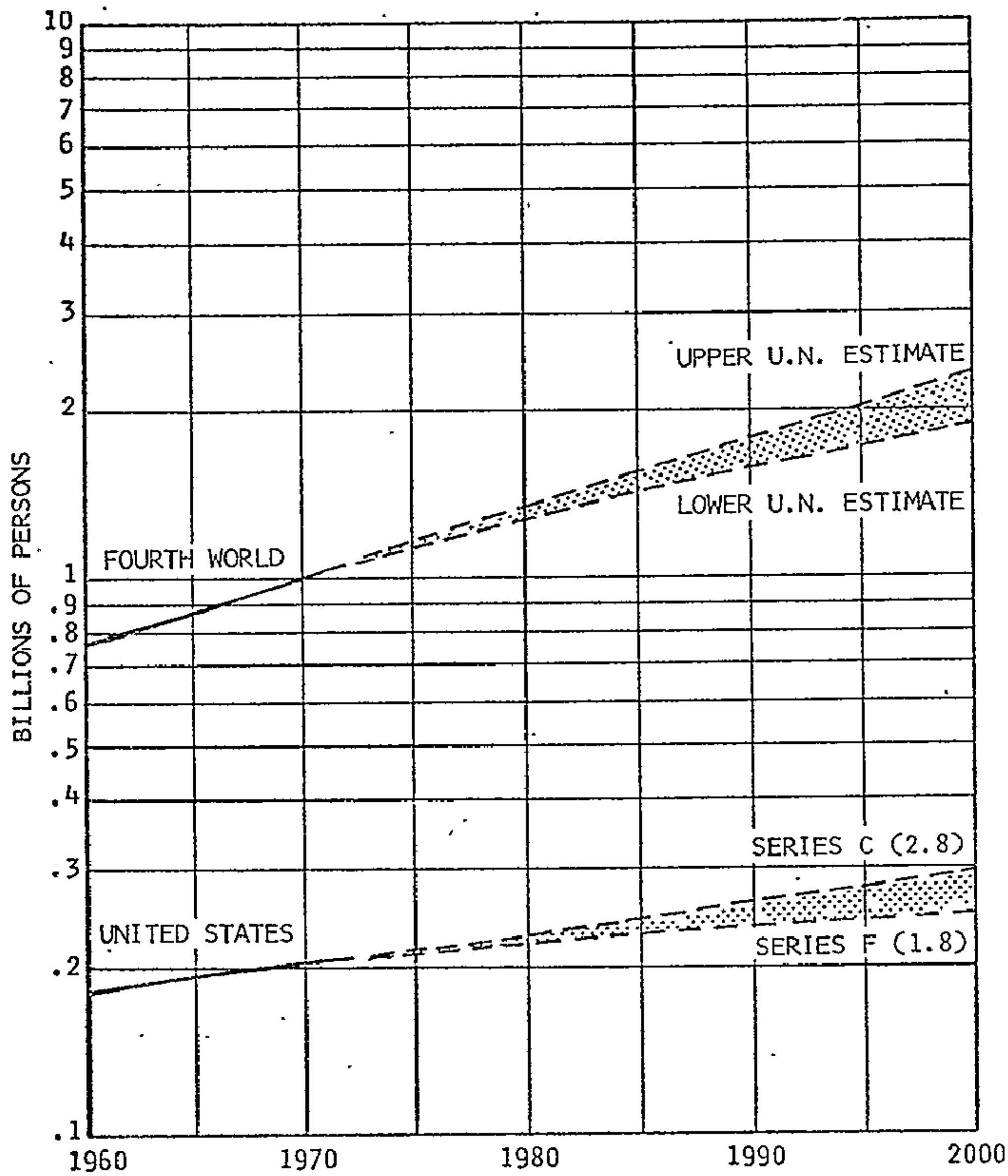
[4] Thomas Frejka, "The Prospects for a Stationary World Population," Scientific American (March 1973).

[5] United Nations Population Studies, No. 41, World Population Prospects, 1965-2000, UN Document ESP/P/WP.37.

FIGURE 2

"FOURTH WORLD"* AND UNITED STATES POPULATION HISTORY AND PROJECTIONS



*"FOURTH WORLD" = THOSE DESIGNATED U.N. STATISTICAL REGIONS MOST CLOSELY APPROXIMATING THE STARVING COUNTRIES OF THE WORLD. INCLUDES INDIA, BANGLADESH, AND SUB-SAHARA AFRICA.

SOURCES FOR U.S.: EXECUTIVE OFFICE OF THE PRESIDENT, OFFICE OF MANAGEMENT AND BUDGET, SOCIAL INDICATORS, 1973 (WASHINGTON, D.C.: U.S. GOVERNMENT PRINTING OFFICE, 1973), P. 249; AND U.S. BUREAU OF THE CENSUS, STATISTICAL ABSTRACT OF THE UNITED STATES: 1973, 94TH EDITION (WASHINGTON, D.C., 1973), P. 5.

SOURCES FOR "FOURTH WORLD": U.N. POPULATION STUDIES, NO. 41; "WORLD POPULATION PROSPECTS, 1965-2000," U.N. DOCUMENT ESP/P/WP.37 AS GIVEN IN PAUL R. EHRLICH AND ANNE H. EHRLICH, POPULATION, RESOURCES, ENVIRONMENT, 2ND EDITION (SAN FRANCISCO: W. H. FREEMAN & CO., 1972), PP. 456, 458, AND 460.

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FIGURE 3

MORTALITY RATES VERSUS BIRTH RATES

Region	1935-1939		1950-1955		1965-1970	
	Deaths*	Births**	Deaths	Births	Deaths	Births
World Total	24-27	34-38	19.3	36.7	14.0	33.8
Developed Regions	14.7	24.9	10.2	22.9	9.1	18.6
Developing Regions	29-34	40-45	24.0	43.9	16.1	40.6

*Crude Death Rates per Thousand
**Crude Birth Rates Per Thousand

Source: Thomas W. Wilson, Jr., World Population and a Global Emergency, (Washington, D. C.: Aspen Institute for Humanities Studies, 1973), p.36.

In the First World War, French battlefield physicians devised the system of triage; that is, classifying the wounded according to their chances of survival. They then devoted their resources to those patients who would survive with attention. Some writers advocate a similar policy for the Fourth World: identify those nations which will survive with aid. Viewing triage in the context of the Fourth World problems, some nations may reach self-sufficiency with or without aid. Other nations, given assistance, may reach self-sufficiency. However, the Fourth World is comprised of countries whose population growth rates are so high and whose food production capacity is so precarious that aid could not help attain self-sufficiency.[6] Hence,

[6] William and Paul Paddock, Famine -- 1975! (Boston, Mass.: Little, Brown & Co., 1967); and Paul R. Ehrlich and Ann H. Ehrlich, Population, Resources, Environment, Issues in Human Ecology, (San Francisco, Calif.: W. H. Freeman & Company, 1972).

regardless of degree of aid, the Fourth World will have a difficult time ever reaching the transition to economic and agricultural self-sufficiency.

Dimensions of the Problem:

World Population Growth: In the history of man the explosive growth of world population is a relatively new phenomenom. Over hundreds of centuries, world population growth was very slow, on the order of a tenth of a percent per year.[7] Only within the last three centuries has the growth rate of population in the world reached relatively high levels (see Figure 4). The current population growth rate of 2% annually implies a doubling time of approximately 35 years, as shown below.

POPULATION GROWTH RATE AND DOUBLING TIME

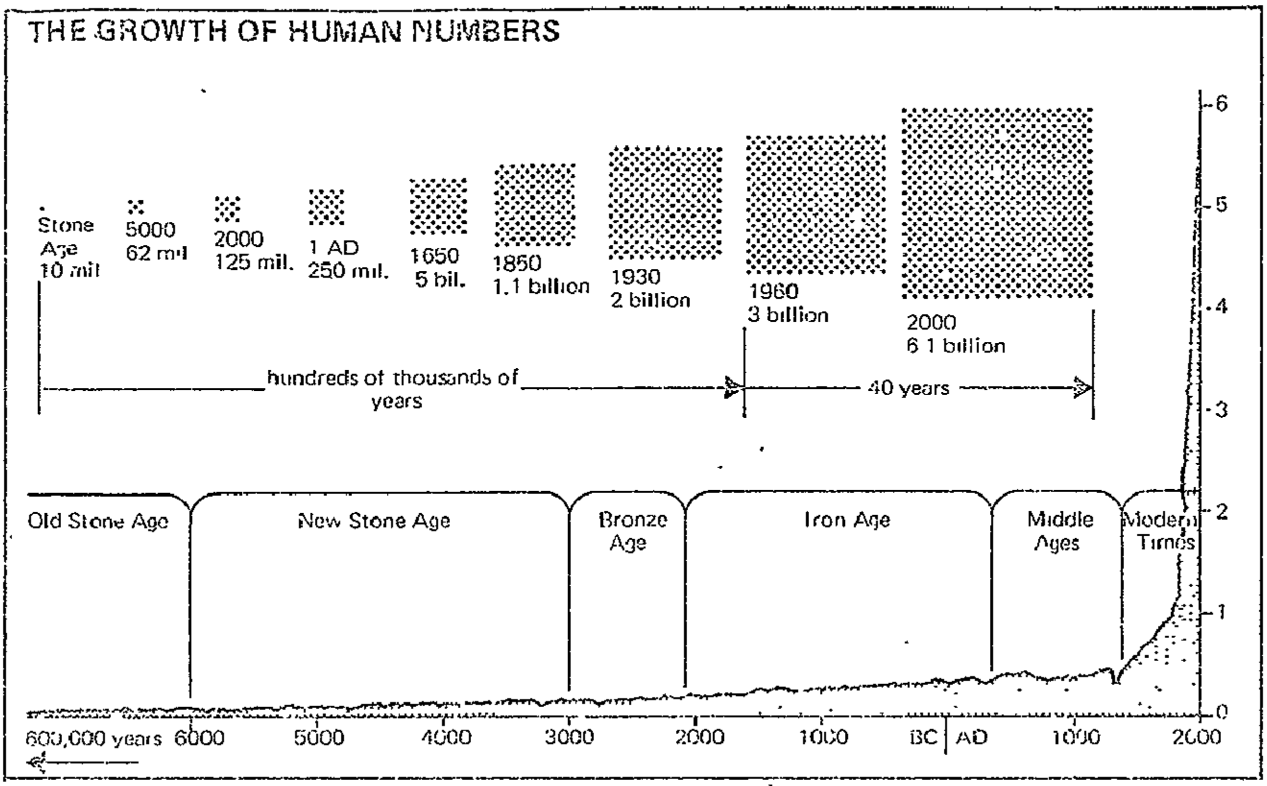
Annual percent increase	Doubling time (years)
0.5	139
0.8	87
1.0	70
2.0	35
3.0	23
4.0	17

SOURCE: Population, Resources, Environment, p. 9.

[7] Ronald Freedman and Bernard Berelson, "The Human Population," Scientific American (September 1974), p.37.

FIGURE 4

THE GROWTH OF HUMAN NUMBERS



Source: John McHale, World Facts and Trends (Macmillan 1972) p.34.

The population in the developing countries is soaring as a result of diminishing mortality but high fertility.

> In the less developed regions, the fertility level, whether measured by birth rates or in other ways, is now twice that in the more developed regions. In fact, few indicators discriminate more sharply between more developed and less developed regions than does the birth rate.[8]

[8] World Population Situation 1970, op.cit.

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One consequence of this situation is that the age distribution of developed countries is very different from that of developing countries. Where fertility is high, there is a preponderance of young people; as birth rate nears replacement level, the age distribution is more homogeneous (Figure 5). Hence, the labor force of developing countries is constrained by the demands of caring for a large non-productive dependent population.

The difference in birth rate between developed regions and developing regions implies a major difference in completed family size; that is, the average number of children born per woman living through reproductive period. In the developed world the average number of children born per women is 2.9, versus 5.5 in the developing region.[9]

Impetus to Large Family Size in Developing Countries: Why does birth rate remain high in developing countries when the problems of large increases in population are so apparent?

- Poverty, extreme and widespread, holds people in "disparing resistance to change."[10]
- Religious and cultural resistance to the birth control movement.[11]
- The slow spread of family planning as an instrument of national population policy.[12]
- The high rate of infant mortality requires additional births in order to ensure survivors.[13]

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[9] World Bank Sector Working Paper, Population Planning, Washington, D. C., March 1972, p.26.

[10] "The Human Population," op.cit., p.36.

[11] Population, Resources, Environment, op.cit.

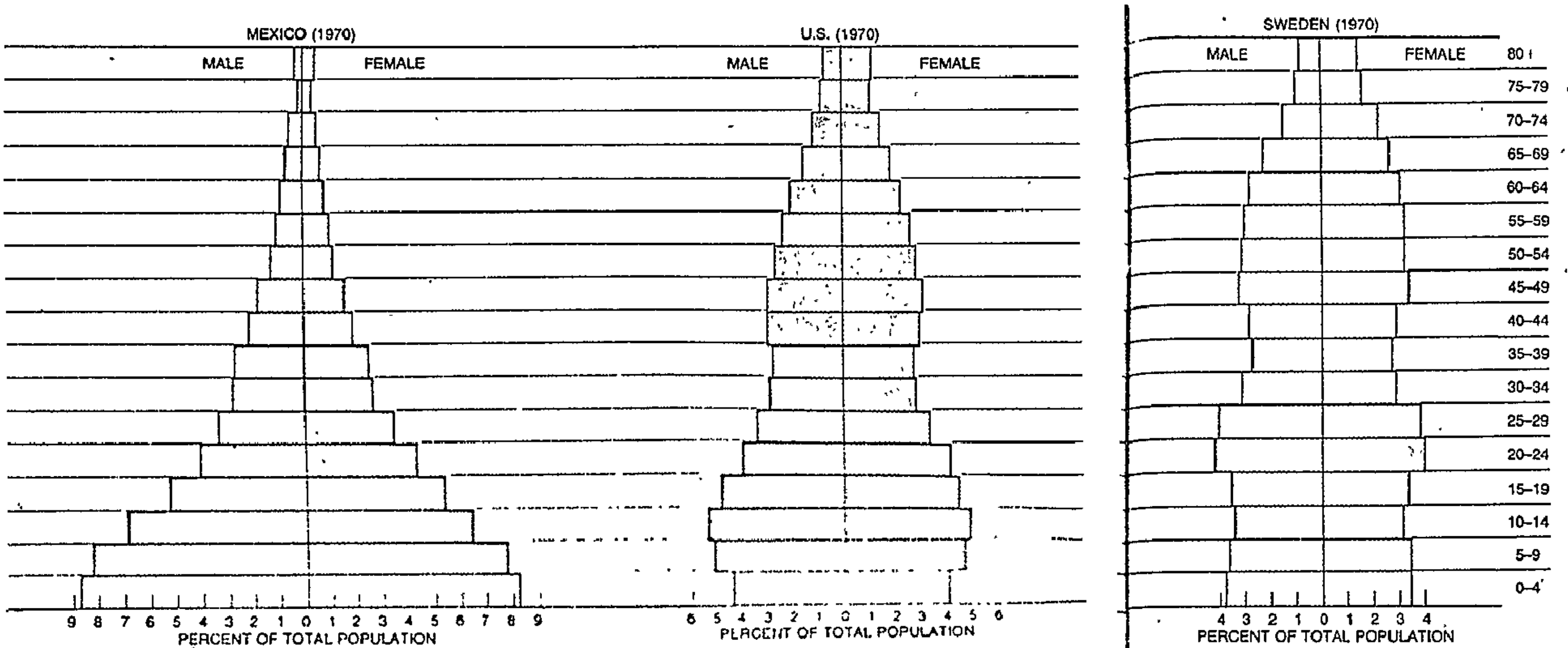
[12] World Population 1970, op.cit.

[13] "The Human Population," op.cit.

FIGURE 8

AGE STRUCTURE OF POPULATIONS

1965-72 Population Growth Rates for: Mexico - 3.5
United States - 1.0
Sweden - 0.7



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SOURCE: "The Human Population," pp. 38-39, and World Bank Atlas, p. 6.

- Preferences for sons to help in agriculture and to provide economic security in old age leads families in impoverished countries to "keep trying for a son," thus increasing population pressures.[14]

The desire for large families is correlated with the level of development as indicated by the results of opinion polls taken in both developed and developing countries (see Figure 6). The demographic transition theory argues that reduced fertility is associated with modernization and economic development. There is no question that these factors are intimately related. However, as Figure 7 indicates GNP per capita *per se* as a measure of economic development is not well correlated with reduced birth rates. However, when other more meaningful indicators of modernization are accounted for, the correlation is clear. Figure 8 shows the relationship of educational achievement (clearly a more accurate indicator of advancement in the quality of life than GNP percaptia) and fertility rates.

Family Planning Efforts in Developing Countries: Population policy has recently become a "legitimate" concern of government planning and policy efforts. In 1960, only three countries had anti-natalist policies; by 1971, twenty-six countries had announced such policies and another twenty-four supported family planning programs without giving them "official status. However, there is little evidence that these programs have been effective. According to the World Bank, "performance has been uneven and there has not yet been a significant or demonstrable impact on...fertility rates."[15]

[14] Ibid.

[15] Population Planning, op.cit., p.18.

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FIGURE 6

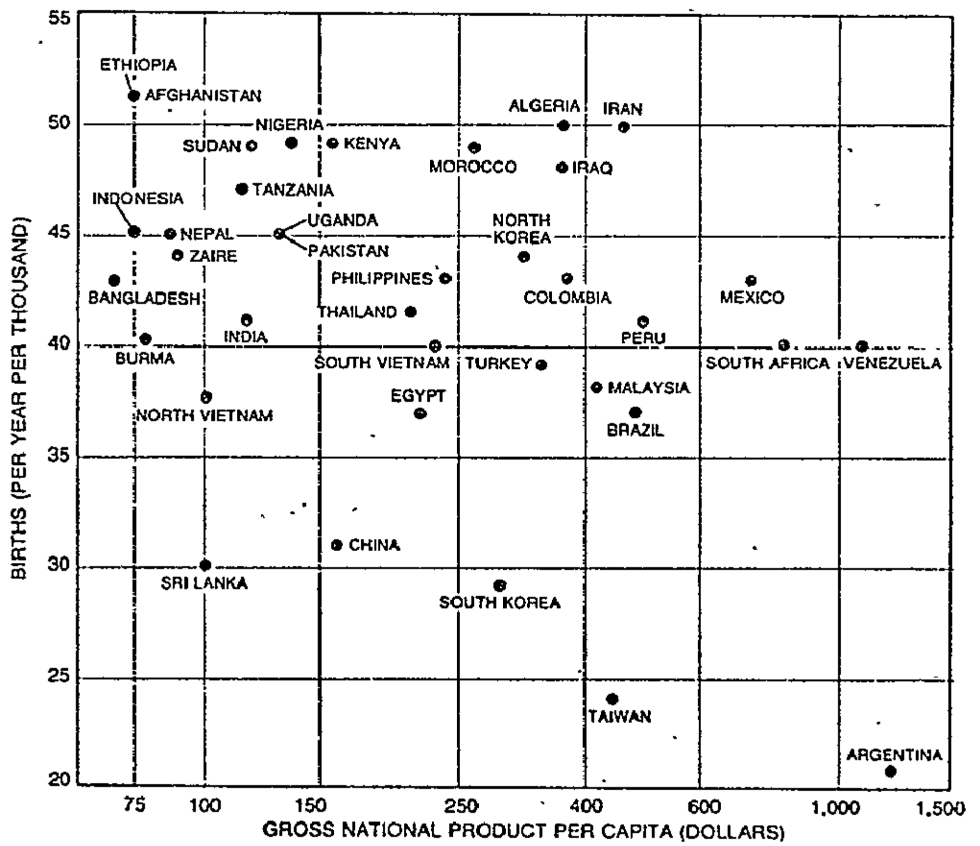
DESIRED FAMILY SIZE COMPARED TO BIRTH RATE

Area	*Date*	*Size sample*	*Average number of children desired*	*Percentage desiring: 4 or more*	*Percentage desiring: 5 or more*	*1971 birth rate*
Austria	1960		2.0	4		16.5
W. Germany	1960		2.2	4		15.0
Czechoslovakia	1959	3,192	2.3			15.5
Hungary	1958–1960	6,732	2.4	13	6	15.0
Great Britain	1960		2.8	23		16.6
France	1960		2.8	17		16.7
Japan	1961	2,753	2.8	22	8	18.0
Switzerland	1960		2.9	22		16.5
Puerto Rico	1953	888	3.0	19		24.0
Italy	1960		3.1	18		17.6
Norway	1960		3.1	25		17.6
Netherlands	1960		3.3	39		19.2
U.S.A.	1960	2,414	3.3	40	15	18.2
Ceylon	1963	302	3.2	25	12	32.0
Jamaica	1957	1,368	3.4–4.2	48	19	33.0
Colombia	1963		3.5			44.0
Turkey	1963	5,122	3.5	42	25	43.0
South Africa (white pop.)	1957–1958	1,022	3.6	54	10	
Taiwan	1962–1963	2,432	3.9	62	22	26.0
Thailand	1964	1,207	3.8	54	26	42.0
Pakistan	1960	2,086	3.9	65	26	50.0
Chile	1959	1,970	4.1	58	26	34.0
Canada	1960		4.2	70		17.6
India	1952–1960	5,909	3.7–4.7	57–63	25–34	42.0
Indonesia	1961–1962	2,208	4.3	66	36	47.0
S. Korea	1962	1,884	4.4	77	44	36.0
Ghana	1963	637	5.3	88	56	48.0
Philippines	1963	7,807	5.0	71	53	46.0

SOURCE: Data from Studies in Family Planning No. 7, Population Council, 1965. Birth rates from 1971 World Population Sheet, Population Reference Bureau.

FIGURE 7

WEALTH VS. BIRTH RATE OF UNDERDEVELOPED COUNTRIES
(with more than 10 million population)



Source: "The Human Population," p.155.

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FIGURE 8

RELATIONSHIP BETWEEN EDUCATIONAL AND FERTILITY LEVELS IN GHANA, JORDAN, AND CHILE

EDUCATIONAL LEVEL	NUMBER OF CHILDREN PER WOMAN		
	Ghana	*Jordan*	*Chile*
No education	5.7	8.7	4.9
Elementary education	5.2	7.3	1.3
Secondary education	2.5	4.5	1.7
At least one university degree	0.5	4.0	n.a.

Source: Lester R. Brown, In the Human Interest A Strategy to Stabilize World Population (New York: W. W. Norton & Company, Inc., 1974), p.115.

The Consequences of Population Growth on Food Availability. A study recently conducted at Iowa State University projected the prospect for world food; it included projections for 96 countries to the year 2000. The study assumed high and low per capita income, crop acreage, and crop yield and then the assumptions about population and other factors were permuted in order to obtain estimates of the food availability in different regions of the world. While there is considerably uncertainty, the results indicated a food deficit regardless of whether low or high populations are assumed.[16] In any event, the high income countries must anticipate supplying the lower income countries, and even if all surpluses of the high income countries flow to the

[16] Leroy L. Blakeslee, Earl O. Heady, and Charles F. Framingham, World Food Production, Demand, and Trade (Ames, Iowa: Iowa State University, 1973), (Hereafter called World Food Production.)

others, there may be significant shortages until population growth slows. The study makes it apparent that if the low income and medium income countries studied are to survive, it is imperative that they limit their population growth.

At the heart of such forecasts is the question of whether or not developing countries can increase their food productivity at a rate equivalent to their population.

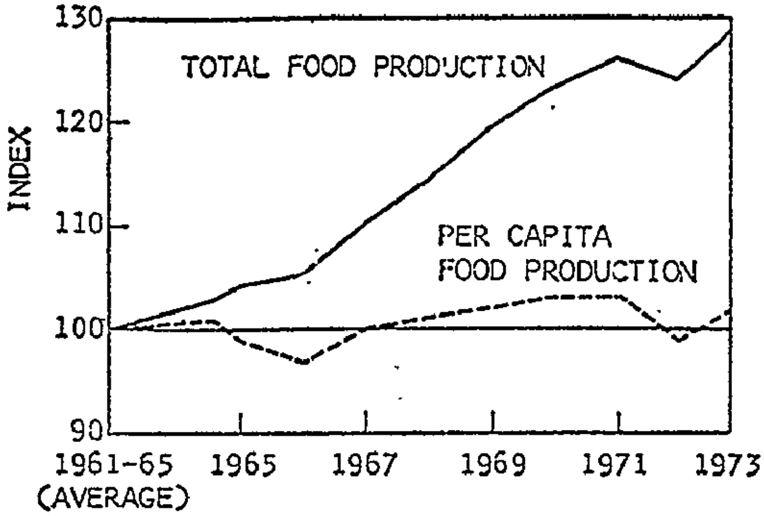
The developing countries have made herculean efforts to increase their own food production. In the years 1948-1960, the results were especially impressive. In some cases, total production was increased by 50 percent or more; and per capita increases over the same time period were as high as 5 percent.[17] But by 1960, agricultural growth in developing countries began to falter in its race with population: per capita production of food leveled off even though total production continued to grow. In some areas, notably Africa, per capita production declined. Figure 9 demonstrates the precarious race between food production and population in the less developed countries over the last decade, and Figure 10 presents the same data for developed countries over this interval.

Some Controversial Views about Population. There is not universal agreement regarding the desirability of lowering fertility. Francis Olu Okediji, Head of the Department of Sociology at the University of Ibadan, Nigeria, argues that the prevailing opinion among officials and decisionmakers in his

[17] World Population Production, op.cit.

FIGURE 9

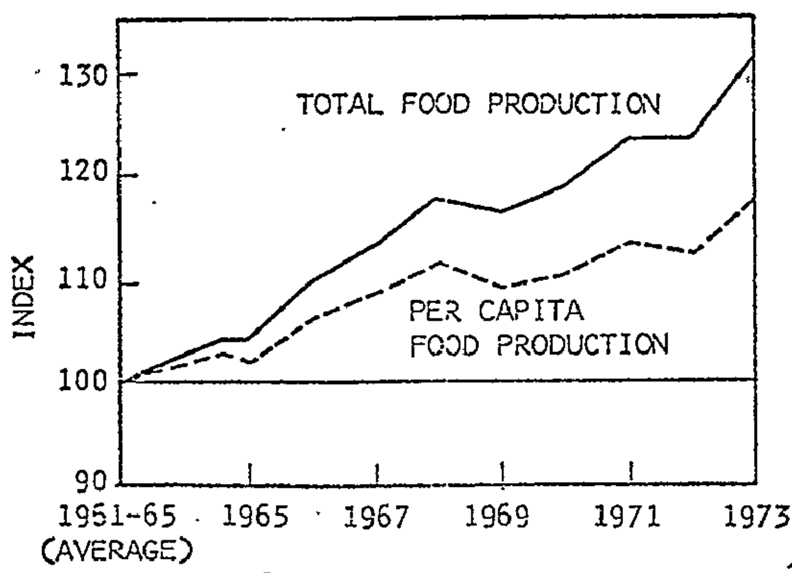
LESS DEVELOPED COUNTRIES (EXCLUDING COMMUNIST ASIA): POPULATION GROWTH ABSORBS FOOD PRODUCTION INCREASES



Source: U. S. Department of Agriculture

FIGURE 10

DEVELOPED COUNTRIES: TOTAL AND PER CAPITA FOOD PRODUCTION RISES SUBSTANTIALLY



Source: U. S. Department of Agriculture

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country is that "most African countries would benefit from having at least double their present population."[18] He says such growth is necessary for industrialization in order to create purchasing power that can absorb products to be manufactured locally. Similarly, Otoniel Valasco, Technical Director of the National Planning Institute of Lima, Peru, argues that:

> There are undoubtedly limits to population growth in this finite world, but the limits will not be a constraint for several generations. Meanwhile, we are suffering from artificial limits to growth resulting from unjust economic and political structures. There would be more than enough for everyone if income distribution were not so uneven, if technology were not so irrational, if social and political structures were not so inhuman....Why are the developing countries so worried about population growth in the third world? If they are so concerned about the poverty of our people, why don't they allocate at least 1 percent of their national incomes for development projects? Are they motivated by humanitarian considerations or are they really afraid of our large populations?[19]

Potential Actions:

The dilemma is simply this: the population limiting policies of countries cannot have a major effect on population size within the next two and a half or three decades. The implications of population growth are therefore especially serious in Fourth World countries: the food required may well exceed the capability of the countries to produce the food required. Yet unless voluntary means for reducing birth rate are pursued

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[18] Population Dynamics Quarterly: Interdisciplinary Perspectives on Population Programs and Policies (Winter 1974), p.10., op.cit.

[19] Ibid.

now, the problem will become immeasurably more difficult in the future. And without inspired and arduous activity devoted to increasing agricultural production, starvation seems a plausible outcome. What can be done?

- Freedman and Berrelson suggest five courses of action:

> Persuade, manipulate services, change incentives, transform social institutions, and coerce. For example, Taiwan offers a positive incentive in the form of educational bonds for parents who stop at three children. In Bangladesh, the possibility of coersive measures such as limitations on ration cards and compulsory sterilization for parents who have two or more children, has been discussed openly.[20]

- Mesarovic and Pestel propose these solutions:

> A global approach to the problem of world food; investment aid rather than commodity aid, except for food; a balanced economic development program for all regions; effective population policy (with all of the problems implicit); worldwide diversification of industry, leading to a truly global economic system.[21]

The World Bank has established certain areas of emphasis in its own work. These include *training*--filling shortages of adequately trained personnel in medical, paramedical, and social services in the developing countries; *physical facilities*--health services and institutions for training, education, and research; *communication strategy*--including providing information to individuals about family planning, group motivation, and family life education; *reducing infant mortality*--in the hope that lowered

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[20] "The Human Population," op.cit.

[21] Mihajlo Mesarovic and Eduard Pestel, Mankind at the Turning Point (New York: E. P. Dutton & Co., Inc./Reader's Digest Press, 1974).

infant mortality will provide an effective motivation to the practice of family planning; and research in all areas involving population questions.[22]

There are some more distant possibilities. While clearly not currently feasible nor desirable, mass administered fertility control agents added to water supplies or food is a potential technological innovation. Parental licensing is another possibility. No doubt advances in contraception technology are on the horizon, including time-release contraceptives and reversible vasectomies. Policies to encourage late marriages and fewer children are legend. Rewards might be given for sterilization and for appropriate child spacing. Maternity benefits could be withdrawn or taxes levied on all births after the nth child. Pensions might be initiated in certain countries to provide more adequately for poor parents with a low number of children and for the elderly. Two types of marriage licenses might be initiated: one which permits children and the other which does not. Finally, the minimum age at marriage could be raised by legislation.[23]

Robert MacNamara, President of the World Bank, related the unforgiving truth of the situation when he said, "the population problem will be solved one way or another. Our only option is whether it is to be solved rationally and humanely, or irrationally and inhumanely."

Perhaps the most powerful means of creating a voluntary reduction in birth rate in any nation may be through ways which provide financial security to the population and largely increase the level of affluence. It

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22 Population Planning.

23 Shirley Foster Hartley, Population: Quantity Versus Quality (Englewood Cliffs, N.J.: Prentice-Hall, 1972), p.325.

is not clear that such conditions are reasonably attainable for fourth world countries within this century -- at least for a significant percentage of the population within these countries.

INADEQUATE FOOD SUPPLIES IN THE FOURTH WORLD MAY LEAD TO MASSIVE STARVATION

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ISSUE: INADEQUATE FOOD SUPPLIES IN THE FOURTH WORLD MAY LEAD TO MASSIVE STARVATION

The Issue:*

Since the end of World War II, developing countries have made enormous gains in increasing their total food production: from 1954 to 1973 developing countries' food productivity increased 75%, as compared to world-wide increases of 69%.[1] However, because of population growth, this represents only a per capita increase of 3% in contrast to a 30% increase which occurred, in the developed world.[2] Furthermore, food supplies per capita in the Fourth World remain below minimum nutritional requirements, averaging about 60-85% of the per capita food supplies available in the developed nations.

Available food supplies in the Fourth World are largely domestically produced. Because of balance of trade problems; rising prices of energy, pesticides, fertilizers, etc.; and projected food shortages within the developed countries, Fourth World areas must produce, in large measure, their own food supplies for the future. Unfortunately, the bulk of arable land is already under cultivation so that future food supplies basically depent on decreases in population, overall economic education and development, and localized technological improvements.

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*The Fourth World, for the purposes of this discussion includes Bangladesh, Central African Republic, Chad, Ethiopia, Gambia, India, Mali, Mauritania, Niger, Pakistan, Senegal, Sri Lanka, and Upper Volta, countries experiencing malnutrition, significant food shortages, or likely to in the future.

[1]Philip H. Abelson, "The World's Disparate Food Supplies," Science, Vol. 187, No. 4173 (January 24, 1975), p.217.

[2]U. S. Department of Agriculture, 1974 Handbook of Agricultural Charts, Agricultural Handbook No. 477 (October 1974) p.50.

Development of new hybrid strains of grains has increased productivity of existing land under cultivation in Asian areas; but our belief that technological improvements in agriculture would answer our world food problems, and particularly prevent starvation in the Fourth World nations, appears in question. Hybrid strains develop epidemics easily and require irrigation, pesticides, fertilizer and herbicides -- all of which cost money. The emphasis of the following issue is an effort to capture the circular dilemma Fourth World areas face in terms of critical food supplies in the future: in short, advanced agriculture provides economic development and lower population; but as is shown here, technology costs for agriculture have become a serious obstacle to the production of even minimal food supplies.

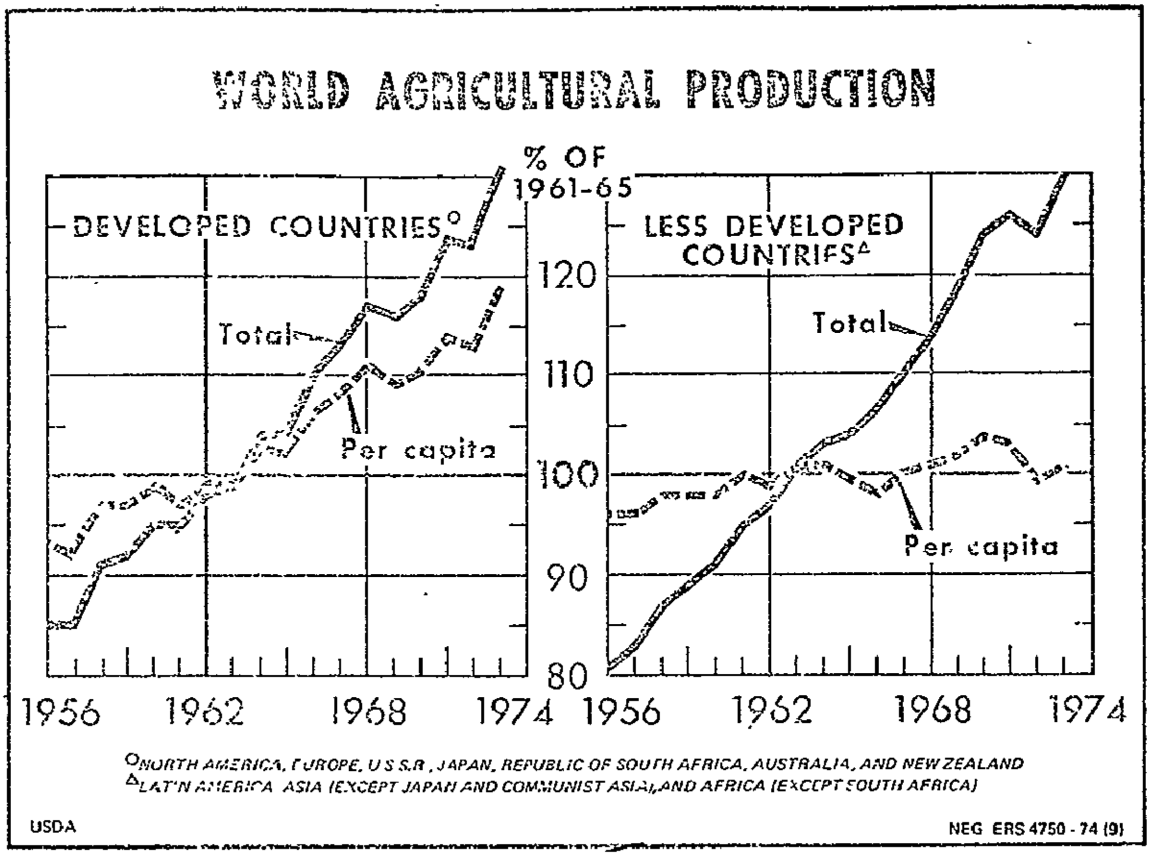
Dimensions of the Problem:

Growth in Food Production: There has been substantial growth in good production in the developing world. (See Figure 1) In fact, the developing world accounts for half of the world's grain and cereal crop in the 1951-1971 period. During this time total world production of grain and cereals doubled. However, because the developing world accounts for 2.6 billion people versus the 1.1 billion of the developed world, the per capita production (see Figure 2) of the developing world is only 40% of that in the developed world.[3] It is important to note the developing world has been able to maintain unprecedented increases in total output. Even during the decline in food production due to bad weather in 1972, food production in the developing countries was 20% higher than 1966, the most recent year that such conditions had occurred.[4]

[3] Roger Revelle, "Food and Population," Scientific American, Vol. 231, No.3 (September 1974) p.165.

[4] The World Food Conference, Selected materials for the Use of the U.S. Congressional Delegation to the World Food Conference Committee on Agricultural Forestry, U.S. Senate (October 30, 1974) p.22.

FIGURE 1



Source: U.S. Department of Agriculture, 1974 Handbook of Agricultural Charts, Agricultural Handbook No. 477, p.50.

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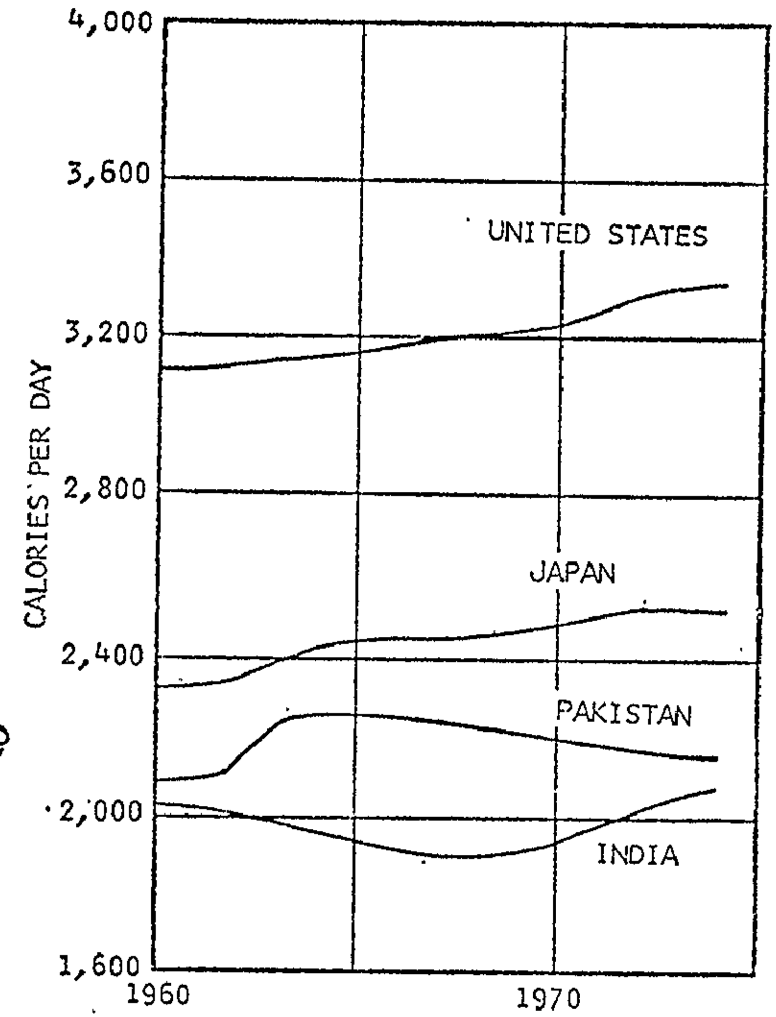
FIGURE 2

FOOD SUPPLIES PER CAPITA

FOURTH WORLD COUNTRY	KILOCALORIES /CAPITA PER DAY (1969-71 AVERAGE)	GNP/CAPITA (U.S. DOLLARS) 1972
Bangladesh	1840	70
Central African Republic	2200	160
Chad	2110	80
Ethiopia	2160	80
Gambia	2490	140
India	2070	110
Mali	2060	80
Mauritania	1970	180
Niger	2080	90
Pakistan	2160	130
Senegal	2370	260
Sri Lanka	2170	110
Upper Volta	1710	70
DEVELOPED COUNTRY (10 top countries in GNP/capita)		
United States	3330	5590
Sweden	2810	4480
Canada	3180	4440
Switzerland	3190	3940
Denmark	3240	3670
France	3210	3620
West Germany	3220	3390
Norway	2960	3340
Belgium*	3380	3210
Australia	3280	2980

SOURCE: U.S. Senate, Committee on Agriculture and Forestry, The World Food Conference, pp. 37 and 39; and World Bank Atlas, (Washington, D.C.: The World Bank, 1974), pp. 6-7.

*Belgium-Luxembourg



Source: United Nations Statistical Yearbook, 1970, 22nd Issue (New York 1971), pp.518-524; and Time, Vol. 104, No.20 (November 11, 1974), pp.66-67.

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Many have suggested that we merely need repeat the process that resulted in substantial productivity gains in U.S. agriculture and the Fourth World food shortages will be solved. However, methods used to increase productivity in developing countries, such as India and Pakistan, have not closely paralleled the techniques used in the developed nations, especially since the end of World War II.

Let us review the history of American agriculture. Output per acre of the American farmer was essentially constant from the formation of the nation until about 1940. Until then, increases in total production occurred through increases in land under cultivation. By 1866, land devoted to grain surpassed 50 million acres and by 1877, had exceeded 100 million acres. This expansion continued until 1899 when the acreage devoted to raising grain leveled off at about 175 million acres for about 10 years. Another expansion began in 1909 and grain acreage reached 211 million acres in 1915.[5] During this period, a small amount of capital was invested in American agriculture. It was not until World War II that American agriculture became highly capital intensive. The war demanded increases in production of food and fiber but the nation had largely used up its frontier land. Although agricultural output in America increased steadily through the war, dramatic increases did not really occur until the early 1950's.

U.S. agriculture is now highly capital intensive, energy intensive, chemical intensive and technology intensive. Like every other industry in America it has benefited from the fruits of R&D, high technology and advanced entrepreneurial and management skills: all characteristics and behavior traits that are, by definition, lacking in the lesser developed countries.

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[5] Lester R. Brown, Increasing World Food Output, Washington, D.C.: U.S. Department of Agriculture, Economic Research Service, Foreign Regional Analysis Division, U.S. Government Printing Office, 1965. [Hereafter called Increasing World Food Output.]

To repeat the agricultural success of the United States means to repeat the Industrial Revolution and speed the process of modernization, clearly an elusive goal for the lesser developed countries.

Lester Brown argues that four factors are essential prerequisites for a "yield takeoff" in any nation's agricultural output: (1) reasonably high levels of literacy, (2) reasonably high per capita income, (3) a market oriented agriculture, and (4) an economy which supports agriculture through a variety of goods and services. Brown believes that literacy is an important factor in the equation as it enables the farmer to practice management skills which are necessary to successful, highly efficient agricultural production. Some argue that merely the development of an adequate market structure in the lesser developed countires would contribute significantly to the solution of the food shortage. Much of the agricultural surplus of a given farmer is lost, is is argued, because of an inadequate marketing, storage and distribution network in the developing countries.

How, then, has the developing world managed to increase its agricultural output? Several factors have contributed to this increase in production. One, over the past two decades the amount of land under cultivation has increased. During the past two decades, for instance, India has increased the amount of land under cultivation by 20%. However, it will be difficult to increase the amount of land under cultivation much beyond the current level without substantial capital investment. For example, most "potential" arable land in Asia could not support even one four-month growing season without significant irrigation. It has been estimated that an additional 1.5 million square miles of land could be brought into cultivation, an increase of 26%. However, to bring this land just up to today's productivity levels could take 50 years and $500 billion of investment.

Increases in output per acre have been accomplished through hybrid grain varieties specifically developed for the tropical and subtropical climates. While these hybrid varieties have resulted in spectacular increases in output per acre, especially in wheat and rice, it has been accomplished at a cost of increased dependency on energy, fertilizers, pesticides and irrigation support. India, for instance, has increased its utilization of fertilizer by a factor of 30 since 1951.[6] With increasing cost pressures on both energy and agricultural chemicals, it becomes increasingly difficult for the poorest nations to adopt this technology.

While the consequences of adoption of the high yield hybrids have been dramatic, the hybrids are not intensively cultivated. It has been estimated that only 12% of the rice growing land outside of the developed countries (U.S., Europe, Japan, Taiwan) and China (about whom there is no data) is devoted to the high yield hybrids. While this seems insignificant, the amount becomes substantial when one realizes this percentage was zero before 1967.[7]

Substantial improvements in agriculture production in the developing world have also been achieved through irrigation. For instance, since 1951 India has doubled the amount of land under irrigation.[8]

Demand and Consumption of Foodstuffs: Americans are freely accused of food waste because of their high consumption of beef, an extremely inefficient source of protein because it requires 8 1/2 pounds of grain to produce 1 pound of beef. It has been suggested that if the United States were to reduce its consumption of beef, or merely adapt to grass fed beef rather

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6 Revelle, op.cit.

7 Robert F. Chandler, Jr., "The Scientific Basis for the Increased Yield Capacity of Rice and Wheat, and Its Present and Potential Impact on Food Production in the Developing Countries," in T.T. Poleman and D. K. Freebairn, Food, Population and Employment: The Impact of the Green Revolution (Praeger Publishers: New York) 1973, p.26-27.

8 Revelle, op.cit.

than grain fed beef that two purposes would be served: it would free enough grain in the United States to meet the Fourth World's shortage and the animals themselves would serve as "factories" for converting marginal "grassy protein" into high-grade protein for human food. While contentions such as these must be questioned, it is quite clear that worldwide affluence is increasing the demand for beef and other foodstuffs higher up on the food chain, which in turn is further aggravating worldwide food supplies.

The developing world, on the other hand, primarily consumes vegetable protein and starch (see Figure 3). This protein base does not meet minimum dietary requirements. By contrast, in the period 1969 to 1971, the supply of food energy available to persons in the developed countries was estimated to be 23 percent above minimal requirements and protein supplied 12 percent of the available food energy. In terms of energy, the developed countries averaged over 3100 kilocalories per capita per day while the developing countries averaged only 2200 kilocalories per capita daily. In terms of protein, the developing nations on the average consumed only 60 percent of that available to the developed nations (see Figure 4).[9]

Imports as a Solution to Food Shortages: In the past, the growing agricultural surpluses in the West, predominantly the U.S., Canada, Australia and New Zealand, have managed to forestall any regional food shortage. In fact, agricultural surpluses were such that the American farmer was paid *not* to grow food and the government absorbed the costs of food storage of surpluses. These programs were not undertaken to feed the hungry, but rather to provide price support to the American farmer. All hopes of winning the age old struggle against hunger ended with the dismal world harvest of 1972, when the harvest was 3% below demand. The international imbalance

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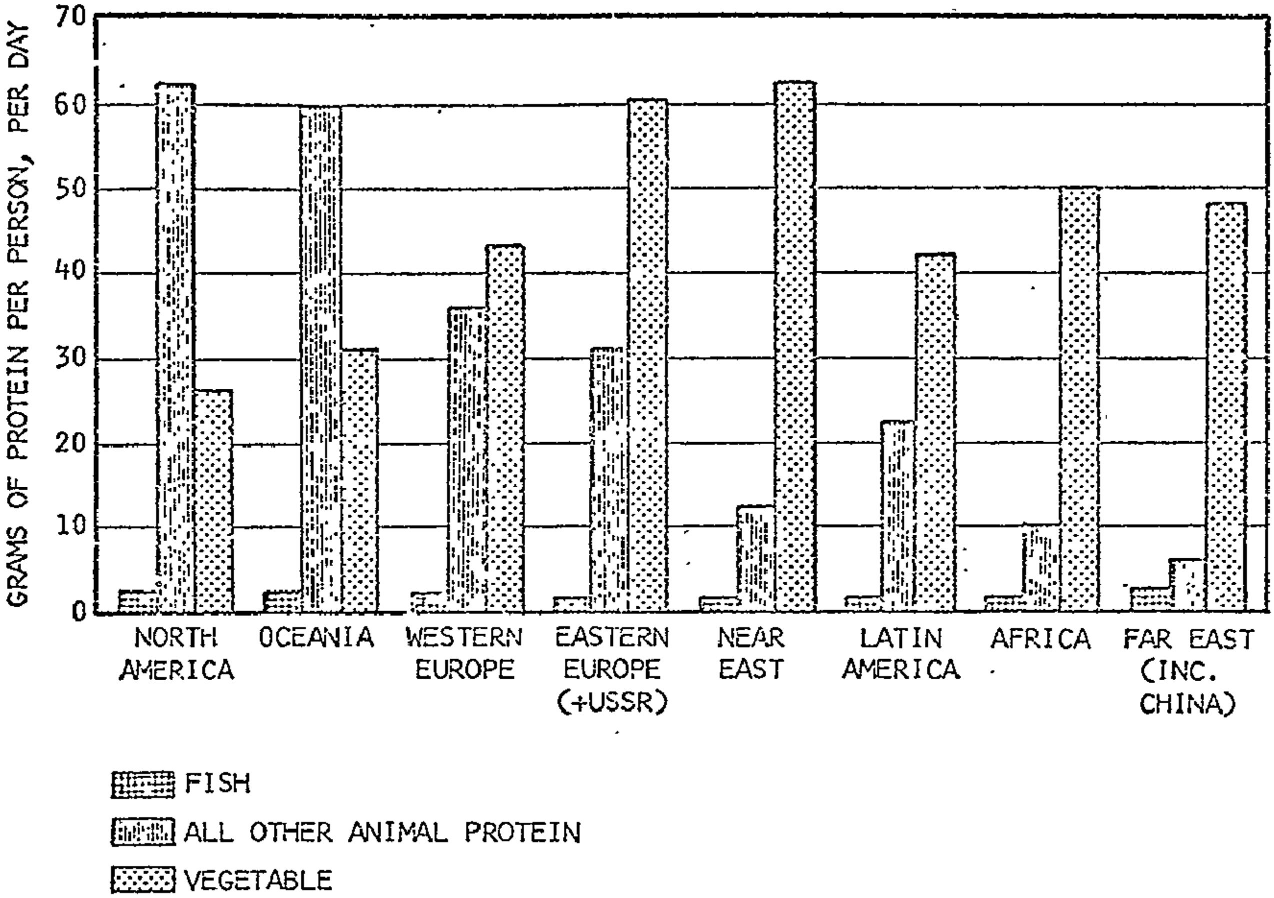
[9] The World Food Conference, op.cit., pp. 37,38,42,43.

FIGURE 3

WORLD CONSUMPTION OF PROTEIN



SOURCE: MCHALE, JOHN, WORLD FACTS AND TRENDS (NEW YORK: COLLIER BOOKS, 1972).

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FIGURE 4

AVERAGE ENERGY AND PROTEIN SUPPLY, BY REGION*

	Energy (kcals per caput)		Protein (grms per caput)		Energy as percent of requirement (percent)	
	1961	1969–71 average	1961	1969–71 average	1961	1969–71 average
Developed market economies......	2950	3090	87.5	95.1	115	121
Western Europe.............	3020	3130	89.3	93.7	118	123
North America.............	3110	3320	92.3	105.2	118	126
Oceania....................	3210	3260	92.7	108.1	121	123
Other developed market economics....................	2420	2550	73.3	79.1	102	108
Eastern Europe and U.S.S.R......	2990	3260	85.8	99.3	116	127
Total developed countries...	2960	3150	87.0	96.4	116	123
Developing market economies.....	2130	2210	55.0	56.0	93	97
Africa.....................	2120	2190	55.7	58.4	91	94
Far East..................	2050	2080	51.3	50.7	92	94
Latin America..............	2410	2530	63.7	65.0	103	105
Near East..................	2200	2500	62.3	69.3	89	102
Asian centrally planned economies..	2020	2170	54.7	60.4	86	92
Total developing countries..	2100	2200	54.9	57.4	91	95
World....................	2380	2480	65.2	69.0	100	104

SOURCE: World Food Conference, p. 42.

*The figures relate to protein and energy content of the food available at the retail level after allowance for the storage and marketing losses and waste.

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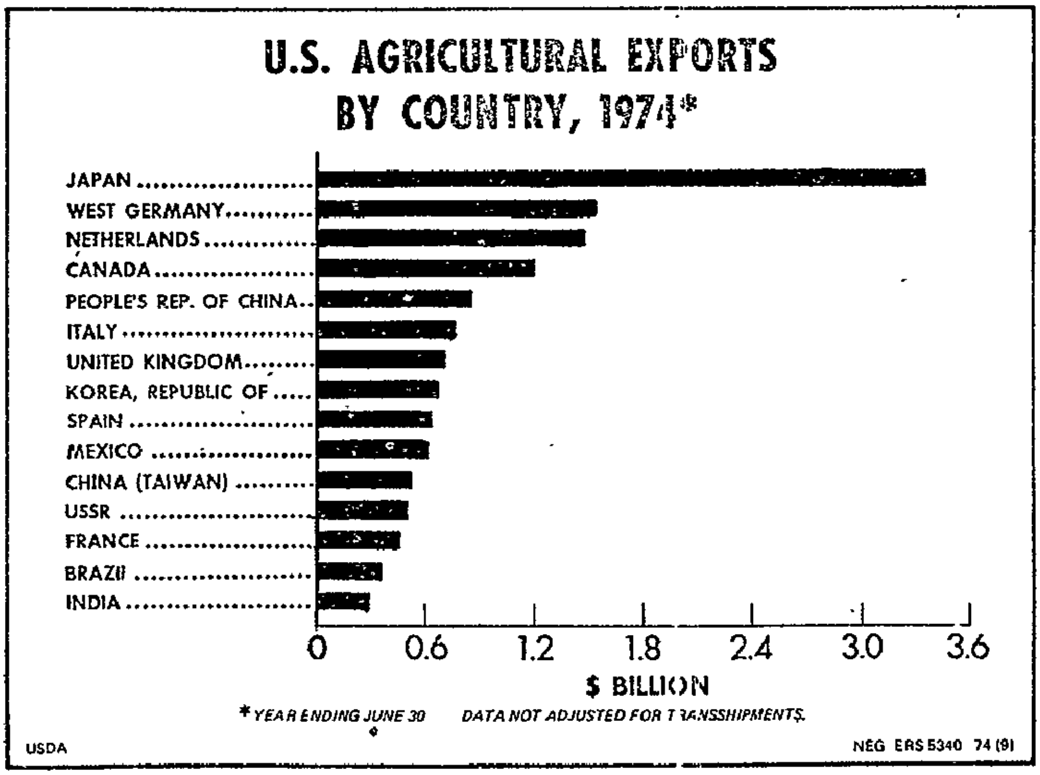
between demand and supply preclude importing as an effective policy for the foreign exchange poor developing nations.

Currently, the developed world provides little to the food supplies of the developing world. While more than 60% of the wheat produced in the U.S. is exported as is more than 50% of the rice and soybeans, the bulk of this is exported to the developed world. The leading recipients of U.S. agricultural exports are the most developed nations: Japan, West Germany (see Figure 5).[10] The developing countries largely grow their own foodstuffs. Only 20% of the wheat and rye consumed in India and Pakistan is imported. But because wheat and rye in these countries comprised 15% to 30% of the food consumed, the total amount of food imported typically comprises only 4% to 6% of the diet in the developing countries.[11]

FIGURE 5



Source: U.S. Department of Agriculture, 1974 Handbook of Agricultural Charts, No. 477 (Washington, D.C.: Government Printing Office) p.48.

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[10] U.S. Department of Agriculture, 1974 Handbook of Agricultural Charts, No,477 (Washington,D.C.: Government Printing Office).

[11] United Nations Statistical Yearbook 1970, 22nd Edition (New York: United Nations. 1971). pp.508-513.

The international commerce in food has changed drastically since the end of World War II. From the mid-1930's to the late 1940's almost all regions of the world exported grain. Only western Europe was an importer. The situation has changed substantially since then, as only the United States, Canada, Australia, and New Zealand currently export grain. All other regions import grain as shown in Figure 6. In 1972 more than 75% of this export trade was from the United States, about 15% from Canada, and the remainder from Australia and New Zealand.[12]

As shown in Figure 7, exports comprise a relatively small and decreasing portion of the total grain produced in the world. However, they may make an extremely important contribution. If the world continues to consume grain at the current worldwide average, the addition of about 70 million people anticipated annually in the next few years would require about 300 million tons of grain yearly. That amount is roughly equivalent to about 40 percent of U.S. exports or the total sales of Canada, Australia, Argentia, and South Africa in 1973. Any external event which might reduce grain exports from the U.S. and Canada would diminish grain imports elsewhere in the world and, hence, could aggravate food shortages in specific areas. Such events might include unfavorable weather or even continued consumer resistance against the exportation by the U.S. as a result of higher food prices in America.

Because of the dominant role the U.S. plays in the worldwide production of grain, changes in the pattern of world trade in grain seem to hinge upon decisions which are made in the U.S. As noted earlier, at about the time

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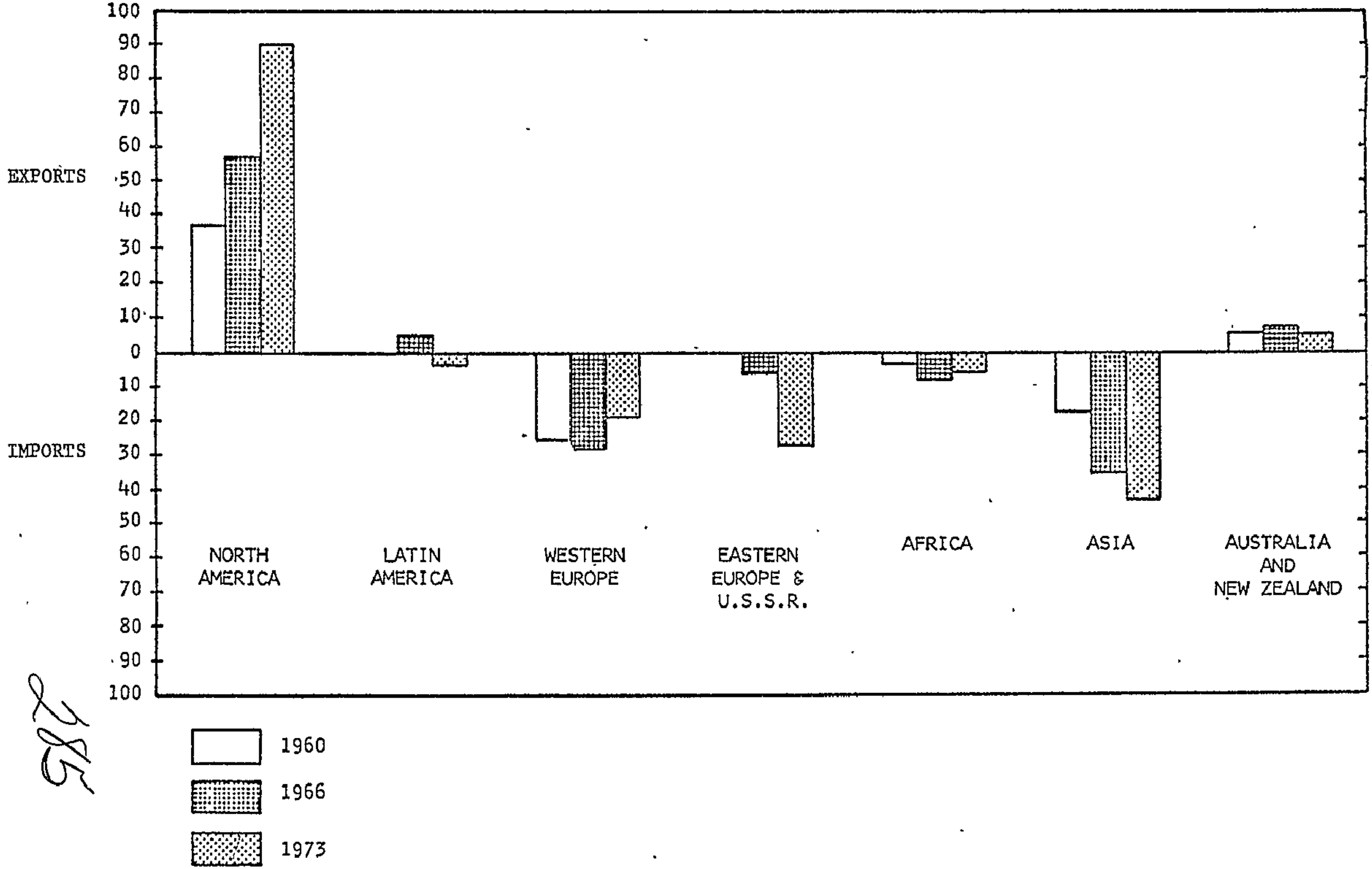
[12] Theodore J. Gordon and R. Richmond, A Preliminary Technology Assessment of Agricultural Information Systems, Report 166-67-02 (November 20, 1974), p.27.

FIGURE 6

WORLD GRAIN TRADE



SOURCE: SCRIMSHAW, N.S., "THE WORLD-WIDE CONFRONTATION OF POPULATION AND FOOD SUPPLY," <u>TECHNOLOGY REVIEW</u>, VOL. 77, NO. 2 (DECEMBER 1974), P. 19.

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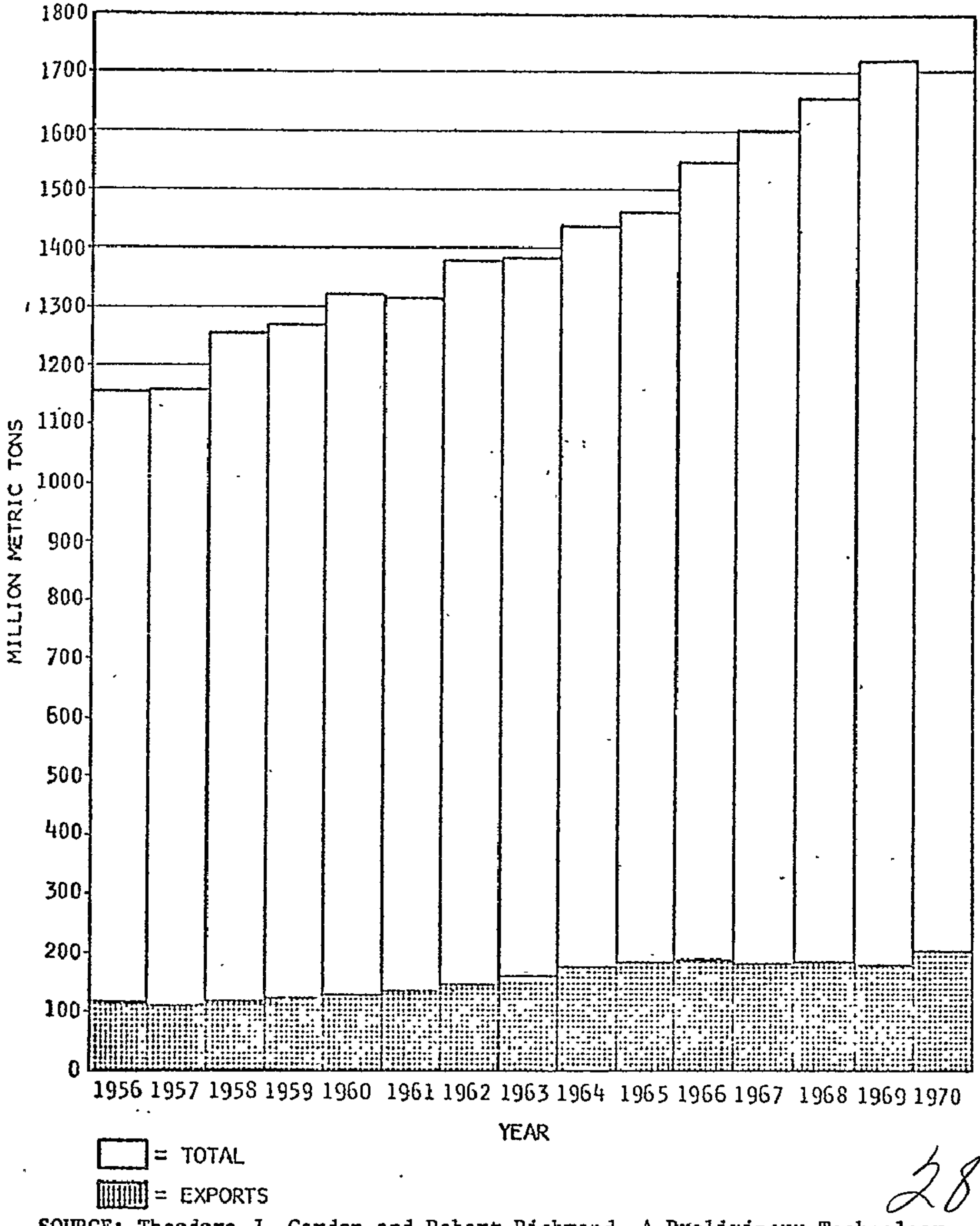
FIGURE 7

TOTAL WORLD FOOD PRODUCTION -- WORLD FOOD EXPORTS



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SOURCE: Theodore J. Gordon and Robert Richmond, A Preliminary Technology Assessment of Agricultural Information Systems, Report 166-67-02 (Glastonbury, Conn.: The Futures Group, November 20, 1974), p. 2.9.

of World War II, the U.S. initiated a policy of increasing the output per acre rather than merely increasing the acreage under cultivation.[13] This policy resulted in the generation and storage of enormous food surpluses by the U.S. As population in developing areas of the world began to increase faster than food production, Americans responded to their needs by exporting the surpluses. Clearly, one of the incentives for exporting food to parts of Asia and Europe after World War II was to influence those regions politically. No doubt these programs also had important humanitarian motivations. The motives of the Marshall Plan and the United Nations Relief and Rehabilitation Administration were certainly directed along such lines. But productivity increases also occurred in Argentina, Canada, Australia, New Zealand, South Africa and other countries with advanced agricultural technology. These increases led the United States to initiate tariff barriers to imported foods,and it grouped various relief programs under Public Law 480, the "Food for Peace" program. Under this program, food would be shipped to political allies under highly attractive terms whereby the buyers could pay in local currency or borrow over a 40 year interval at low interest rates. Other aspects of the program provided for the donation of food to various nations. This program in effect reduced surpluses in the U.S. and provided an economic boost to farm incomes and even reduced government costs for storage of food. It also helped the Merchant Marine, as foodstuffs were shipped in American flag carriers.[14]

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[13] Increasing World Food Output, op.cit.
[14] Gordon and Richmond, op.cit., p.212.

Ultimately, transporting and overseeing distribution of these foodstuffs stretched American capabilities to the point where the U.S. gradually shifted its emphasis and began to encourage the growth of better systems of agriculture in the developing nations, while supplying emergency needs from its own surpluses. Currently there are indications that the U.S. is now ending, or at least slowing, the Food for Peace program. For example, there were no shipments of powdered milk in the fiscal year 1974. The amounts of food supplied under this program were not insignificant -- comprising about 30% of world agricultural exports during the 1950's and 1960's.[15]

However, without further substantial production increases in the major grain producers of the world, U.S., Canada, Australia and New Zealand, imports are not a feasible solution to the Fourth World food shortages. A return to the agricultural surpluses of the fifties are not likely in the U.S. either. In fact, there is some concern in the U.S. that land shortages, fuel shortages, fertilizer shortages, rail car shortages in the face of ever increasing demand for food and fiber may mean that the U.S. is facing a potential food shortage: projected production of food and fiber lags behind projected 1985 consumption by as much as 7% to 12% under current extrapolations in the opinion of some experts.[16]

Availability of Fertilizers and Pesticides: The worldwide increases in output per acre have occurred as a result of increasing dependence upon fertilizers and pesticides. Changes in world commerce have resulted in serious concerns over the long run availability and price of both fertilizers and pesticides.

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[15] Willard W. Cochrane, The World Food Problem (New York: Thomas W. Crowle, 1969), p.135.

[16] Norman H. Fischer, "Growing Enough Foods for the Future May Tax U.S. Farm's Capacity," The Wall Street Journal (November 19, 1973) p.1.

The developing countries import the bulk of the fertilizer they consume. Until just recently, the United States was one of the major producers and exporters of fertilizers in the world -- producing about three times more fertilizer than it consumed. Likewise, Japan produced about 10% or 15% more fertilizer than it consumed. India imported all of its fertilizers during the 1960's and it was not until the early 1970's that India began producing about one-third of the fertilizer it consumed.

The five-fold increase in oil prices has had substantial impact upon the cost and availability of fertilizers. Japan has decided, at least temporarily, to cease exporting fertilizers. The FAO estimated that from July 1973 to June 1974, developing countries received about 1.5 million tons (in terms of nutrient content) of fertilizer less than the quantity that would have been required to match recent rates of increase in fertilizer utilization.[17] This reduction represented about 15% of the total fertilizer consumption of the developing countries. It was estimated that this would reduce cereal production by about 12 million tons. Some fertilizer prices have risen by a factor of 3 over the 1971 levels -- primarily as a result of the scarcity of nitrogenous and phosphate fertilizers. And, because of increasing balance of payments difficulties, the world fertilizer supply will be increasingly difficult for the developing nations to purchase. It is estimated that in 1974-1975, developing countries again will be short at least 1.5 million tons of fertilizer.

High prices of materials also have influenced the production of pesticides, resulting in a slight reduction in output. A 20-30% shortfall in worldwide production of pesticides is expected during 1974-1975, while at the same

[17] The World Food Conference, op.cit., p.20.

time high prices and scarcities of diesel fuel are creating difficulty in food production for developing countries, particularly in pumping of irrigation water. It is likely that cost and accessibility problems will continue to effect fertilizer and pesticide availability for several years.[18]

Impact of Weather and Environment Constraints: By the beginning of the 1970's, it appeared the world might have solved its food problem. World grain production reached a record 1.2 billion metric tons and for six years had outpaced population growth.[19] But in 1972, for the second time in a decade, grain production declined. Weather affected crops that year in the Soviet Union, China, India, Australia, Sahelian Africa, and Southeast Asia and reduced production by 33 million tons.[20] Food output in the developing nations declined by more than 3 percent from their previous level.[21]

As another section discusses in some detail, there is a great deal of evidence to suggest that there are profound global climatic changes taking place. It now appears that the first half of the twentieth century provided better weather conditions than have prevailed in at least a thousand years.

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[18] The World Food Conference, op.cit., pp.20-21.

[19] Task Force of the Council for Agricultural Science and Technology, The Impact of an International Food Bank (December 1973).

[20] United Nations Preparatory Committee of the World Food Conference, Second Session, Preliminary Assessment of the World Food Situation, Present and Future (New York: April 1974).

[21] Quentin M. West, Administrator of U.S. Department of Agriculture Economics Research Service, The World Food Situation and How Others See It, speech presented at the Conference to International Agricultural Training (Virginia: April 3, 1973).

These favorable weather conditions resulted in warmer weather during the summer growing seasons, a longer growing season (2-3 weeks longer), and consistent and predictable weather patterns. This unprecedented period of good weather had two effects. One, it contributed to the tremendous increases in agriculture production. But, two, the favorable weather conditions also contributed to the substantial increases in world population, especially in the lesser developed areas. A world-wide cooling trend apparently began in the 1940's, which influenced the world's atmospheric circulation. The current prolonged droughts in Africa, India, and other countries in the earth's so-called warm zone seem to be the result of this change -- as were floods and other unusual conditions in the United States and elsewhere in recent years.[22]

Exacerbating the weather problem are other environmentally imposed constraints upon the lesser developed countries. Much of the developing world lies in tropical or semi-tropical areas which have soils of poor quality. They contain little organic matter, their mineral content is frequently low, and they are vulnerable to high erosion losses because of heavy rainfall and erratic winds.[23] This may seem counterintuitive since many tropical regions are covered with lush vegetation. However, these tropical soils are mineral rich and when exposed to air turn into a bricklike form of rock, called laterite which has been an important building material since prehistoric times. Hence, clearing the area of vegetation for agricultural purposes could turn much of that region into a wasteland. At Iata, an equatorial site in the heartland of the Amazon

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22 Martin Walker, "Drought," The New York Times Magazine (June 9, 1974), pp.11-13,43-46.

23 George Borgstrom, "The World Food Crisis," Futures, Vol. 1, No. 4 (June 1969), p.343.

basin, the Brazilian government established an agricultural colony. The forest was cleared and crops were planted, but the soil disintegrated after the first or second planting. The equatorial sun turned the iron-rich soil into brick and in less than five years the cleared fields virtually became pavements of rock.[24]

Other developing countries have experienced similar disasters. India, Pakistan, and Bangladesh during the past two decades cleared large areas in the Himilayan foot hills for farming. Without the forest, rain water rapidly ran off the slopes, causing disasterous floods over the past several years. In other areas such as Mexico, Guatemala, and Brazil, heavy rains quickly leached the nutrients in the small layer of top soil and effectively rendered the land infertile within a year or two after the land had been cleared for planting.[25]

Indeed, major portions of the world seem to be losing large acreages of crop land each year because of severe soil erosion, industrialization and residential development. Estimates have been made that it is only a matter of decades before conventional agriculture will no longer be able to supply the food the world needs due to the loss of agricultural land. It is argued that this situation is valid even if the number of acres in cultivation increases markedly and if productivity increases by a factor of 2 to 4 as shown Figure 8.[26] Few countries have established clearcut land use policy to protect agricultural land. For example, in the

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[24] Mary McNeil, Scientific American (November 1964).

[25] "The World Food Crisis," Time (November 11, 1974), p.79.

[26] Donella H. Meadows, et al., The Limits to Growth (New York: Universe Books, 1972).

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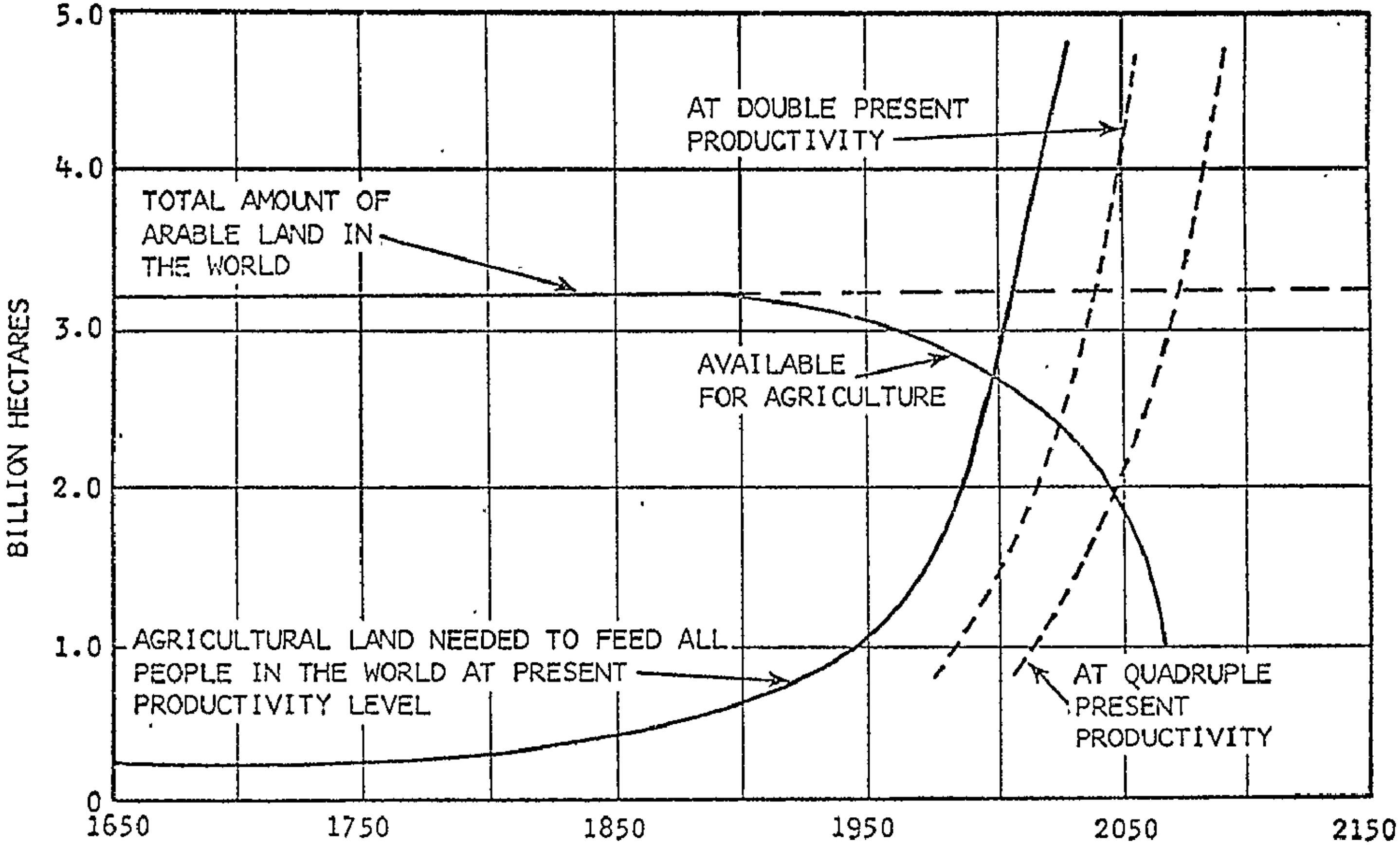
FIGURE 8

ARABLE LAND



SOURCE: DONELLA H. MEADOWS, ET AL., THE LIMITS TO GROWTH (NEW YORK: UNIVERSE BOOKS, 1972).

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U.S., large areas of farmland have been diverted to other purposes in recent years with little thought about potential long-term consequences. Japan and several western European countries have experienced reductions in the land used for crop production for several decades.[27]

The availability of water may prove to be even more important for the future. Effective agriculture production could be accomplished in many regions of the world if water were available. However, most of the rivers that can be dammed for irrigation purposes have already been turned to such uses. The growth in irrigation is now slowing markedly, and further efforts to expand fresh water supplies for agricultural use will emphasize the diversion of rivers (as in the U.S.S.R.), the manipulation of rainfall patterns and eventually desalination of sea water, depending upon the cost.[28]

The Oceans as a Source of Food: There is marked controversy concerning the possible role of the oceans to provide a significant source of the world's food supply. On the one hand are those who believe that, with proper technology and management, the oceans can supply an increasing percentage of the world's food supply. On the other hand, there are those who believe that "the most pervasive myth of the population food crisis is that mankind will be saved by harvesting the immeasurable riches of the sea."[29]

In a committee report prepared for the U.S. Senate in preparation for the World Food Conference it was noted that the level of output of food production from the oceans that might be reached in 10 or 20 years is

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[27] Lester R. Brown, In the Human Interest (New York: W.W. Norton & Company, Inc., 1974), p.48.

[28] Ibid.

[29] Ehrlich and Ehrlich, op.cit., p.125.

difficult to forecast. But the report went on to state that appropriate economic incentives accompanied by proper investment would allow technology to meet foreseeable future demand. This report notes that, in 1972, the world's catch had increased to the point where about 50% of the potential (estimated at 100 to 118 million tons) was being harvested. It was cautioned, however, that doubling of the world's seafood catch is not possible for all species, as an increasing number are becoming fully or overly exploited and thus still yield less than their full potential. Also, several species have largely disappeared from commercial fishing, due primarily to excess fishing. It is argued, however, that species that have not yet been exploited do exist. For example, some stocks within the Indonesian archipelago might be harvested with new techniques and vessels. It is also noted that species in the northwest Indian Ocean of the south-western Atlantic are too distant from the main consuming centers and that the burden of license fees currently makes working these areas uneconomical. Cultural differences, although they allow certain species to be consumed in one area, preclude consumption of those species in other areas. Squid and other cephalopods are examples.

Species which are now used in the production of fish meal for animal feed might be directed for human consumption, although trends in this area have already begun, e.g., herring, Alaska pollack, etc. Reductions in waste are offered as another possible means of increasing production, including retention of "trash" fish, which are currently thrown back into the sea, In the longer run, it may be possible to increase world supplies of food by harvesting less familiar marine animals, such as krill in the Antarctic and lantern fish in warmer oceanic waters. Technical problems exist here which could be overcome if the catch were to prove economically viable.

For the developing countries, especially in the foreseeable future, it seems likely that supplies will be comprised of more conventional types of fish. But improved management schemes are required to maintain yields of the more heavily fished species. Finally, the Senate report mentions the possibility of increasing food production through the cultivation of fish, especially in the tropical areas of Africa and Asia, and in particular, in the latter where aquaculture is already well established.[30]

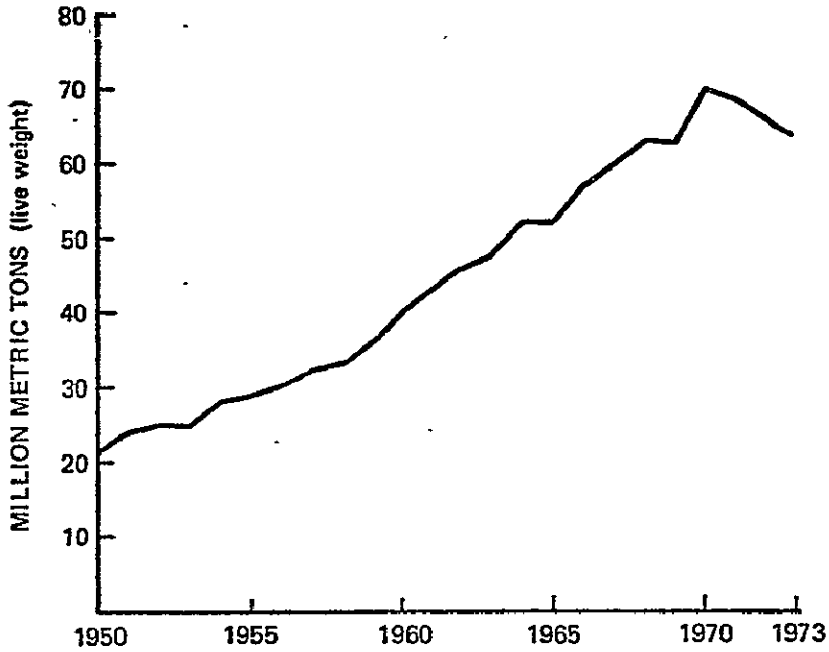
Others are skeptical of the role that fish can play. While fish provide only a small portion of world caloric intake, their contribution is substantial in some countries and extremely important as feed for agricultural animals. The period 1950-1970 saw substantial growth in world fish catch from about 20 million tons annual yield to about 70 million (see Figure 9). While this growth is attributed to technological improvements and capital investment, Ehrlich suggests a large part of the growth may be due to more accurate and complete reporting of the existing catch rather than from actual increases in yield.[31]

There is equal skepticism regarding the further role the oceans can make. Estimates of the additional fish yield that the oceans could provide vary significantly. Recent investigations of the fish producing capabilities of the oceans reveal that the open seas (90% of the oceans) are essentially a "biological desert," producing a negligible fraction of the world fish

[30] The World Food Conference, pp.85-86.
[31] Ehrlich and Ehrlich, op.cit.

FIGURE 9

WORLD FOOD CATCH, 1950-73



Source: Food and Agriculture Organization

catch at present with little or not potential for yielding more in the future.[32] Estimates of the productivity of the upswells and coastal regions vary, however. The Woods Hole Oceanographic Laboratory has estimated that the amount of fish available for sustained harvesting (that is, leaving an adequate reproductive population sufficient to sustain the species and continued harvesting) is approximately 100 million metric tons;[33] the FAO suggests that the upper limit may be 110 million tons;[34] and still another estimated suggests that the upper limit is 200 million tons.[35] To increase

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32 John H. Ryther, "Photosynthesis and Fish Production in the Sea," Science (Vol. 166, pp.72-76) 1969.

33 Ibid.

34 J. A. Gulland, The Fish Resources of the Oceans (United Nations Food and Agricultural Organization: 1971).

35 George A. Doumani, Science, Technology and American Diplomacy: Exploiting the Resources of the Seabed, Prepared for the Subcommittee on National Security Policy and Scientific Developments of the Committee on Foreign Affairs U.S. House of Representatives, by the Congressional Research Service (July 1971).

the yield by several tens of tons appears to be possible through exploitation of current species, productivity improvements and improved fish resource management. However, to substantially increase the production beyond this level does not seem possible. Ehrlich points out that "to surpass the potential annual fish production of 100-150 million metric tons would require moving down the food chain from the big fish ordinarily found in fish markets to the harvesting of plankton. All signs at the moment indicate that this will not be feasible or profitable in the foreseeable future, if ever. More calories of fuel and human energy would be spent on harvesting the plankton than could be gained, the expenditure of money would be colossal in relation to yield, and the product would require considerable processing to be made palatable as human food.[36]

Some Positive Actions:

Clearly, a great deal of worldwide attention has been devoted to the question: well, what do we do now? Before discussion of specific strategies and actions it is important to note the cultural taboos that apply to agriculture and the role of economic development in improving agricultural productivity. Agricultural productivity in lesser developed countries is low because they are lesser developed; the mammoth improvements in agriculture in the United States exist because it is a capital and technology intensive industry, rather than a labor and tradition bound society. Hence, the agriculture problem is but a part of the fundamental condition of economic underdevelopment.

[36] Ehrlich and Ehrlich, op.cit., p.125-127.

In traditional agrarian societies, agriculture is more than an occupation, it is a way of life and many cultural, religious and mythical taboos, superstitions, and beliefs dictate agricultural practices. Hence, any strategy must be cognizant of these cultural values and must recognize that cultural change is slow, gradual and disruptive. Any action implemented by a given nation or any action that becomes the basis of a nation's foreign aid program must reflect and incorporate these cultural biases.

Many writers on the subject of the world food problem have advocated an immediate application of western technology as the solution. If one examines the underlying causes of the food problem in the developing world, the futility of this approach becomes manifest. As Figure 10 indicates, very few of the causative factors are amenable to technological interventions, rather it is the problem of modernization and economic development that is facing the starving nations. Hasan Ozbekhan has observed: "The problem of hunger and undernourishment itself emerges as but one of the manifestations of the general problem of *underdevelopment* -- albeit one of the most constant and tragic."[37]

Despite this, most of what we know is technology based; despite years of study we have little insight into how to trigger an Industrial Revolution in an underdeveloped country. Hence, much of the discussion below concentrates on technological solutions, while admitting that the problem is not primarily technological in origin.

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[37] Hasan Ozbekhan, "The Role of Goals and Planning in the Solution of the World Food Problem," in R. Jungk and J. Galtung, Eds., Mankind 2000 (International Peace Research Institute: Oslo) 1969 p.127.

While the successive introduction of many new varieties has reduced the danger, it still exists. The danger lies in the possibility that all strains have a common recessive gene that confers susceptibility to a given pathogen. As farfetched as this may sound, it has already happened once. The epidemic of southern corn blight that destroyed 20% of the U.S. crop in 1970 was caused by a genetic linkage of this sort. That the toll was limited was due to the expertise of American agribusiness. "If a thing like that should happen in places like India or Nigeria, it would really be a disaster," says J. M. Deller of the Crops Evolution Laboratory at the University of Illinois.[39]

It is becoming increasingly clear that the new high yield varieties do well only under limited ecological conditions. The over-reliance upon the expectations of the Green Revolution is best exemplified by the Philippines. It was the first Asian nation to make extensive use of the high yield varieties (HYV) of rice and convinced 60% of its farmers to use them. By 1971 the Philippines was self-sufficient in rice. But by the end of 1971-72 the nation had been struck by storms, floods, then a drought and then a disease against which the HYV had no resistence. Soon the nation faced famine. Recognizing the failure of the domestic Green Revolution, the nation then began a program aimed at becoming self-sufficient while teaching agricultural science, management techniques and some basic economics along the way. The program, "Masagana 99," is so successful it is becoming the model for other nations for the efficacious administration of Western technology.[40]

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[39] Nicholas Wade, "Green Revolution (II): Problems of Adapting a Western Technology," Science (Vol. 186) December 27, 1974, p.1186.

[40] Peter R. Kann,"Green Revolution is Easing Hunger Slower Than Had Been Hoped," The Wall Street Journal (November 18, 1974) p.l.

So what was wrong with the Green Revolution (the popular name for the HYVs)? While the hybrids could result in unprecedented yields under the proper growing conditions, these conditions were difficult to maintain. The strains were, as noted,genetically vulnerable. They were also more vulnerable to pests than the traditional varieties, partly due to the practice of transplanting HYV's developed in one part of the world to another without adapting them to local conditions.[41] The recommended growing practices (close planting, luxuriant foliage) also made them more susceptible to pests.

A very serious problem was the genetic erosion of plant species. The rapid proliferation of HYV's destroyed many local varieties of crop plants.[42]

Finally, the Green Revolution hybrids are reliant upon high energy inputs such as fertilizer, pesticides and fuel for their high yields. The astounding energy dependence of American agriculture has recently been indicated: to raise an acre of corn in the U.S. in 1970 required 80 gallons (2.5 barrels) of gasoline.[43] Because of this dependency, Pimentel quite correctly wonders "...if many developing nations will be able to afford the technology of U.S. agriculture."[44]

Improved Plant Genetics: Preliminary experience with the high yield varieties indicate that the essential next step is to develop species with resistence to insects and diseases. Other research is currently being devoted to improving the protein content of grain. The original hybrids

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[41] Wade, op.cit.

[42] Ibid.

[43] David Pimentel, et al, "Food Production and the Energy Crisis," Science (Vol. 182) November 2, 1973, p.447.

[44] Pimentel, op.cit., p.448.

primarily were developed to increase yields, regardless of protein content. However, it is estimated that such research is lengthy and the rewards may be so far in the future as to be irrelevant to the Fourth World requirements.

Energy, Fertilizers and Pesticides: We have indicated that substantial increases in output per acre are dependent on energy and chemical inputs. In the near term, chemical fertilizers represent the most significant means of improving crop yields. It has been estimated that each ton of fertilizer applied to an underdeveloped country's grain crops could increase the harvest by ten tons.[45] The use of fertilizers in developing countries currently ranges from less than one-tenth to a quarter of that used per hectare in most developed nations. Even so, fertilizer consumption in developing countries has doubled every five years and will probably continue to increase at about 11 percent annually for the next several years. But, fertilizer prices have increased by factors of 3 and 4 in the past three to four years, and significant shortages of fertilizers currently prevail and are expected to last at least five years.[46] The developing countries currently import at least half of their fertilizer needs (including materials from which fertilizers are produced). Wide-scale expansion of fertilizer production capacity in developing countries is necessary in order to provide sufficient amounts, especially to take full advantage of the high yield varieties and to capitalize on potential advancements in irrigation.

[45] "The World Food Crisis," Time, November 11, 1974.
[46] Ibid.

Fertilizers themselves can be improved and, in light of likely price increases, such advancements should prove highly desirable. Here, concepts include slow-release mechanisms, use of nitrogenous inhibitors, nitrogen-fixing legumes, and more efficient use of organic manure supplies. Improvements are also possible in the use and formulation of other agricultural chemicals for control of pests, fungus, and weeds.

Clearly, efficient use of seeds, fertilizers, and plant protection items in many developing countries is hindered because the farmer does not have sufficient funds to purchase them. It has been noted that, in southern Asia, the average farmer spends $6 per hectare annually when $20-80 (depending upon the crop) should be spent. Improved means of providing credit on attractive terms could make large inroads into the farmer's ability to purchase equipment, to level and clear land, and to improve utilization of irrigation water by purchasing various equipment and tools.

In the aforementioned Phillippine program "Masagana 99" it was the provision of low interest loans and subsidies by the government that guaranteed the success of the program. In fact, in areas where there were no banks the Philippine National Bank provided the money -- in remote areas, banks provided cash by Jeeps carrying credit supervisors and cashboxes.[47]

Improving Land and Water Resources: Less than 13% of the arable land in the developing world is currently irrigated. It has been suggested by one writer that "the improvement of existing irrigation systems in the tropics and the installation of new ones is probably the most profitable single enterprise that man can engage in."[48] Some writers indicate that the primary

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47Kann, op.cit.

48Chandler, op.cit., p.39.

barrier to the Green Revolution is the lack of water.[49] The FAO estimates that the global demand for water will increase 240% by the year 2000, yet the "easiest" big dam and irrigation projects have already been constructed.

In parts of the developing world, significant amounts of land are still left idle or are under-utilized. These areas are primarily in South America, Africa, and parts of southeast Asia and this under-utilization stems from high rainfall and high temperatures. It has been suggested by the FAO that there are promising agriculture lands available in:

- The Amazon River Basin
- The Savannahs of Colombia, Venezuela, Ecuador and Brazil
- A broad band of 1.7 billion acres across Central Africa now infested with the tsetse fly
- Areas in Malyasia, Thailand, Burma, Indonesia[50]

Others suggest that any use of this land requires road construction, installation of irrigation systems, warehouse construction, as well as expansion and modernization of the food expansion system -- at a cost of $500 billion.

Development of new lands must, of course, be associated with adequate means of access. Remote sensing techniques can be applied here, including their application to land management schemes. It has been estimated that arable land in developing countries can be increased over 20% by 1985 from the 1970 level. In addition, it has been estimated that $90 billion (see Figure 11) would be required to upgrade existing irrigated areas, to develop new irrigation approaches, and to bring new land under cultivation.

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[49] "The World Food Crisis," <u>op.cit.</u>

[50] "The World Food Crisis," <u>op.cit.</u>

FIGURE 11

ESTIMATED COST OF WATER AND LAND DEVELOPMENT FOR THE PERIOD 1974-1985
(Million Dollars [at 1974 prices])

ORIGINAL PAGE IS OF POOR QUALITY

	Renovation and improvement of existing irrigated area		Equipping new land for irrigation		Development of new arable land	
	Total estimated cost	Foreign exchange component	Total estimated cost	Foreign exchange component	Total estimated cost	Foreign exchange component
Far East	11,700	3,500	22,000	11,600	9,500	500
Near East	6,700	2,700	7,400	5,000	2,500	250
Africa	500	200	2,400	2,400	1,500	570
Latin America	2,100	100	6,200	2,500	12,800	2,500
Total	21,000	6,500	38,000	20,000	30,000	3,820

SOURCE: U.S. Senate, The World Food Conference, 93d Congress, 2d Session, Subcommittee on Foreign Agricultural Policy of the Committee on Agriculture and Forestry (Washington, D.C.: U.S. Government Printing Office, October 30, 1974), p. 141.

Improvements in Livestock: Forecasts of demand for livestock products in the developing countries show demand rising by 4.4% annually into the 1980's. Efficiency in livestock production is quite low in the developing countries, with some few exceptions. Improvements in veterinary services, including advice to farmers, are needed in the short term. In the long term, genetic improvements of all animal stocks are appropriate. A major part of the improvement in feeds relates to improved methods of using natural grasslands. Any freeing of grain supplies would improve the international food supply situation, at least in the short run.

Control of pests, such as the tsetse fly,could markedly increase areas of livestock production. African animal trypanosomiasis, which is a disease borne by the tsetse fly, is one of the primary causes of under-utilization of certain African lands. If this disease were brought under control, the area could support an additional cattle population of about 120 million, producing approximately 1.5 million tons of meat annually. Methods of controlling the disease include cattle breeding, insect spraying, preventative and remedial treatment of animals, and ultimately immunization of animals. Any methods ultimately will have to be adapted to local conditions, but such programs will require research in many areas in order to develop effective approaches. Total program costs are estimated to run between $2 and $2.5 billion (U.S. dollars), although admittedly cost estimates are difficult in this area.

Reduction in Post-Harvest Losses: Losses in food which occur between harvest and availability to the consumer range between 20% and 40%, depending upon the crop and country involved. "At least one quarter of the world's food disappears between the field and the table."[51] Losses occur from poor management in harvesting; insect, rodent, and fungus damage during storage; inadequate packaging; inefficient handling during transportation; inadequate functioning of milling equipment; and improper distribution of milled products. These items are exemplary and suggest that a single program would not have significant impact on the overall problem. Ways of attacking the problem include improvement in storage of grains and other crops in both small villages and large centers, improved packing materials and transportation facilities, and improvements in the milling of cereals and oil seeds, and improvements in the organization of both wholesale and retail distribution.

[51] Ibid.

Agricultural Research Institutes: The collection, storage and dissemination of agricultural information, both in terms of basic research and monitoring of current crops is essential to international agriculture. The technical institutional mechanism for such sharing, especially for sharing of remote sensing data, does not exist.

POPULATION GROWTH IN THE LESSER DEVELOPED NATIONS INHIBITS ECONOMIC GROWTH AND DEVELOPMENT, LEADING TO A GROWING DISPARITY OF LIVING CONDITIONS BETWEEN DEVELOPED AND UNDERDEVELOPED COUNTRIES

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The Issue:

The population growth rate in the lesser developed countries has increased enormously in the last several years. The population of developing countries is growing at a rate of about 2.5% annually, as contrasted to a growth rate in the developed countries of about 1%.[1] As Figure 1 shows, about 70% of the world's population lives in "less developed" regions, up from about 64% in 1920. Thus, while output is increasing worldwide, the relative position of the lesser developed countries with regard to the more advanced nations has deteriorated considerably over the past 40 years. Present patterns of population growth have *increased* the imbalance between the distribution of the world's population and wealth.[2] If these rates of population growth continue, the underdeveloped nations will increase their share of the world's population and underdevelopment will spread further.

The concern is not with population growth *per se*, but the inability of the host country to adequately provide for its population. Hence, population growth becomes a major concern only if economic development has not progressed. However, in areas of high levels of economic development and industrialization, the rate of population growth is low. This correlation has led to an interesting inquiry of economic development theorists: does industrialization and economic development result in lower birth rates or

[1] UNESCO Statistical Yearbook, 1973 (Paris: UNESCO Press, 1974), pp.32-33.

[2] Department of Economic and Social Affairs, The Determinants and Consequence of Population Trends: New Summary on Findings on Interaction of Demographic, Economic and Social Factors, (United Nations: New York) 1973, p.529.

Figure 1

THE SPREAD OF UNDERDEVELOPMENT

Year	Percentage of Total Population	
	More Developed Regions	Less Developed Nations
1920	36.2%	63.8
1930	36.7	63.3
1940	35.8	64.2
1950	34.5	65.5
1960	32.1	67.9
1970	30.0	70.0

Source: Department of Economic and Social Affairs, The Determinants and Consequence of Population Trends: New Summary on Findings on Interaction of Demographic, Economic and Social Factors, (United Nations: New York) 1973, p.529.

are decreases in birth rates a necessary pre-requisite for economic development? The current consensus appears to reflect the latter viewpoint: control over birth rates is essential to achieve economic growth and development in the twentieth century. While the prior argument may have explained the population behavior of previous centuries, it does not appear to be valid today.

Economic advancement in developing countries is clearly hampered by the increasing number of people sharing present jobs, facilities, etc.; but unfortunately, initial successes in economic development tend to temporarily retard development. New health programs decrease infant mortality rates and present epidemics; but unless comparable advances are made in agriculture, education, etc., the result is only more mouths to feed on the same quantity produced. Furthermore, economic development increases consumer demands instead of encouraging savings for much needed capital investment and provides a source for social unrest and migration to cities, not yet ready to accept an increased labor force.

The problems of economic development associated with population growth in developing countries are based upon conditions both inherited from the past and created by the process of change itself.[3] However, the central issue for the developing country is the lack of funds for growth investment which is essential to economic advancement.

Dimensions of the Problem:

Impacts of Population Growth on Per Capita Income. GNP growth in underdeveloped countries has not been insignificant. During the 1960's, world GNP growth was in excess of 30%. During the same period of time, GNP growth in the lesser developed nations approached 40% (Figure 2). However, population growth in developing countries outstripped growth in GNP; as GNP growth per capita rose less than 20% in the underdeveloped countries, it approximated 25% in the developed countries.[4] If population and economic growth trends continue, the problem will become worse, as shown in Figure 3.

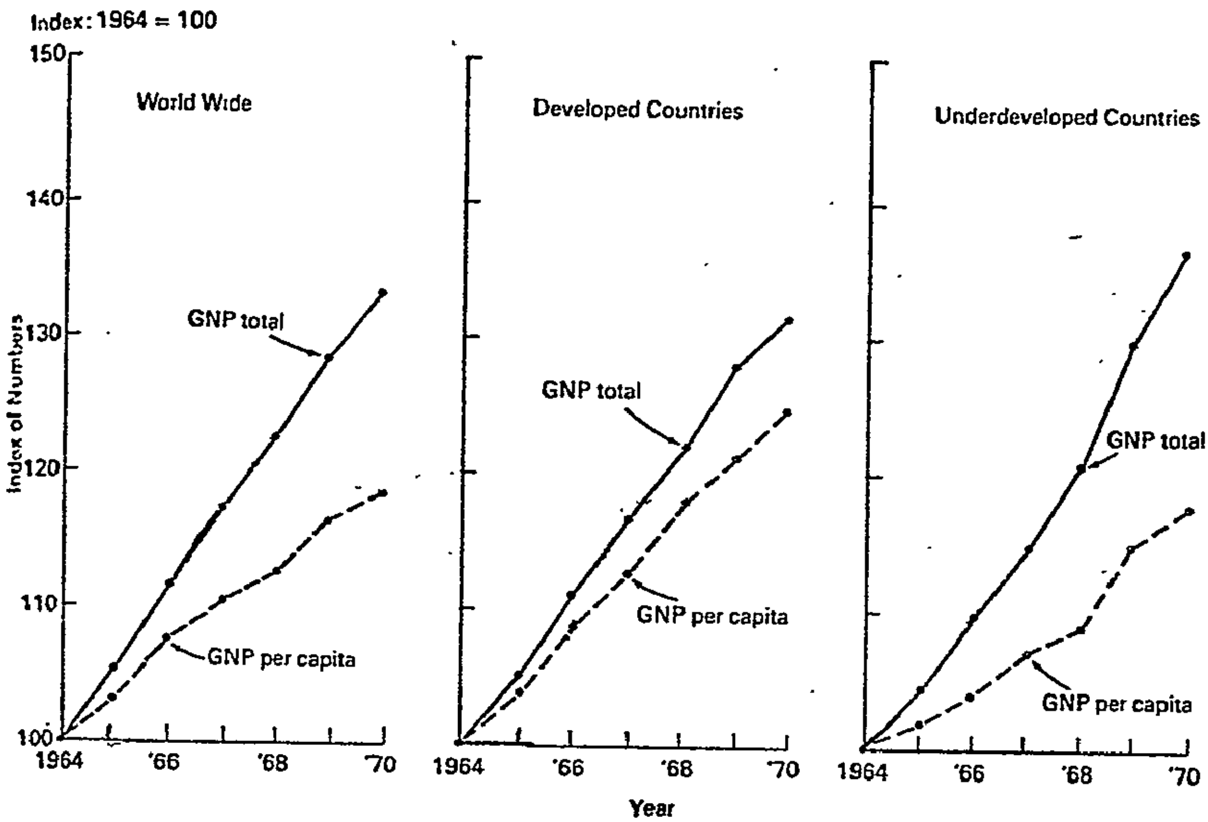
The differences in growth rates become more significant when a comparison is made of the levels of per capita income in the developed nations with the lesser developed nations. In the case of the developed

[3] Irving S. Friedman, "Dilemmas of the Developing Countries: The Sword of Damacles," Finance and Development, Vol. 10, No.1 (March 1973), p.13.

[4] Paul R. Ehrlich and Anne H. Ehrlich, Population, Resources, Environment (San Francisco, Calif.: W. H. Freeman & Co., 1972), p.433.

Figure 2

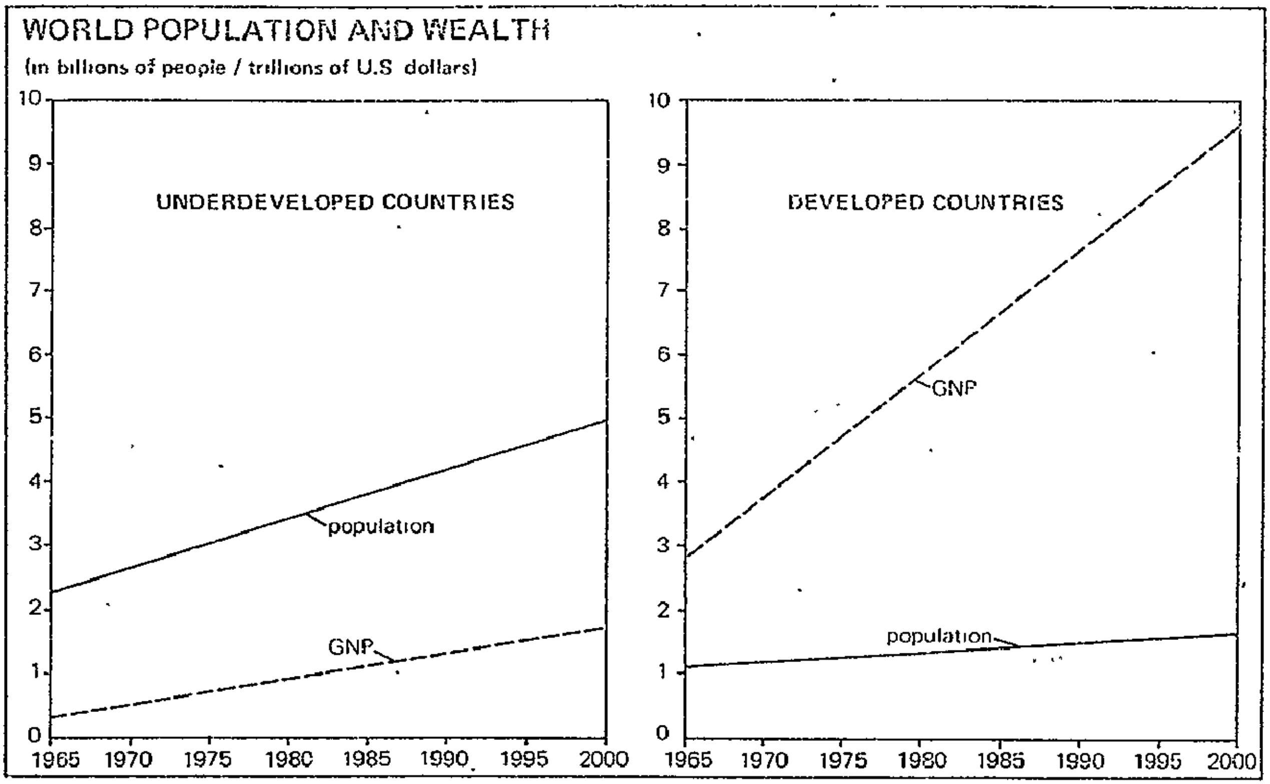
GNP AND GNP PER CAPITA



Source: Paul R. Erhlich, and Anne H. Erhlich, Population, Resources, Environment: Issues in Human Ecology (San Francisco, Calif.: W.H. Freeman & Co., 1972), p. 433.

countries, GNP per capita (current U.S. 1972 dollars) ranges from about $3,000 to almost $6000 per capita, with the United States heading the list. In the lesser developed nations, per capita income ranges to below $100.

Figure 3



Source: John McHale, World Facts and Trends (Collier Books: New York) 1972

Quite clearly, since the developing countries have, in fact, undergone economic growth and development, per capita income would have increased if population growth had been lower. The relationship in recent times between economic growth and population growth is not clear. However, there is no question that in modern times (beginning with the Industrial Revolution of the 18th Century) economic growth has been accompanied by rapid growth in population In fact, it was thought that population growth was *necessary* for economic growth to continue as a source of increasing markets. This position is still advocated by many lesser developed countries as well as by many individuals in this country who are fearful of the implications of our low birth rate. However, a study of the recent data led one study to conclude that the data on population and economic growth implies "either a negative association or the absence of a systematic relationship."[5]

Another student of the problem, Shirley Hartley, concludes that "numerous economists are convinced that a 2 or 3 percent rate of natural increase [in population] is a principal barrier to development. There is evidence that rapid population growth lowers the potential economic development of the less developed nations...." [6] Rapid population growth simply attracts resources away from savings and capital accumulation, profoundly affecting the level of capital investment that is possible, and requires a smaller amount of economic wealth to support a larger and burgeoning population.

Lincoln Gordon notes that in almost all countries where per capita annual income exceeds the $600-800 range, the population increases no more than 1.5 % annually. Under the assumption that lower birth rates are in fact correlated with per capita incomes of $600 or more (a disputed assumption), then countries with average income levels of $100 and annual population growth

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[5] The Determinants and Consequences of Population Trends (op.cit.), p.514.

[6] Shirley Foster Hartley, Population Quantity vs. Quality (Englewood Cliffs, N. J.: Prentice-Hall, 1972).

of 2.5% would have to sustain overall economic growth rates of 5% for more than 72 years before incomes reached the level of lower fertility. Under those conditions, such a country would have a population six times its present size. Gordon states that the chances of maintaining a 5% growth rate under such conditions would be minimal.[7]

Unemployment, Underemployment and Labor Productivity: Unemployment and underemployment are typical characteristics of lesser developed countries. A dominant characteristic of lesser developed countries is the existence of dual economies. The vast majority (70-80%) of the population is involved in labor intensive traditional agriculture characterized by peasant traditions and reliance upon a barter system of exchange. This exists in parallel with the smaller portion of the labor force employed in the westernized and industrialized modern sector. Open unemployment is not a prevalent problem in such economies; rather, pervasive underemployment in the traditional sector is the major problem. Underemployment refers to employment at less than full time and well below full capacity. Characteristically, in conditions of underemployment the number of employees in a given task can be reduced *without* a concomitant reduction in total output. This is typical in the agrarian societies where the family five acre plot can employ almost unlimited and constantly varying numbers of friends and family members without any appreciable change in farm output. Even if this underemployed population were sufficiently skilled, employment opportunities do not exist in the modern sector as shortages of capital for plant and equipment investment constrain the rate at which these sectors can be expanded.[8]

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[7]Lincoln Gordon in Thomas W. Wilson, Jr., World Population and a Global Emergency (Washington, D.C.: Aspen Institute for Humanistic Studies, 1973), p. 53.

[8]Bruce F. Johnston, "Unemployment and Underemployment," in Brown & Hutchings, Eds., Are Our Descendants Doomed? (The Viking Press: New York), 1972.

The rapid growth of the labor force only aggravates the problem as the economy is unable to provide job opportunities for the new entrants. Nor can the economy adequately train an increasing labor force for modern industrial jobs. However, efforts to reduce the rate of population growth will not affect the labor force size for some period of time. A decrease in the birth rate today would not have an effect upon the labor force until those infants entered the labor force, fifteen or twenty years hence.

Impact on Urbanization: One aspect of population growth is its impact on rapid urbanization. As mentioned earlier, the growth of urban areas in the lesser developed countries is accelerated by the total lack of job opportunities in the rural areas. Economic development has not occurred in any country without massive population redistribution and urbanization. While it does give the modern sector, usually located in urban areas, a pool of cheap labor from which to choose, the urbanization process is also likely to cause severe societal disruption. The extended family network and reliance on agricultural underemployment in rural areas at least provided minimum levels of subsistence for the population. No such network or "living off the land" is possible in the city. There is little evidence that any city in a lesser developed country exists that has a sufficient absorptive capacity to accommodate the volume of in-migration.

Consider the impact of the immigration process and population growth merely on the demand for housing. This is a problem which even the United States has been unable to solve. Figure 4 presents an estimation of the level of housing needed in the three less developed continents, Africa, Asia, and Latin America. Meeting this demand is clearly impossible under current capital shortages.

Despite the short term problems of unemployment and the tremendous strains placed upon municipal services, some experts believe that any effort 318

Figure 4

ESTIMATED ANNUAL HOUSING NEEDS
(in millions of dwelling units)

	AFRICA		ASIA		LATIN AMERICA	
	1960	1975	1960	1975	1960	1975
Due to population increase:	0.84	1.50	5.30	9.40	1.10	1.70
To eliminate the deficit or shortage in 30 years:	.73	.73	4.80	4.80	.60	.60
To replace the stock:*	1.03	1.03	7.10	7.10	.90	.90
Total new housing needed:	2.60	3.26	17.20	21.30	2.60	3.20

* Average life of a dwelling unit is assumed to be 30 years in urban and 20 years in rural areas The 1975 figures do not take into account increments of stock between 1960 and 1975.

Source: John McHale, World Facts and Trends (Collier Books: New York) 1972

to retard the urbanization process in lesser developed countries will actually have long term *negative* consequences. It has been noted that "the long-run consequences of retaining people in rural environments are unfortunate. Policies restricting migration may have near-term ameliorative effects, but in time they will become negative. The numerous changes required to bring about the transition to a "developed" status are best made in an urban environment."[9]

In addition, it has been observed that lower fertility is typically associated with urbanization;[10] hence, the migratory process may be an essential part of demographic transition.

Economic Growth and Population Growth: Previously it was noted that the Industrial Revolution and the tremendous increases in wealth and economic growth and development that accompanied it was also accompanied by huge increases in population. It is argued by some economists that a growing population is necessary to sustain an economy through ever increasing demand and capital investment. However, this says nothing about underdeveloped countries where the problem is insatiable demand, lack of capital and total lack of familiarity with modern industrial and managerial procedures. It is also dangerous to use the British and American experience of the eighteenth and nineteenth centuries as an economic development model for completely different cultures in a completely different time. Because of the contingencies of today's economic situation, it is quite clear that by and large unrestrained population growth

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[9] Harley L. Browning, "Migrant Selectivity and the Growth of Large Cities in Developing Societies," in Rapid Population Growth: Consequences and Policy Implications, Volume II: Research Papers, (National Academy of Sciences: Johns Hopkins Press) 1971, p.311.

[10] In Search of Population Policy: Views from the Developing World, (National Academy of Sciences: Washington, D.C.) 1974, p.35.

is a substantial barrier to economic growth. However, there are many parts of the world that do not agree with the need to control population growth; and, in fact, feel threatened by the concept. Because population densities are not uniformly high by any means, many African and Latin American nations use their low population densities as evidence that they need not limit their population growth. Of course, large portions of both of these continents are not suitable for habitation.

During a recent conference on population growth, it was quite evident that the representatives of the Latin American countries did not perceive that they were hampered by population growth. Population size was not viewed as a problem but distribution of the population is a problem. "Almost all the participants viewed population questions as integral, but subsidiary, to economic and social development... In many Latin American countries a larger population would help development, because it would provide larger markets for locally manufactured goods and make possible a more effective exploitation of natural resources, including land, water, energy, forests, and minerals... With the possible exception of rapid urbanization, the macro-economic effects of population changes including population growth on development are fairly small."[11]

Capital Formation: Clearly, one of the fundamental problems facing a lesser developed country is the problem of capital accumulation so that current consumption can be postponed to free capital for essential investment in infrastructure (i.e., communication and transportation networks, municipal services, etc.)

[11] In Search of Population Policy: Views from the Developing World, op.cit. p.43.

and basic industries (energy, steel, extractive, industrial machinery and heavy durables). It is essential to divert scarce capital for plant and equipment from non-essentials such as luxury goods, small appliances, consumer durables, and so forth.

The primary source of capital for investment purposes is savings; that is, those resources which could be allocated to current consumption but are not and hence, are "freed" for other purposes. Investment, then, is the allocation of these resources to productive purposes. Traditional economic theory asserts that savings must equal investment; therefore, investment capital cannot exceed the level of savings available (recognizing that firms as well as individuals may have savings). While this equality ignores capital that is available from gifts, loans, and foreign investments, developed nations by and large rely on the savings of its people for investment purposes; and it is argued that lesser developed nations must rely on foreign sources for start-up capital.

Quite clearly, one can see that high fertility contributes, all other things being equal, to reduced per capita income. While these rapid rates of population growth will increase the size of households and their demand for goods and services, it is unlikely that the number of wage earners will be increased. In fact, the large number of children *reduce* the number of family members that are available for employment because of child care necessities. Hence, while the size of the family unit increases, the income does not. Savings, for the purposes of this discussion, may be defined as the excess of income over consumption. Quite clearly, then, rapid population growth, especially in poorer countries, dramatically reduces savings.

Within the lesser developed countries wealth is especially inequitably allocated and only the wealthy can "afford" the luxury of savings. While a variety of incentives exist to manipulate the level of consupmtion to increase the savings available for investment, the value of these incentives is, of course, related to the level of income. Per capita incomes in the range of several hundred dollars clearly is not adequate foundation for capital formation, whatever the incentives are. Therefore, in these countries the most realistic strategy is to minimize consumption (not so much to encourage savings but to control demand) and to rely on industry and the wealthy elite for the domestic capital sources.

Capital, of course, can also come from gifts, loans, and foreign investment. Historically, unconditional grants of money from one nation to another have been rare; and Israel is the only modern day example of such largesse.

Most often foreign assistance is in the form of foreign aid and this is often tied to certain purchasing requirements. Of course, such foreign aid is often granted more on the basis of political and military considerations than the economic development requirements of the recipient nation.

Foreign aid as a percentage of GNP has been decreasing in all the major non-Soviet nations except for Sweden (see Figure 5-). During this period there has been some increase in absolute levels of foreign aid but clearly this has not been increasing concurrently with the rates of economic growth experienced by the developed nations or with the worldwide inflationary trends.

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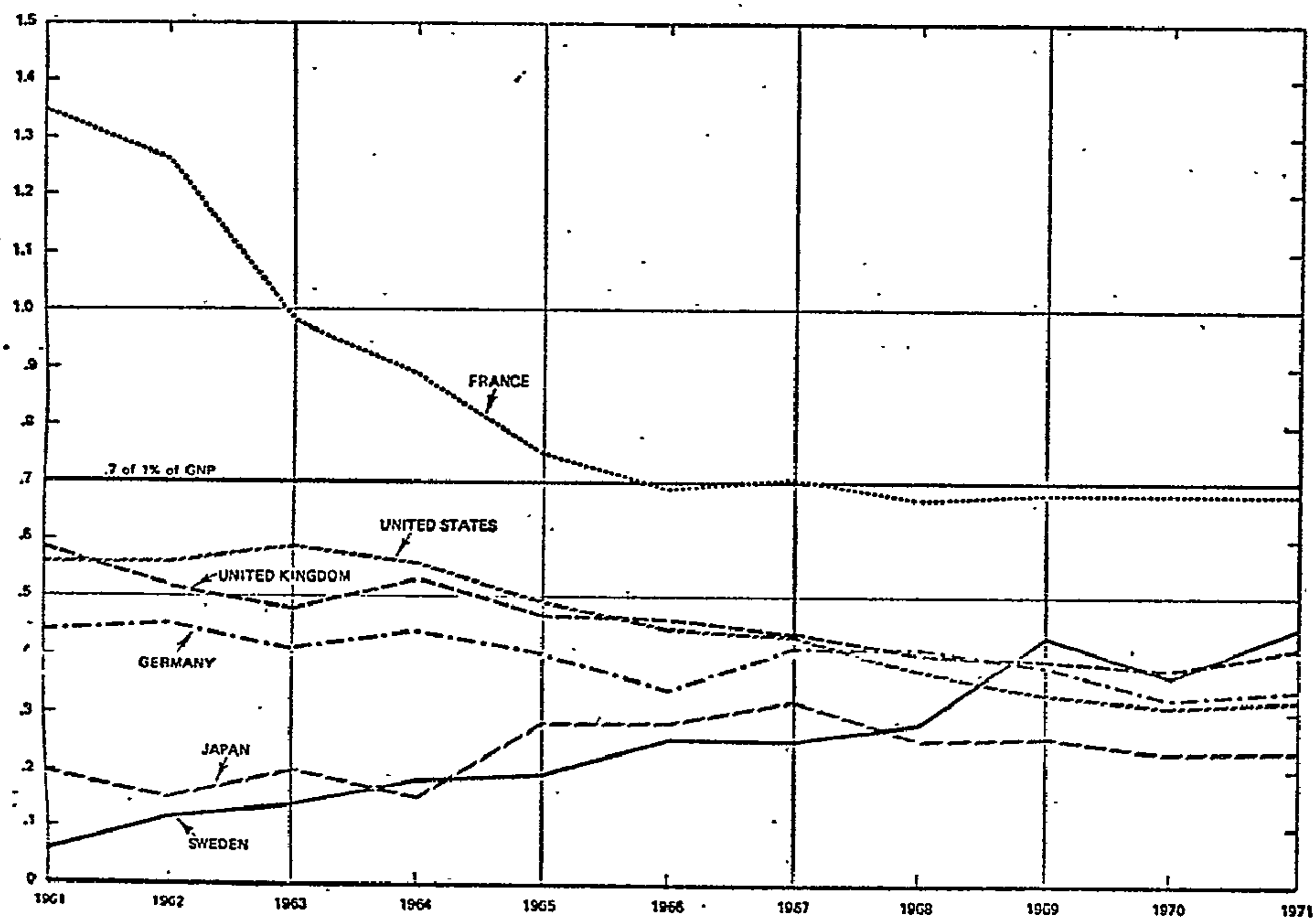
Figure 5

NET FLOW OF OFFICIAL DEVELOPMENT ASSISTANCE FROM SELECTED DAC COUNTRIES TO DEVELOPING COUNTRIES AND MULTILATERAL AGENCIES AS A PERCENTAGE OF GROSS NATIONAL PRODUCT, 1961-1971



SOURCE: Trends in Developing Countries, (Washington, D.C.: The World Bank, 1973), Chart 4.4.

*"DAC" stands for Development Assistance Committee of the Organization for Economic Co-operation and Development (OECD); the 16 DAC countries are Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Sweden, Switzerland, the United Kingdom, and the United States.

A recent source of capital for the lesser developed countries is the growing concentration of petro-dollars in the petroleum exporting countries. Venezuela has already offered to make available some of its petro-receipts to its Latin American neighbors. However, a severe problem with relying on loans for capital investment is the tremendous burden of debt servicing upon the economy.

Finally, foreign investment, usually by private industry, is a basic capital source and probably considerably more significant than the largesse of governments. U.S. firms had over $25 billion in direct investments in lesser developed countries in 1972, about the about the same total level of investment as the U.S. has in Canada. The bulk (about one third) of the foreign investment in the lesser developed countries was in the petroleum industry.[12] There is no doubt that this level of investment will increase as the developed nations try to ensure material and energy supplies as well as guarantee markets for products which were domestically produced and have saturated their domestic markets. Through foreign production (to minimize costs), foreign markets may be exploited. Quite clearly, these investment decisions are made on the basis of expected returns for the investing firm, yet they can be equally advantageous to the receiving country. Increasing fears of exploitation by the lesser developed countries and increasing fears of nationalization or expropriation by the host country have changed the picture of foreign investment somewhat. However, there is no doubt that the rate of foreign investment by the developed countries will increase.

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[12] U.S. Bureau of the Census, Statistical Abstract of the United States: 1974 (95th edition) (Washington, D.C.), p. 781.

The role of the multinational firm in international capital flows cannot be underestimated. The multinational firm truly views the world as its marketplace irrespective of political boundaries and it can participate in capital markets essentially outside of central banking authority. The multinational firm is likely to be the most dominant force upon the economic development of the lesser developed countries in the next several decades.

One economic development specialist, Professor Albert Hirschman, suggests that foreign capital is absolutely essential "to enable and to embolden a country to set out on the path of unbalanced growth."[13] This theory of development argues *against* balanced growth, on the grounds that unbalanced growth, because of its inherently unstable nature, continually provides incentives for sectors of the economy to "catch up" and growth continues to occur. Foreign capital, Hirschman argues, has more freedom, is less inhibited in its investment decisions and can avoid parochial investment areas. Foreign capital also can replace the "scatter" approach of domestic investment with concentration.

As important and fundamental as capital is to economic development, the role of entrepreneurial capability is probably more important. Hirschman notes that "among the proximate causes of economic development, the supply of entrepreneurial and managerial abilities now occupies in official documents a position of preeminence at least equal to that of capital."[14]

Of course, it is quite clear that those nations most requiring capital investment are those which least have the domestic resources and are least attractive to foreign investment.

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[13] Albert O. Hirschman, The Strategy of Economic Development (Yale University Press: New Haven) 1958, p.205.

[14] Hirschman, op.cit., p.1.

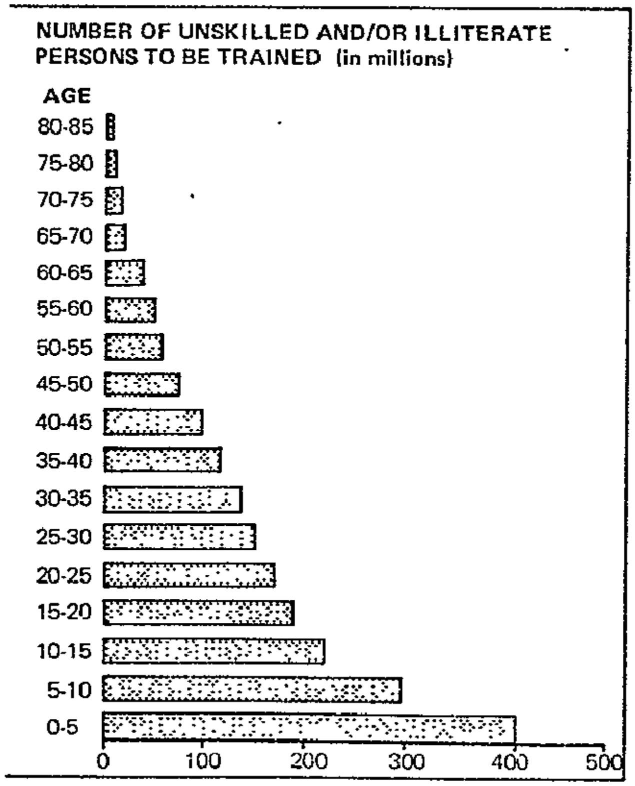
Impact of Population Growth Upon Social Overhead Capital: As the discussion has indicated, a fundamental step in the economic development process is to reduce consumer demand for goods and services to "free" capital. Unfortunately, population growth, especially when combined with increasing urbanization, renders this increasingly difficult to accomplish.

Rising population growth puts phenomenal strain on the education, health, communication, transportation, public water and sewage systems, utilities -- all of which are already underdeveloped, badly managed, poorly maintained and randomly located. Especially hard hit is the education structure. Education, both in the sense of academic training and acclimation to modern methods and culture, is an essential part of economic development. Yet most lesser developed countries have high rates of adult illiteracy, a shortage of teachers, and lack of educational plant equipment. UNESCO has estimated that more than 40% of the global adult population cannot read or write (see Figure 6). The cost of educating this population which, of course, is ever increasing would be overwhelming. The lack of higher education facilities induces the educated elite to leave the country for higher education.

Capital diverted from productive purposes for any sort of social overhead structure, while necessary, will merely aggravate the short run economic development problems.

Potential Actions: While the causal relationship between population growth and economic development is not precisely understood, it is quite obvious that effective population policy is necessary if the lesser developed countries are to have any chance of success at economic development.

Figure 6



Source: John McHale, <u>World Facts and Trends</u> (Collier Books: New York) 1972

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Population policy reduces to only two approaches: (1) reducing population growth by reducing fertility or (2) accommodating and adapting to and providing for the existing population. The essential and most efficacious method is to drastically lower the birth rate.

Unfortunately, many of the social welfare programs that an underdeveloped country is likely to immediately implement for humanitarian purposes can aggravate the population problem in the short-run however socially advantageous their effects may be. For instance, any public health programs which significantly reduce infant mortality and increase life expectancy without concomitant reduction in birth rates will accelerate population growth and contribute to starvation, all other things being equal.

Alternative ways of reducing fertility are discussed in another chapter, and any policy chosen will be a function of the unique social and cultural pattern of that country.

One of the contributing social problems to both population growth and lack of economic development is the social barriers in the education and employment of women. The educational infrastructure of the lesser developed countries is inadequate and contributes to the problems of the labor force. Population pressures, of course, exacerbate this difficulty. Education has a particularly important role in economic development and provides three functions. First, it generates the skills that a developing modern economy requires. One of the historical problems of developing countries has been the lack of administrative, bureaucratic, managerial, and technical skills. Hence, government officials have discovered that mere construction of basic industries -- electric power plants, for instance -- is not sufficient if the necessary manpower to manage and maintain them is lacking. However, "overtraining" of the domestic labor force should be discouraged as well. A large group of professionally, rather than technically, trained personnel are unlikely to find alternative employment opportunities in their native land and will seek careers elsewhere, drawing away some of the potentially most valuable members of the labor force.

A second function that education provides is its impact on birth rates. Low fertility is correlated with educational achievement. Sri Lanka has the lowest fertility rate in South Asia, as well as the highest (82%) rate of literacy. Even if education *per se* does not immediately reduce the birth rate, universal literacy will make any public education and information program more successful.

A third function that education plays is to keep people out of the labor force. As previously discussed, one of the problems of lesser developed countries is unemployment and underemployment. The longer that the burgeoning population can be kept out of the labor force, the more time the economy has to generate employment opportunities for the population.

Finally, education for women is especially necessary if they are to become productive members of the labor force. Those countries which have made effective use of their female population have made the greatest strides (witness Israel and Japan).

To improve the quality of its labor force, a developing country can:

1. Emphasize basic technical training, including vocational instruction in primary and secondary schools and on-the-job training in such fields as agriculture, commerce, industry and construction.

2. Develop middle level skills such as and including draftsmen and technicians.

3. Utilize foreign experts, especially to offset "the brain drain."

One roadblock is the lack of teachers. During the 1960's, Iran established a "literacy corps" which encouraged men of military age to serve as teachers in rural areas instead of undertaking conventional military service. The country also introduced short-term teacher training programs and employed a large number of high school and university graduates.

One of the characteristics of an underdeveloped country is the existence of a dual economy: a large traditional agrarian economy functioning in parallel to a smaller modern sector. It is essential that agricultural productivity improve to permit capital accumulation and to free members of the agrarian society for industrial employment. Because the "Green Revolution" requires substantial technical backup, its benefits can often not be adequately realized because it is as technologically sophisticated as industrialization. A first step often advocated to the modernization of agriculture is the introduction of the tractor. Even this is likely to be unsuccessful without adequate maintenance, repair and fuel facilities. An intermediate step (which the Soviets have successfully implemented in their aid programs) is the introduction of advanced horse drawn equipment. The substitution of horse for human power would dramatically increase productivity and would be an important step in the industrialization of agriculture.

In sum, any economic or social development plan must incorporate population growth policies if there is to be any chance of economic success.

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CONTINUED URBANIZATION OF THE UNITED STATES IS CAUSING THE DETERIORATION OF THE CENTRAL CITY: COSTLY SUBURBAN DEVELOPMENTS: AND INCREASES IN CONGESTION, POPULATION, CRIME, VIOLENCE AND ALIENATION

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The Issue:

The Current Urban Dilemma: The rise of modern cities is associated with economic advantages such as the following:

- economies of scale that would accrue through high density and specialization, such as the development of a financial infrastructure and marketplace;
- economies of scale so substantial that without attainment of a minimum market size a given service would not be implemented, such as a communications network or utilities network;
- locational advantages necessary for a given endeavor such as water transportation, raw material supplies, access to a market.

One theory[1] of urban growth is based on the concept of the city as a center for human interaction and offers the notion that cities grew and developed because of the opportunities for face-to-face transactions. However, technological advances in communication decreased the necessity of face-to-face contact, and urban problems such as traffic congestion are encouraging costly suburban growth and deterioration of the older central city. The dilemma which the U.S. now faces is two-fold: central cities of extremely high density do cause increases in pollution, crime, alienation and bankrupt local governments but the "urban sprawl" outward to the fringes of metropolitan areas often causes a new set of economic and environmental problems. Furthermore, urbanization is such an important part of modernization

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[1] Richard L. Meier, A Communications Theory of Urban Growth (MIT Press: Cambridge) 1962.

that some development theorists believe that any efforts to retard the growth and spread of urbanization will, in fact, retard the growth and spread of economic development. Many of the characteristics deemed requisite for modern industrialization such as lower fertility rates, maintenance of a bureaucracy, establishment of a political infrastructure and a money based economy are correlated with the historical development of cities.

The Origin of Cities: Archaeological evidence from studies of the earliest Mesopotamian cities indicate that the origin of cities may have been a *social* process reflecting more of a change in man's interaction with man than man's interaction with his environment. While the development of cities rested ultimately on agricultural advances that made it possible for farmers to produce more than they required and to make this surplus available to city dwellers engaged in other activities, the essential element of urbanization was a whole series of new institutions and the vastly greater size and complexity of the social unit, rather than innovations in basic subsistence.[2]

The first cities appeared in Mesopotamia at about 3500 B.C. (see Figure 1).[3] The origin of cities was a profound social and cultural process and reflects a first step of the modernization process: the shift from nomadism, hunting and gathering to settled agriculture. Cities provided a mechanism for meeting some of the basic needs that were generated by the introduction of modern agriculture: defense, early manufacturing and processing ("cottage industry"), commerce, recreation, political and religious centers.[4]

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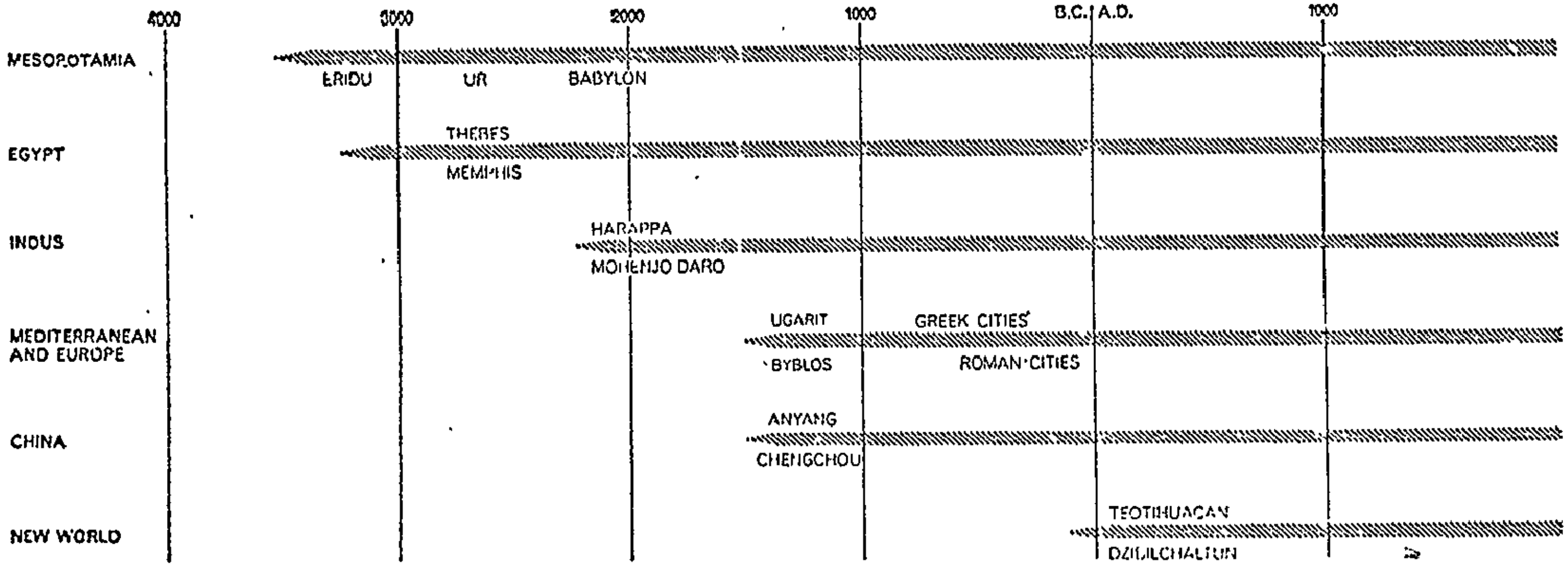
[2] Robert M. Adams, "The Origins of Cities," Scientific American (September 1960), pp.156-168.

[3] Gideon Sjoberg, "The Origin and Evolution of Cities," in Cities by Scientific American (New York: Alfred A. Knopf, 1967), p.29.

[4] Ralph Thomlinson, Population Dynamics: Causes and Consequences of World Demographic Change (Random House: New York) 1965, p.271.

FIGURE 1

THE ORIGIN OF CITIES



SEQUENCE of urban evolution begins with the first cities of Mesopotamia, makes its next appearance in the Nile Valley, then extends to the Indus, to the eastern Mediterranean region and at last to China. In each area, the independently urbanized New World included, cities rose and fell but urban life, once established, never wholly disappeared.

SOURCE: GIDEON SJOBERG, "THE ORIGIN AND EVOLUTION OF CITIES", IN CITIES BY SCIENTIFIC AMERICAN (NEW YORK: ALFRED A KNOPF, 1967), P. 29.

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While economic development was made possible by the cultural and social changes that resulted from urbanization, immediate economic change was *not* the central characteristic of the earliest cities, rather this was a result of another trend. The first trend that is apparent from the archaeological record is the rise of temples. It has been suggested that as new patterns of thought and social organization developed within the temples, the religious institution served as the primary force in bring people together and setting the modernization process in motion.[5] Priests were the first persons freed from direct subsistence labor and the first to develop administrative and bureaucratic skills.

It is further evident from Mesopotamian archaeological evidence that contrary to modern thinking, technological advance was (in this case the development of metallurgy) *not* a precondition or even a stimulant for urban growth, but rather a *consequence* of city growth, which in turn contributed to the growth of militarism and social stratification.[6]

The modifications and changes in the social order and the development of new skills that occurred with the rise of early cities made possible the industrialization, economic development and the rise of a modern economy. Among these fundamental changes were:

1. The increase in occupational specialization.
2. The release of a few persons from direct subsistence labor and their emergence as a priesthood and religious infrastructure.
3. The transformation of traditional religious activities related to fertility, rainfall and the streams into the administration of the water supply (the introduction of irrigation made possible the production of an agricultural surplus) and the management of lands and herds.

[5] Adams, op.cit.
[6] Ibid.

4. The emergence of a political leadership and organization of the work force.

5. The increased differentiation of rewards for diversified tasks.

6. The development of a defense force to protect the food supply and guarantee the security of the city.

7. The development of a marketplace for the exchange of goods.

8. The development of regional specialization (while this did not occur until the rise of medieval cities, it was a precondition to the modern city).

9. The gradual collapse of a feudal class structure and the rise of a middle class bourgeoisie contributed to the evolution to modern cities.[7]

These fundamental institutional and social changes (characterized by increasing complexity and specialization through the division of labor, development of an economic surplus, and the rise in administrative skills) made economic innovation and industrialization possible. The development of cities and the creation of an economic surplus encouraged the rise of trade. Historically, trade has served as a tremendous channel for the transfer and dissemination of knowledge and innovation and provides a strong impetus to economic development.

While much of the discussion which follows will stress the "problems" of present urbanization, it is important to note the historical role of cities in the current standard of living that the nation enjoys. The proliferation of cities and widespread urbanization made possible the Industrial Revolution and economic development and the high standard of living that the developed world enjoys.

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[7]Adapted from Thomlinson, op.cit. and Leonard Broom and Philip Selznick, "Urban Man," in Sociology (Harper & Row: New York) 1955.

Dimensions of the Problem:

The Evolution and Growth of American Cities: The first census of the United States, taken in 1790, showed that 95% of the population resided in rural areas (defined as less than 2500 persons). At that time, only 24 urban sites existed, and only 2 had populations in excess of 25,000 people.[8] By 1900, the number of urban areas had increased to more than 1700 and by 1970, the number had risen to almost 7100. While some of this urban growth was due to naturally occurring population growth, much of it was the result of large shifts in population from the agricultural and rural areas to the cities, as well as the hugh influx of foreign immigration to this country prior to World War I. As Figure 4 shows, at the turn of the century during the fastest growth period of the East Coast "old cities," a substantial portion of the American population was of foreign origin. While Figure 2 does not indicate the degree to which this population was urban, the vast majority of the immigrants at least originally settled in the East Coast cities. In fact, from 1900 to 1914, the population of the United States increased by about 24 million people; and almost 50 percent of this increase stemmed from immigration.[9]

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8 Philip M. Hauser, "Urbanization: Problems of High Density Living," Paper prepared for Conference on World Population Problems, School of Business and the International Affairs Center, Indiana University, May 1967.

9 U.S. Bureau of the Census, Historical Statistics of the United States, Colonial Times to 1957 (Washington, D.C.: U.S. Government Printing Office), p.56.

FIGURE 2

NATIVITY OF THE WHITE POPULATION
FOR THE UNITED STATES: 1850 TO 1960

Year	Population (in millions)	Nativity (percent)		
		Foreign born	Native	
			Foreign or mixed parentage	Native parentage
1960	159	5.8	15.0	79.2
1950	134	7.5	17.5	75.0
1940	119	9.6	19.5	70.9
1930	110	12.7	23.5	63.8
1920	95	14.5	23.9	61.6
1910	82	16.3	23.1	60.5
1900	67	15.3	23.4	61.3
1890	55	16.6	20.9	62.6
1880	43	15.1	19.1	65.6
1870	34	16.4	15.9	67.8
1860	27	15.2	84.8	
1850	20	11.5	88.5	

Source: Richard Irwin and Robert Warren, "Demographic Aspects of American Immigration, in Charles F. Westoff and Robert Parke, Jr.,(Eds.), Demographic and Social Aspects of Population Growth, Vol. 1, The Commission on Population Growth and the American Future (Washington, D.C.: GPO) 1972, p.169.

The contribution of the rural population shift was substantial as well. At the beginning of the 20th century, about 40% of the American population resided in urban areas. In 1920 the country crossed the threshold from a rural to an urban population, and by 1970 almost 74% of the population was living in urban areas.[10]

[10] Irene B. Taeuber, "The Changing Distribution of the Population of the United States in the Twentieth Century," in Sara Mills Mazie (ed.) Population, Distribution and Policy, Vol.5, The Commission on Population Growth and the American Future (Washington, D.C.: U.S. Government Printing Office, 1972).

Viewed another way, almost the entire gain in the U.S. population during the 1960's (almost 24 million persons) took place in metropolitan areas and occurred in those areas with populations greater than 100,000.[11] As Figure 3 shows, the fastest growing cities proportionately have been the moderate sized cities, while the largest cities have declined proportionally.

Of course, it is extremely important to differentiate between population growth in a metropolitan area and growth in the center city. Since World War II the predominant growth has been in the suburban outer ring areas, while the central city has often actually *lost* population. Figure 4 shows the regional growth in the New York Metropolitan Area since 1900. The figure indicates that the center city population was stable during the decade of the fifties. Later data indicates that the population of the center city of New York, as contrasted to the metropolitan area, declined 5.6% by 1970 from its level in 1960.[12]

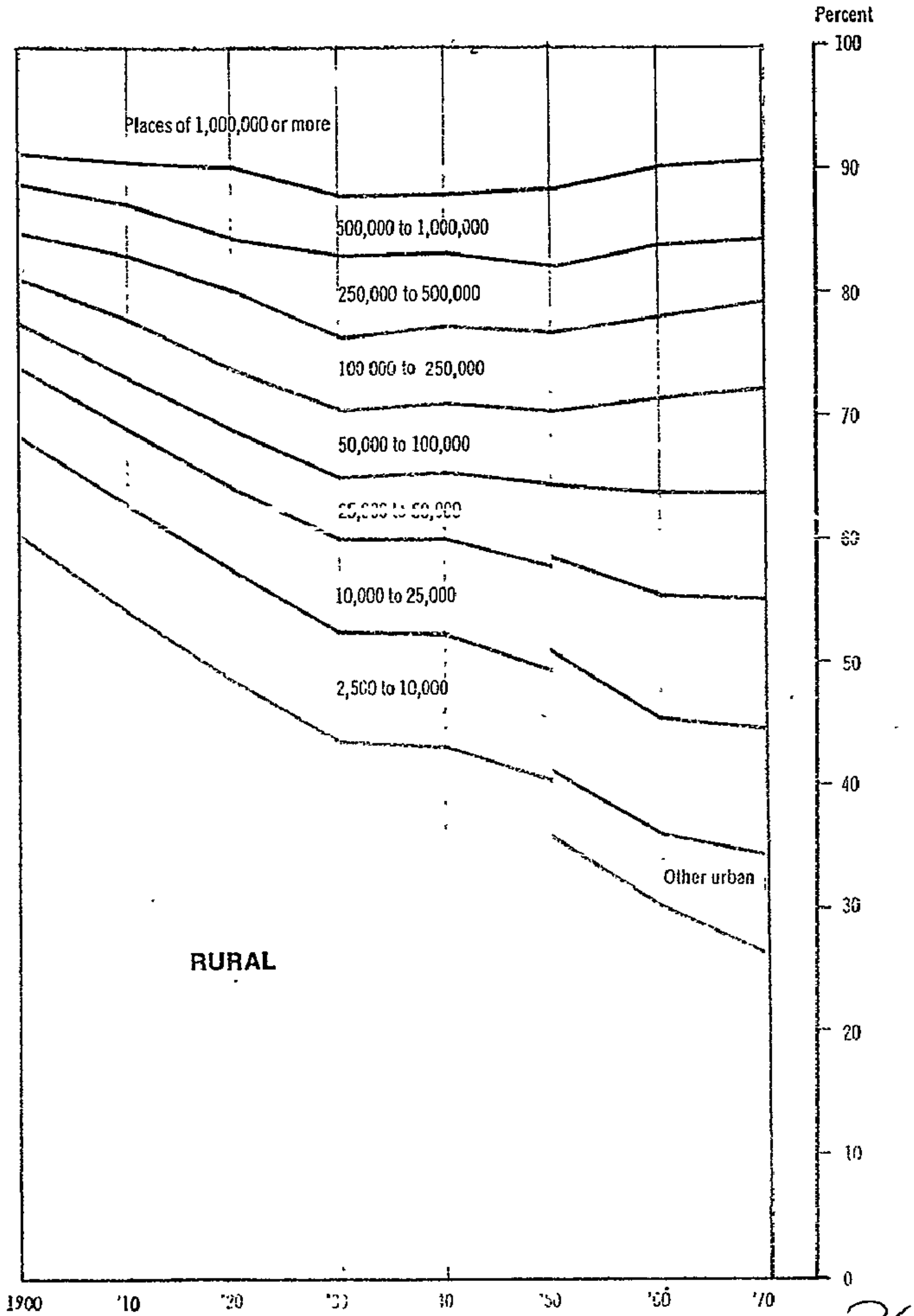
This behavior is typical of most older cities. Resident population of the older center cities is declining, especially among the middle income groups. However, the demand for services in the city is continuing unabated as the older city's plant becomes obsolete and poorly maintained; the demand for services by the remaining population (which is dominated by lower income groups) increases even on a per capita basis; and the demand for services by the labor force, employers and industries increases. This loss of the

[11]James L. Sundquist, "Europe Stops the Urban Swarm," The Brookings Bulletin (Vol. 12, No. 1, Winter 1974), p.7.

[12]Statistical Abstract of the United States, op. cit.

FIGURE 3

POPULATION BY SIZE OF PLACE



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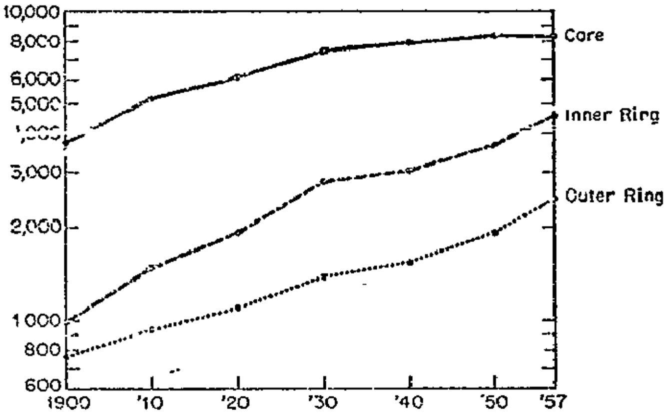
Source: Office of Management and Budget, Social Indicators 1973 (Washington, D.C.: GPO) p.242.

FIGURE 4

POPULATION GROWTH IN NEW YORK METROPOLITAN REGION, 1900-1957



Source: Raymond Vernon, Metropolis 1985: An Interpretation of the New York Metropolitan Region Study, (Harvard University Press) 1960, p.22.

upwardly mobile middle class, and with them their tax revenue, partly accounts for the precarious financial position of most cities.

The differential growth rates within a metropolitan area results in a somewhat confusing data base. For instance, population density figures are not likely to reflect accurately the population patterns as an extremely dense central city can be surrounded by suburban developments that are zoned for anywhere up to five acre residential lots.

While high population density was periodically found in the ancient cities, by and large ancient cities were small. It has been estimated that hardly more than a few ancient Greek city states ever had more than 10,000 citizens or a free population beyond 40,000.[13] The huge (greater than one million) cities of high population density are a fairly recent phenomenon. However, a few historical cities have rivaled the current population density. It has been estimated that Ur in Mesopotamia had a density of about 125,000 persons per square mile (out of a total population of 500,000) by the year 200 B.C., and the population density of the center of Paris may have reached 142,000 per square mile in 1329.[14]

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[13] Richard F. Wycherly, How the Greeks Built Cities, (MacMillan: London) 1962, p.14.

[14] Thomlinson, op.cit.

American cities generally do not exceed a population density of about 17,000 persons per square mile; excepting, of course, New York City with a population density approaching 28,000 (see Figure 5). Manhattan Island itself has a population density of almost 70,000 persons per square mile.[15] The highest population density in the U.S. (and, in fact, in the Western world) was 350,000 per square mile, reportedly in the poorest districts of the Lower East Side of New York around 1900.[16] Hong Kong, of course, has the world's highest population density, estimated to be 800,000 persons per square mile.[17]

Despite these massive numbers, to a large degree population densities are limited by technology. While high-rise apartment dwellings and underground habitats increase the carrying capacity of an acre of land, the diseconomies associated with it (congestion, pollution, etc.) are likely to limit the feasible population density, at least in a wealthy country with high consumer expectations such as the United States.

Transportation and communications technology have permitted cities to "sprawl" in land mass. Lewis Mumford noted that "early cities did not grow beyond walking distance.[18] As means of communication and transportation have improved, areas of high density living have expanded in size. Such developments have contributed to the growth of the suburban ring at the expense of center city locations (see Figure 6). The speculation in land and real estate has escalated the land costs in the center city, and the reliance upon property tax financing of a growing urban debt has further

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[15] U.S. Bureau of the Census, Statistical Abstract of the United States 1974, 95th Edition (Washington, D.C.: 1974), p.25.

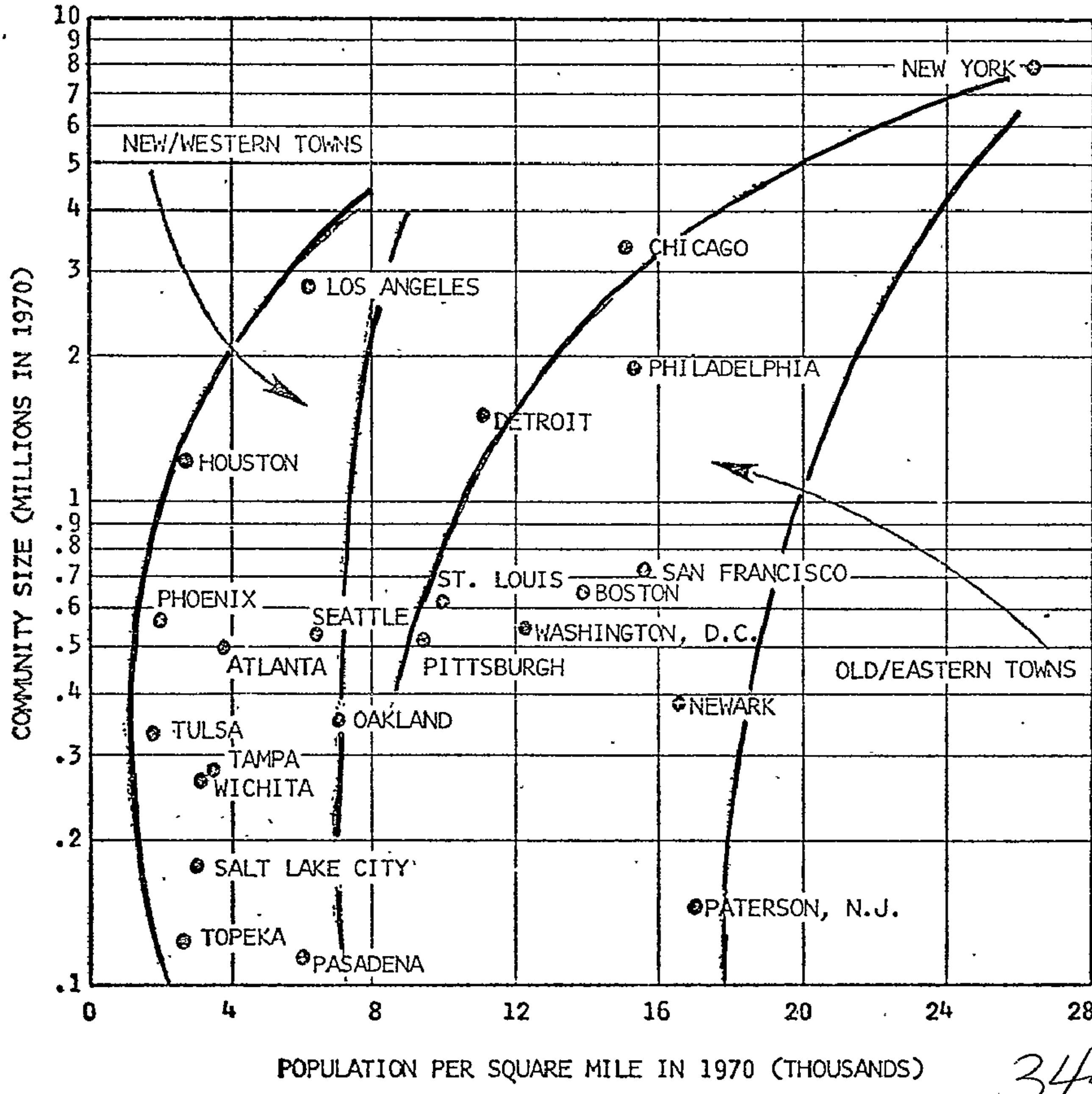
[16] Thomlinson, op.cit., p.272.

[17] Ibid.

[18] Hauser, op.cit., p.

FIGURE 5

POPULATION DENSITY AS A FUNCTION OF CITY SIZE



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SOURCE: U.S. BUREAU OF THE CENSUS, STATISTICAL ABSTRACT OF THE UNITED STATES, 1973, 94TH EDITION (WASHINGTON, D.C., 1973), P. 23-24.

FIGURE 6

Decade	Central Cities	Suburbs
	Percentage of Total Metropolitan Area Population Growth in Central Cities and Suburbs*	
1900-1910	72.1%	27.9%
1910-1920	71.6%	28.4%
1920-1930	59.3%	40.7%
1930-1940	40.8%	59.2%
1940-1950	40.7%	59.3%
1950-1960	23.8%	76.2%
1960-1970	16.0%	84.0%

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*Anthony Downs, Opening Up the Suburbs (New Haven: Yale University Press, 1973), p. 199. The central city and suburbs are divided out of the Census Bureau's Standard Metropolitan Statistical Area (SMSA). 212 SMSA's were identified from 1920-1960; 230 areas from 1960-1970. The table appears in the statement by Anthony Downs before the Subcommittee on Economic Developments of the Committee of Public Works, House of Representatives, 93rd Congress, 1st Session, November 1, 1973.

aggravated the economics of center city business. Hence, the suburbs have been growing at the expense of the center city. The noted transportation economist, Anthony Downs, observes that (a) most new jobs are now being created in suburbs, (b) central cities have far less usable land available for development than suburbs, and (c) locating new housing and other urban facilities on vacant land at the periphery of built-up areas tends to be much less expensive and less difficult that locating such new construction in older areas that have to be redeveloped.[19]

However, there is some evidence of countervailing trends. Continuation of "urban sprawl" development patterns result in substantial environmental and economic costs. Contrary to some expectations, low density developments may actually be more harmful to the environment than higher density complexes. A recent study supported by the Council on Environmental Quality, The Cost of Urban Sprawl, investigated the comparative cost of low, medium and high density communities. They concluded that low density urban sprawl communities traditionally made up of single family homes on quarter acre lots that "leap frog" the suburban area consumed more than twice as much land as the high density communities.[20] Low density communities also contribute to land abuse by increasing the proportion of land allocated to vacant-improved and semi-improved uses -- at best, an inefficient use of land, at worst, a waste of land. Because this land is

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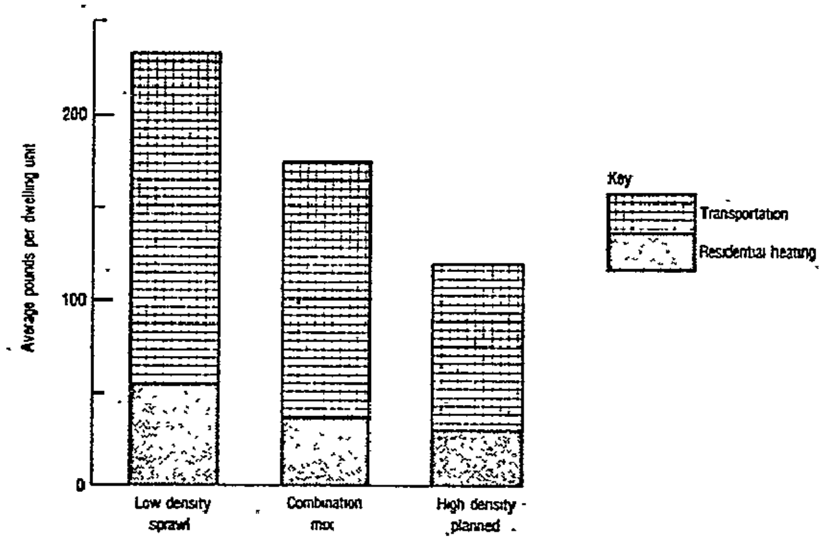
[19] Anthony A. Downs, Opening Up the Suburbs (New Haven, Conn.: Yale University Press, 1973), p.199; and Anthony A. Downs, Testimony before Hearings of the Subcommittee on Economic Development of the Committee on Public Works, House of Representatives, November-December 1973, pp.27 and 28.

[20] Real Estate Research Corporation, The Costs of Sprawl: Executive Summary (Washington, D.C.: U. S. Government Printing Office, 1974).

scattered between housing units, housing development and community developments, it is essentially unusable. In addition, low density urban sprawl development actually *increases* air pollution because of the increased requirements for automobiles and residential heating. The Costs of Urban Sprawl determined that high density planned communities generated about 45% *less* air pollution than the low density sprawl community (assuming the same population) as shown in Figure 7. The simple shift of housing density alone could result in reduction of air pollution from automobiles from 20 to 30 percent.[21]

FIGURE 7

COMMUNITY COST ANALYSIS ANNUAL AIR POLLUTION EMISSIONS



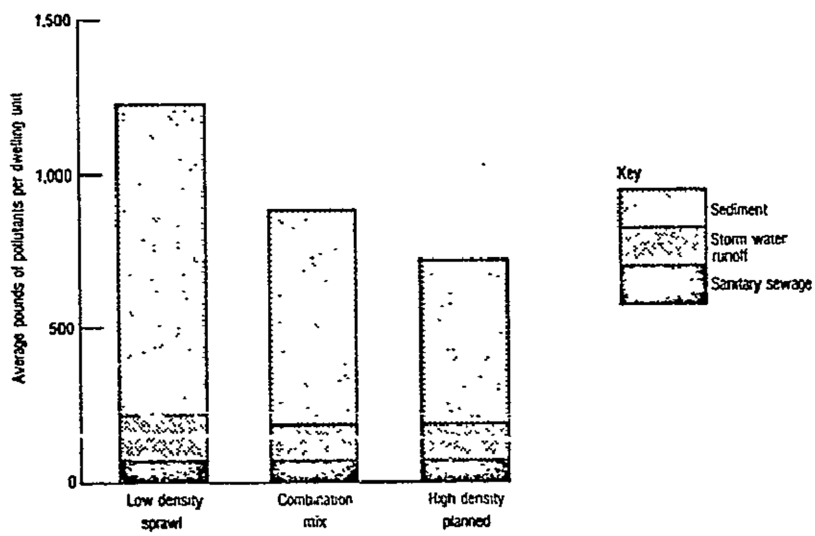
Source: The Costs of Sprawl: Executive Summary, p.4.

[21]Ibid.

Water pollution problems also vary with the kind of urban development that is permitted. The Costs of Urban Sprawl analyzed the types of water pollution problems that are generated by alternative housing and density communities. Figure 8 indicates that low density areas actually contribute higher levels of water pollution than high density areas (again, assuming the same population levels). This somewhat counterintuitive result is largely the result of increased sediment pollution which occurs when large amounts of land are disturbed.

FIGURE 8

COMMUNITY COST ANALYSIS ANNUAL WATER POLLUTION GENERATION



Source: The Costs of Sprawl: Executive Summary, p.5.

Such environmental costs suggest that urban sprawl cannot be allowed to continue. In addition, single family housing, the most expensive method of housing the nation's population, is extremely wasteful of materials, does not permit economies of scale (such as through shared heating, air conditioning, sanitation, water, utility systems) and is not easily amenable to industrialized housing technologies. The recognition that this urban sprawl is inherently inefficient is leading to a host of "no growth" legislation in suburban communities. While many of these are slowly being rejected as unconstitutional, it does reflect a growing demand to limit growth. Fairfax County, Virginia, a suburb of Washington,D.C., is attempting to regulate its growth through regulation of the sewer system.

The growing costs of energy is another trend that may inhibit the growth of the surrounding suburbs. The costs of commuting, and the potential insecurity of gasoline supplies, may result in shifting the comparative advantage to the central city. The savings that once accrued through lower land prices and lower taxes are now being erased by increasing energy costs and equalization of property tax structures.

<u>The Problems of the City</u>: While the economies of scale; the easy exchange of goods, information, and labor and the concentration of resources all accrue from urbanization, the urban process contributes to crime, pollution, congestion, and alienation. Some theorists argue that the process of modernization and urbanization inevitably leads to such disruption. "This disintegration of traditional norms and values is apparent in many forms of pathology that characterize modern societies. It is generally believed, although it is difficult to prove, that all categories of social

disorganization -- crime, deliquency, divorce, suicide, mental illness -- have seen an increase in frequency as societies have become more modern. Underlying this trend is the circumstance that the close ties of individuals to others in the immediate environment are loosened as individuals by the millions migrate from rural to urban areas,and the conformity to norms and effectiveness of sanctions characteristic of traditional societies are weakened. In a general sense this isolation of the individual is referred to as alienation."[22]

The problems of the city generally fall into the following categories:

(1) behavior characteristics of social disorganization including crime, family breakdown, mental illness, etc;

(2) diseconomies resulting from high density living such as congestion, pollution, breakdown of urban services;

(3) financial collapse of the urban government.

(1) Social Disorganization: The indicators of social disorganization suggest that overcrowding contributes to anti-social behavior. Animal experiments indicate that sexual perversion, irrational and excessive aggression, increased mortality rates, lowered fertility rates, maternal neglect of the young, withdrawal and other psychotic behavior all result when animals are forced to live in crowded conditions.[23] High population density in American and European cities has been positively correlated with deaths due to heart disease, admissions to hospitals and mental hospitals, juvenile deliquency, divorce, infant mortality, prison rates, and TB and VD rates.[24] Any inhabitant

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[22] C. E. Black, The Dynamics of Modernization: A Study in Comparative History (Harper and Row: New York) 1966, p.32.

[23] Robert J. Trotter, "Cities, Crowding and Crime," Science News (Vol. 106) November 2, 1974, p.282.

[24] Ibid.

of American cities is aware of the phenomenon: violent crime is five times more prevalent in cities over 250,000 than under 10,000 (see Figure 9.), and crime rates are increasing at 11-12% for cities of all sizes. Rapidly rising expenditures in the criminal justice system have had little effect: the nation currently spends about $15 billion annually on criminal justice.

At the same time, the recession is contributing to a further increase in crime. Urban areas with the greatest unemployment are experiencing the greatest increases in crime.[25] In addition, there is evidence that teenagers are becoming the most likely victims of suicide. Suicide is the second leading cause of death for teenagers and the suicide rate for the young has doubled in the past decade.[26]

Why is this happening despite massive efforts to curtail it? Sociologists and psychologists indicate that traditional cultural patterns are destroyed in cities and that high number of contacts with individuals not a part of one's normal social circle may lead to mental disturbances. Others have indicated that the extent to which urban environment is an underlying cause of these behavior patterns is not known; nor is the extent to which the urban environment precipitates a behavior pattern that may have long been latent in the individual. Deviant personalities may tend to drift toward some areas where their breakdowns finally occur, although their difficulties may have begun in other areas.[27]

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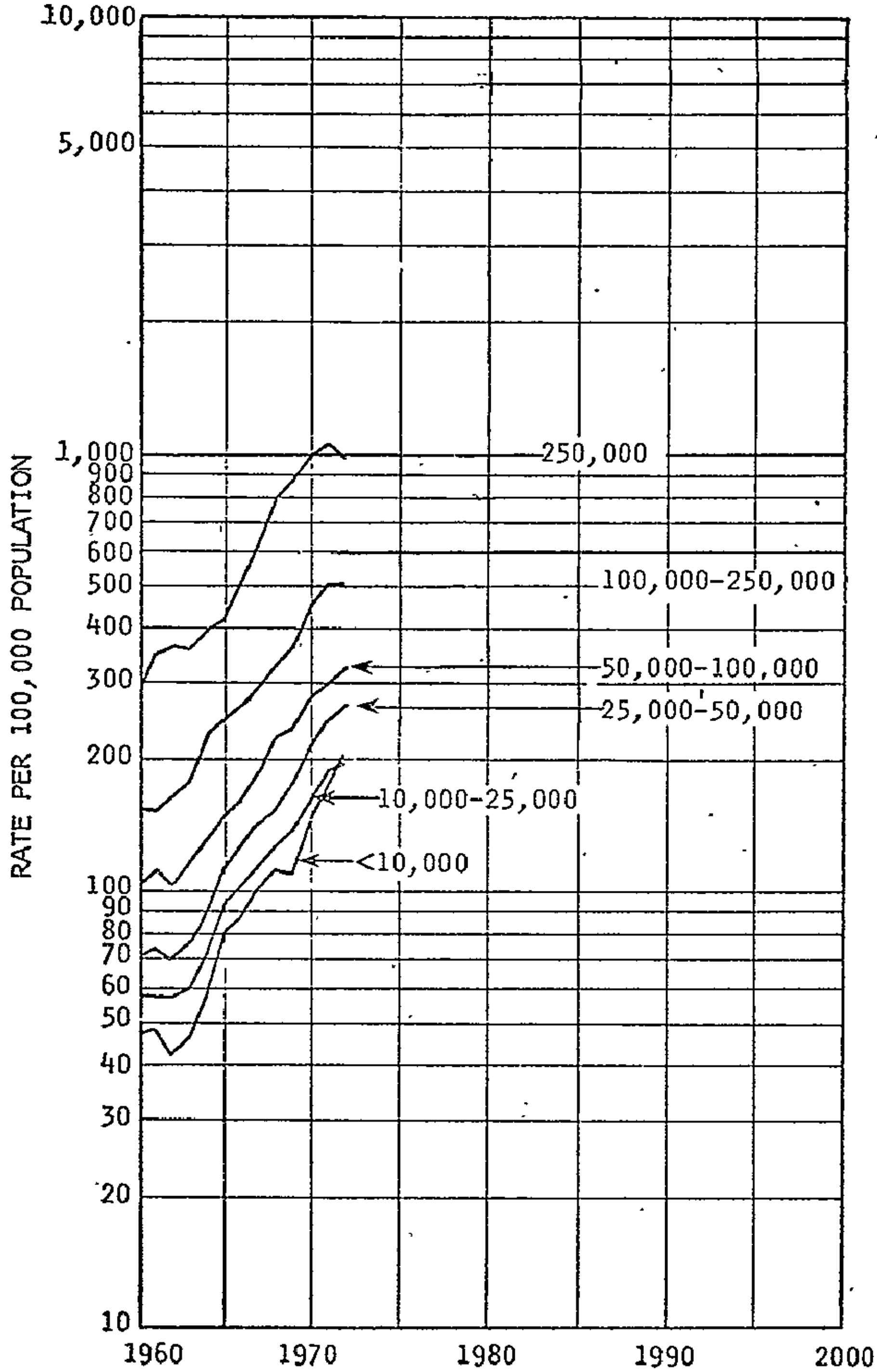
[25] B. E. Calame and E. Morgenthaler, "Crime Rate is Rising as Joblessness Spreads and Economy Recedes," Wall Street Journal (February 25, 1975), p.1.

[26] Richard M. Cohen, "Suicide Rate for Young Rises Sharply," Washington Post (April 28, 1975) p.1.

[27] Broom and Selznick, op.cit.

FIGURE 9

INCIDENCE OF VIOLENT CRIME* IN THE UNITED STATES BY SIZE OF COMMUNITY



*VIOLENT CRIME IS DEFINED AS CRIMINAL HOMICIDE, FORCIBLE RAPE, ROBBERY, OR AGGRAVATED ASSAULT.

SOURCE: EXECUTIVE OFFICE OF THE PRESIDENT, OFFICE OF MANAGEMENT AND BUDGET, SOCIAL INDICATORS, 1973 (WASHINGTON, D.C.: U.S. GOVERNMENT PRINTING OFFICE, 1973), P. 65.

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Several theories to explain the behavior patterns have been offered. One is the notion of infringement of interpersonal physical distance (the area surrounding a person's body into which intruders may not come) as a cause of anxiety, stress and tension. Continual infringement of this space can result in anti-social, violent behavior.

A second theory refers to sensory overload. The urban population is subjected to such a large number of sensory stimuli that all stimuli cannot be processed. To adapt to this overload, urban people tend to allocate less time to each input, disregard certain low priority inputs and decrease involvement with other people. This lower rate of social responsibility, and hence, lower rate of intervention in criminal activity, results in higher crime rates. Experimental evidence gives some support to this: people raised in small towns reported shoplifting at about twice the rate of people raised in large cities (those accustomed to sensory overload).[28]

Finally, there is growing evidence that biochemical changes in the brain, resulting in permanent brain damage, lead to violent and aggressive behavior.[29] Studies of repeated violent crime offenders indicate that they have a much higher rate of brain damage than the general population. Research is now trying to determine the underlying causes of such brain damage. Preliminary evidence suggests that isolation during infancy and somatosensory deprivation during infancy cause central nervous system damage. It could be that the rush, congestion and turmoil of urbanization contribute to this infant deprivation.

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[28] Trotter, op.cit.

[29] Gene Bylinsky, "New Clues to the Causes of Violence," Fortune (January 1973) p.135.

(2) Diseconomies from Congestion: Any person living or working within or in close proximity to a large American city has experienced the costs of congestion. The speed of any transportation system decreases rapidly, as traffic exceeds a given level. Beyond that point, each additional traveler reduces the speed at which other travelers can move. It has been suggested that one could move more quickly through the nation's capital in George Washington's time than today.

The problems of urban transportation which the world is now experiencing are not new. In the 1st century A.D., the government of Rome reduced congestion in the streets by restricting vehicular traffic (excepting chariots and state vehicles) to nighttime hours. However, with the exception of ancient Rome, vehicular traffic had not presented a problem until industrialization was well underway during the 19th century. Indeed, the problems of congestion are many, including the overloading of routes and facilities, excessive time of commuting trips, irregularity and inconvenience of public transportation services, and the difficulty in finding parking facilities for private vehicles. These problems arise not only from the size and density of modern cities, but also from the way in which land is used, from the balance between public services and private rights of access and travel and from the choices remaining to the citizen in terms of mode of travel, route, comfort, and cost.[30]

Various experiments have been tried to reduce traffic congestion from staggered working hours to car pooling incentives. However, once a given level of population density is reached, traffic congestion inevitably results.

30 John W. Dyckman, "Transportation in Cities," in Cities, Scientific American (New York: Alfred A. Knopf, 1967), p.133-134.

Environmental deterioration, both physical and aesthetic, is readily apparent in large cities. Pollution levels increase with city size (see Figure 10). Noise is another form of pollution which increases with city size. It has long been known that manual labor and intellectual efficiency deteriorate with exposure to increasing levels of noise. It recently has been demonstrated that some teenagers have suffered permanent hearing loss due to long exposure to amplified rock music. Permanent hearing loss results from chronic exposure to high noise levels, and levels as low as 50-55 decibels delay or interfere with sleep and result in fatigue on awakening. Recent evidence also has indicated that noise of about 90 decibels may cause permanent damage to the autonomic nervous system. Furthermore, noise may be a factor in many stress-related illnesses such as ulcers and hypertension, although this has not been proven conclusively. Noise has also been associated with the incidence of premature infants. Noise is only recently become of concern to the public and the EPA is in the early stages of establishing noise limits.

The delivery of essential urban services is declining. Recent destruction of the telephone exchange building in Manhattan, reportedly by arson, indicated the vulnerability of large scale systems. Similarly, interruption of electrical power in the Northeast due to the famous blackout of November 4, 1965, emphasized the enormous dependence upon uninterrupted electrical service.

The ability of the urban government to provide essential services such as sanitation, police and fire protection, social welfare services, and the like is declining. This is partly due to the difficulty of achieving

FIGURE 10

PARTICULAR MATTER AS A FUNCTION OF CITY SIZE

POPULATION SIZE GROUP	Cities sampled	ANNUAL GEOMETRIC MEAN PARTICULATE MATTER LEVELS													
		0–15	16–30	31–45	46–60 [1]	61–75 [2]	76–90	91–105	106–120	121–135	136–150	151–165	166–180	181–195	196 and over
Total	134	–	1	3	19	29	37	25	8	5	5	–	–	–	2
2,500–49,999	20	–	1	2	3	4	2	2	2	–	3	–	–	–	1
50,000–99,999	25	–	–	–	–	6	9	8	–	2	–	–	–	–	–
100,000–399,999	62	–	–	1	12	14	18	9	4	1	2	–	–	–	1
400,000–699,999	15	–	–	–	3	[illegible]	5	3	1	1	–	–	–	–	–
700,000–999,999	7	–	–	–	1	1	5	–	–	–	–	–	–	–	–
1,000,000 and over	5	–	–	–	–	–	–	3	1	1	–	–	–	–	–
Nonurban	23	5	9	7	2	–	–	–	–	–	–	–	–	–	–

SOURCE: U.S. Bureau of the Census, Statistical Abstract of the United States: 1973 (94th Edition), Washington, D.C. 1973

productivity increases in services, as well as the tremendous increases in the cost of labor. For instance, the technology of trash collecting certainly has not changed significantly over the past several centuries. It may well be that there is a maximum ceiling to urban size and urban density, beyond which the city cannot effectively function.

(3) Financial Collapse: Many of the problems of the city are aggravated by the concentration of low income population groups in the city and the middle and high income groups in the suburbs. This aggravates the deterioration of the ghetto, encourages "slum landlordism," building abandonment, and capital deterioration. And most fundamentally, the flight of the middle class, and the growing flight of employment centers, increasingly render the city bankrupt. The center city must provide services to a wide variety of residents and visitors who do not generate compensating revenue to the city. The fiscal bankruptcy of the city is inevitable, if the pattern progresses.

The present structural forms of local government in large metropolitan areas encourage the exploitation of the center city. Because of unrealistic political boundaries and the use of zoning practices to misallocate land resources, residents of the central city have been forced to carry:

> the financial burden of an elaborate and costly service installation, i.e., the central city, which is used daily by a noncontributing population in some instances more than twice the size of the contributing population.[31]

Encouraged by the general lack of overall authority in a metropolitan region, the suburban municipalities lack incentive to fully compensate the central city for the benefits it supplies. While major metropolitan expenditures have been partially offset by the large commercial and industrial tax base of the city, the demands of modern-day society stress the need for the development of more modern, effective police departments and the assurance of inhabitable communities. The city must satisfy these

[31] Amos Harvely, "Metropolitan Population and Municipal Government Expenditures in Central Cities," Journal of Social Issues, VII, 1951, p.107.

demands with an eroding tax base and in accordance with constitutional and statutory limitations. It is apparent that the central cities of metropolitan regions face impending financial crises.

The inequities that have developed between the city and its surrounding areas cannot be resolved without attention to structural and institutional change that would permit sharing of financial revenues as well as sharing of fiscal responsibilities. Only if the provision of public services as well as their payment are viewed from a *regional* context can the city survive.

"A metropolitan area, both central city and suburban, is a natural economic and social unit."[32] Most of the central city's difficulties are inherently complex in nature and cannot be constrained by artificial geographical boundaries. These problems are compounded by the extreme fragmentation of governments in large metropolitan areas. The enormous number of local governments within a metropolitan area increases the lack of coordination among various municipal jurisdictions in the development of rational policy for solving societal problems.

Hence, a mechanism must be found to insure that the city is recompensed for the services it provides through a mechanism other than property taxation. While the imposition of an income tax on non-residents may provide short-term stop gap solution, it does not address the basic inequity of the city/suburb structure. The essential problem -- and the cause of the city/suburb conflict -- is the disparity between services provided and revenues received. While a revenue sharing mechanism could be

[32] William Neeman, "Suburban-Central City Exploitation Thesis: One City's Tale," National Tax Journal, Vol. 23, No. 2, June 1970, p.117.

created which would provide for intergovernment revenue transfers, a better solution would seem to be the convergence of the boundaries defining an area in which services are provided and revenues are generated. The only solution is to restructure metropolitan government. Many mechanisms have been identified as a way of restructuring municipal government -- metropolitan councils, county government, city-county consolidation, city-city consolidation, annexation, single or multipurpose special districts and federation of urban functions. The true rejuvenation of Toronto, Ontario following implementation of the metropolitan form of government attests to the efficacy of the approach.

Potential Actions:

According to a survey by the Commission on Population Growth and the American Future, 54% of Americans think that population distribution is a serious problem. Half of those surveyed believe that, during the next 30 years, it will be a problem at least as great as population growth.

The survey also found that only 55% of respondents were satisfied with the size of the communities where they live, and of the 45% who were unsatisfied, most would prefer to live in a smaller community. For those who lived in the very large cities, only 39% expressed satisfaction with their situation. Also, the vote was 52:33 in favor of the Federal Government discouraging further growth of large cities. Calls for government intervention are arising from many quarters. In 1970, Congress committed itself to "a sound balance between urban and rural America." and the 1972 Democratic platform included a similar declaration. The National Governor's Conference, the Advisory Commission on Intergovernmental Relations, and the National League of Cities, have adopted measures calling for a national growth policy that would encourage a degree of population decentralization.

Proponents of such programs have yet to produce a cohesive program. James L. Sundquist notes that "nobody has defined the population distribution pattern or proposed the measures that would influence the location of people according to that pattern."[33]

Sundquist proposes that measures taken in Europe might provide some ideas as to how to proceed. He notes that Great Britain, France, Italy, the Netherlands, and Sweden have policies intended to dispurse the national population by stemming migration, and, hence, reducing the congestion of the larger cities. Basically the programs consist of various economic incentives to encourage growth in desirable areas. In Italy these grants and subsidies range from 20% to 50% of total industrial costs.

Industrial incentives in Europe, reports Sundquist, are accompanied by programs to move government organizations to desired areas and to provide extra funds in development regions for roads, ports, utilities, etc. Sweden is presently moving one-fourth of its national government from Stockholm to 13 centers around the country. In France the government has prompted policies whereby potential leasers of Paris office space are provided space if they will, for example, move major portions of their people outside of Paris. They report that a significant number of jobs have been decentralized through such bargaining.

The European countries have apparently been successful in interfacing with the normal economy. Migration has been reduced and population stabilized in areas previously experiencing out-migrations. Sundquist reports that there is now a net migration from the London region and the Paris region

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[33] Europe Stops the Urban Swarm, op.cit., p.8.

and from Provinces of North Holland and South Holland containing Amsterdam, the Hague, and Rotterdam. He notes, however, that some of this may have occurred without government intervention as cities are becoming extremely expensive places in which to do business. He also notes, however, that shifts in demographic patterns followed rapidly and abruptly when the national policies were implemented.

The United States might adopt such policies and also might try to undertake a program of technological advancement which could markedly improve working and living conditions in major metropolitan areas. In fact, requirements to conserve energy and minimize transportation ultimately might make such moves highly desirable and in certain cases, essentially mandatory. There are even those who argue that such a program of new city development and urban renewal in America could provide a focus for marshalling national interest and stimulating the economy.

However beneficial a program this is for Europe, it is unlikely to be adopted in the near future in the U.S. The recent collapse of the HUD sponsored New Towns program and the government proclamation that the urban crisis is over,[34] do not portend well for the cities.

Institutional change in the form of metropolitan government and urban tax reform could do much to alleviate the financial breakdown of the city, and may do more in the short run to improve the quality of life in the city. Current property tax structure *punishes* property improvements and is a fundamental cause of deteriorating plant and building abandonment in the central city.

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[34] Ernest Holsendolph, "Urban Crisis of the 1960's is Over, Ford Aides Say," The New York Times, (March 23, 1975) p.1.

Policies to improve the city may be more feasible in the short run than policies aimed at fundamental population shifts and relocation -- a much longer run goal. Anthony Downs offers some cogent arguments which should not be ignored in considering the attractiveness of various policies. These include:[35]

1. Proposed future patterns for American population growth will be feasible only if they offer the majority of Americans the possibility of continuing to benefit from economies of scale offered by large metropolitan areas.

2. Great uncertainty remains as to whether there is some "critical mass" or urban population size above which pollution effects become much more severe and much harder to control.

3. If we are to generate economic development in "unnatural" areas, it will require intensive concentration of economic activities and incentives on a limited number of locations; such concentration is incompatible with the geographically decentralized, demographic political system in the United States.

4. It is probably impossible to achieve effective coordination among the various federal agencies that would be involved.

5. Initial steps toward encouraging decentralization of economic development would depend upon recognition of a host of impacts from present public decisions and policies and few, if any, political or government bureaucratic leaders which to see such impacts clearly revealed, as it would reduce the scope of the present decisionmaking authority and also would require that they accept responsibility for effects many now argue are accidental and unknown.

Although this is a partial list of concerns offered by Downs, he notes that such considerations do not make it wholly impossible to shift future urban growth from metropolitan areas to other locations outside such areas. But, as he puts it, these cautions indicate that any actions will not be acceptable if they "swim against the tide" of American sentiment.

[35] Downs Hearings, op.cit., pp.32-37.

CHANGING AGE DISTRIBUTION OF THE U.S. POPULATION CREATES FUNDAMENTAL ATTITUDINAL AND SOCIAL CHANGES WHICH MARKEDLY AFFECT THE DEMANDS FOR GOOD, SERVICES, AND RESOURCE EXPENDITURES

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The Issue:

Many factors are important in shaping the national demand for products and services: incomes, prices, expectations about the future, as well as the sex and age distribution of the population. The issue of concern here is the potential impact of the changing age distribution of the national population on the attitudes, values and social structure of the country, as well as the effect on the demands for goods, services and resource expenditures. The consumption patterns of a household are governed by the income level, age and number of children, but fundamentally by the age of the heads of households. Thus, all other things being equal we can expect that as the population distribution of the American population changes, so will the demands for goods and services.

Attitudes and social mores differ as a function of age. If the age structure of the country changes, will this have any impact upon the nation's willingness to take risks? On the level of innovative activity? On the political principles the country adheres to?

Further, there is the additional problem that may increase because of the increasing proportion of elderly citizens, requiring a smaller proportion of the population to care for a rising proportion of dependents. It has been suggested that the elderly are less adaptable to political and social change and the United States could be faced with "social stagnation." As the population of a nation becomes older, job advancement opportunities may diminish as a larger proportion of the labor force is in the older age groups and, hence, occupies higher positions for a longer period of time.

There is a growing body of opinion in the United States that a stable population is a desirable goal for the nation; specifically, a wide-range of academic, business, and public interests have expressed support for a stable population. While this cannot be interpreted as an effective consensus for the cause, it is interesting to note that the U.S. birth rate maintains its lowest level in history. Business leaders today are saying that if the population stops growing, goods will be consumed primarily to replace existing household inventory rather than establish new households. Therefore, it is increasingly suggested that the private sector must grow through the provision of services which can be consumed "infinitely."[1] It may be noted that this will tend to "favor products or activities with a 'luxury' connotation,"[2] since growing demand may not be linked to increases in the number of people to feed and shelter. Furthermore, the recent severe energy and materiel shortages and the need to contribute to the global food supply may give added impetus to the establishment of national policies which encourage a stable population.

A wide range of interests and organizations appear to share the view that reducing population growth (or maintaining a very low rate of growth) is a desirable end. Although the widespread and apparently growing support for maintaining a stable population suggests a solidarity of purpose, there is reason to believe that some of this may be based upon shaky foundations. The rationale for lowered birth rates is often couched in terms of "doomsday" scenarios of doubtful validity, rather than on a reasoned

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[1] P. M. Hauser, "Our Population: Trends and Implications," The Conference Board Record, May 1971, p.19.

[2] E. B. Weiss, "Marketing's Challenge: Dwindling Population and Production Growth," Advertising Age, February 1, 1971.

assessment of alternative societal patterns associated with rapid vs. slow (or no) growth. The critical questions which are associated with the changing population configuration include the following:

- implications of the changing relationships among age groups (the "age pyramid"), particularly with regard to life style and economic dependency;
- implications for employment and overall economic productivity;
- legislative and legal trends, particularly as they affect institutional and individual behavior; and
- implications of technological trends, particularly as they pertain to productivity and the introduction of new goods and services.

Dimensions of the Problem:

What are these changing population configurations? What are the forces at play and what are the likely consequences?

Zero Population Growth (ZPG) means, literally, that the total population remains constant; i.e., the total size remains the same as well as sex and age composition of the population. Births, deaths, emigration and immigration balance each other so that the population remains stable. The population, of course, will continue to grow until that point of stability when births and immigration equal deaths and emigration. The rapidity with which a stable population is achieved is primarily a function, of course, of the birth rate. The stable population can be achieved "slowly," that is, by the year 2040, if beginning now, all married couples have 2.1 children. By 2040 then, the natural population (assuming a constant net immigration of 400,000 per year) would stabilize at 335 million, as compared to today's 205 million.

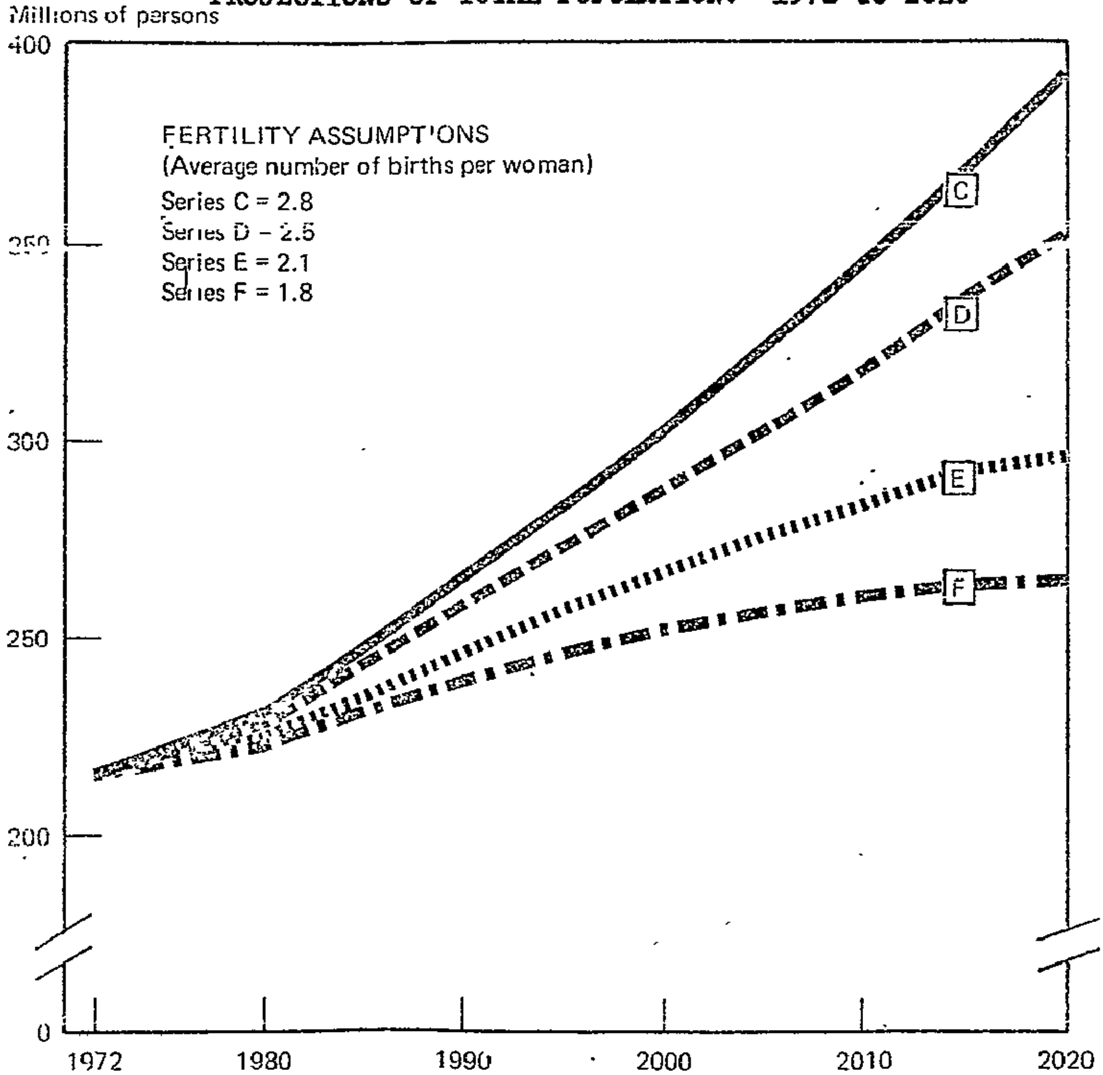
Of course, a state of ZPG could be achieved more quickly if the fertility rates were to drop even further. If married couples were to average only 1.2 children (contrary to 2.1) each for the next several decades, a stable population would soon be achieved. Inasmuch as the most recent survey on family size expectations reports that women between the ages of 18 and 24 expect to have an average of 2.1 children, there is little reason to believe that this might occur.

This population shift can be dramatically shown by comparing these results with a population where women bear an average of three children each. In this case, the U.S. population would approximate 300 million by the year 2000, 400 million by 2015 and one billion by the end of the 21st century. These alternative populations are graphically presented in Figure 1.

As indicated, even under the current birth rates, Zero Population Growth will not be reached for a considerable time. Today, the U.S. population is relatively young, with a large proportion of females just entering their child bearing years. Even if these couples average only 2.1 children apiece, these additions will result in a 40% increase in the aggregate size of the population before stability is reached.

These population projections include annual immigration to the United States. Net immigration to the U.S. presently averages 400,000 per year, and is not expected to decline. This means that to achieve ZPG quickly, the number of births must be less than the number of deaths by this amount. Immigration of young adults not only replaces births, but it also adds to the stock of women of child bearing age, so that the impact on population growth is greater than the actual number of immigrants would suggest.

FIGURE 1
PROJECTIONS OF TOTAL POPULATION: 1972 to 2020



Source: U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 293, December, 1972.

Factors Which Influence Population Change: There are three basic forces which determine the population growth rate: mortality, migration, and fertility. Immigration has in the past had a great impact upon the growth in population in the United States, accounting for 40% of the 1880-1890 population increase. However, this is primarily a function of political decisions rather than individual behavior. At one time (1890) foreign born residents accounted for over 16% of the total population, but since political regulations of the immigration process have been established, the contribution has been increasingly less significant. By 1960, less than 6% of the resident white population was foreign born.[3] Figure 2 displays the decreasing role that immigration has played in shaping American population. It is not probable that a major change in U.S. attitudes and policies will occur to change this influence.

FIGURE 2

NATIVITY OF THE WHITE POPULATION, FOR THE UNITED STATES: 1850 TO 1960

Year	Population (in millions)	Nativity (percent)		
		Foreign born	Native	
			Foreign or mixed parentage	Native parentage
1960	159	5.8	15.0	79.2
1950	134	7.5	17.5	75.0
1940	119	9.6	19.5	70.9
1930	110	12.7	23.5	63.8
1920	95	14.5	23.9	61.6
1910	82	16.3	23.1	60.5
1900	67	15.3	23.4	61.3
1890	55	16 6	20.9	62.6
1880	43	15.1	19.1	65 8
1870	34	16.4	15.9	67.8
1860	27	15.2	84.8	
1850	20	11.5	88.5	

Note: A recent estimate indicates that since 1960 the proportion foreign born of the total population decreased slightly, from 5.4 percent in 1960 to 5.3 percent in 1969.

Sources: U.S. Bureau of the Census, *U.S. Census of Population*, and *Historical Statistics of the United States*, Series A 51-58.

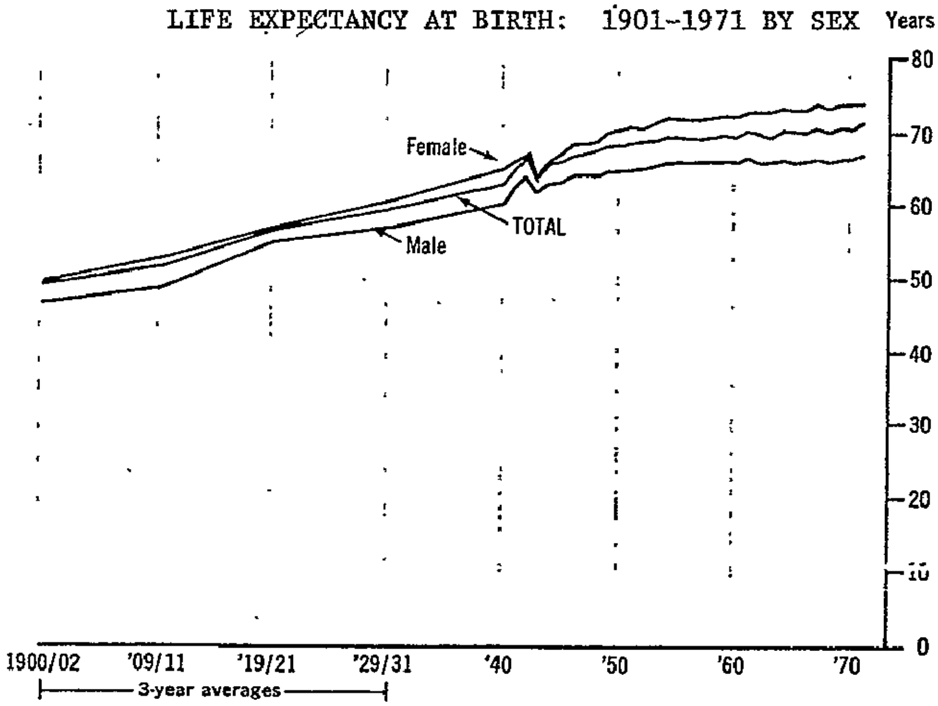
[3] Richard Irwin and Robert Warren, "Demographic Aspects of American Immigration," in U.S. Commission on Population Growth and the American Future. Demographic and Social Aspects of Population Growth, Charles F. Westoff and Robert Parke, Jr., eds., Vol. 1 of Commission Research Reports. Washington, D.C.: Government Printing Office, 1972.

Mortality refers to both infant mortality, as well as life expectancy. Infant mortality affects population size in two ways: one, by the obvious decrease resulting from the death of an individual, and secondly, by reducing the number of females who reach child-bearing age.

The death rate has fallen from about 17 per 1000 persons at the turn of the century to its present level of about 9 per 1000, and average life expectancy is currently about 70 years (23 years longer than in 1900). Major reductions in mortality were achieved prior to 1960, due largely to reductions in infant mortality and advances in medical science such as the introduction of penicillin, broad spectrum antibiotics and vaccines (see Figures 3 and 4). As mortality during the early years of life is now low, any significant improvements in life expectancy will have to come primarily from extending the life of persons over the age of 50 (See Figure 5).

FIGURE 3

LIFE EXPECTANCY AT BIRTH: 1901-1971 BY SEX



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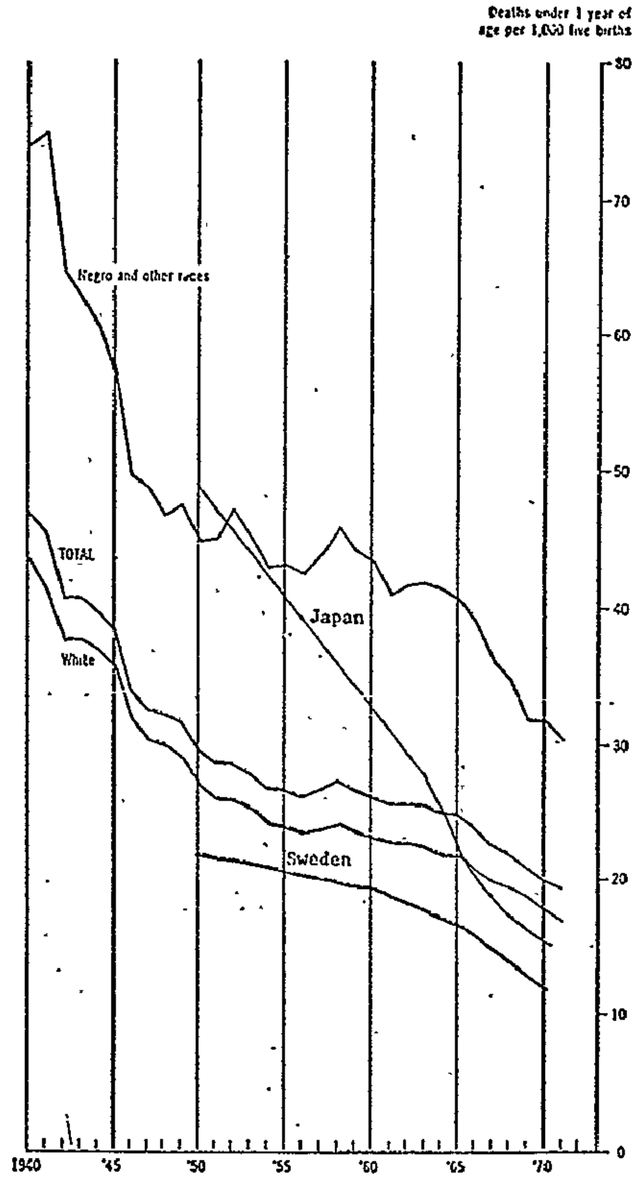
Source: Executive Office of the President: Office of Management and Budget Social Indicators, 1973 (Washington, D.C.: U.S. Government Printing Office, 1973), p. 2

FIGURE 4
INFANT MORTALITY RATES: 1940-1971



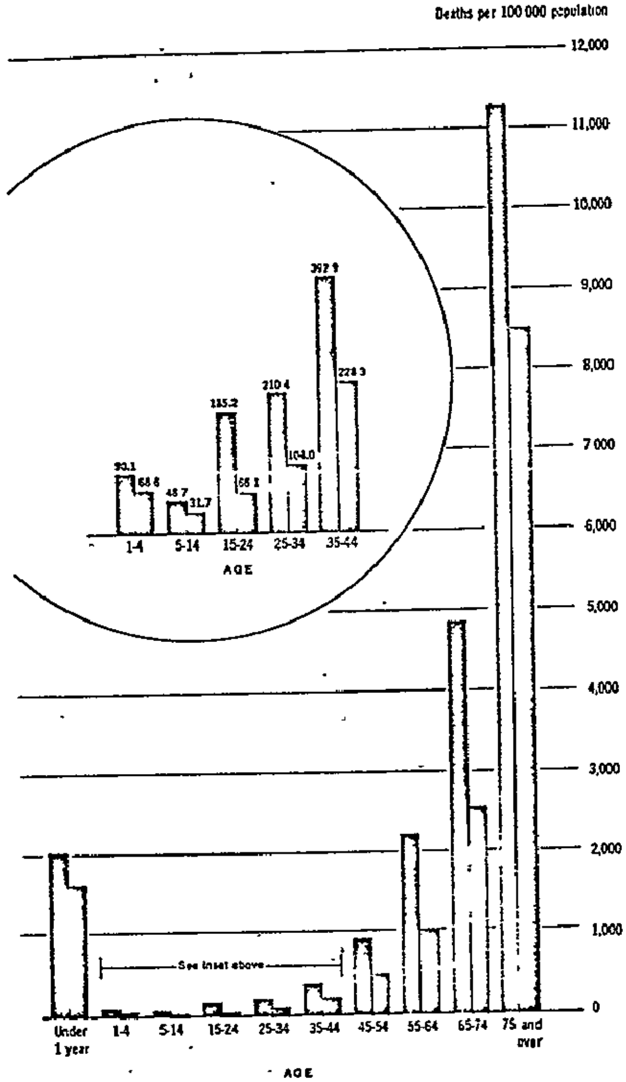
Source: Executive Office of the President: Office of Management and Budget, Social Indicators, 1973 (Washington, D.C.: U.S. Government Printing Office, 1973), p. 8. U.S. Bureau of the Census, Statistical Abstract of the United States, 1974 (Washington, D.C.: U.S. Government Printing Office, 1974); and Statistical Yearbook of the United Nations, 25th Issue (New York 1974), pp. 80-85. United Nations Statistical Yearbook, 1973, 25th Issue (New York 2974), pp.80-85.

FIGURE 5

DEATH RATES, BY AGE AND SEX: 1971

Male: Left Column

Female: Right Column



Source: Executive Office of the President: Office of Management and Budget Social Indicators, 1973 (Washington, D.C.: U.S. Government Printing Office, 1973)

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The largest single cause of death in the United States currently is heart disease, claiming about 250 persons per 100,000 population; some improvements have been made and death rates have been reduced by about 17 percent since 1950. (See Figure 6.) Mortality rates of cancer have remained essentially constant, perhaps even increasing. There is a growing concern that this may be related to widespread environmental contamination.[4] If mortality from heart disease and cancer were largely eliminated, it would only extend life expectancy seven years, a relatively small increase compared with the advances which have been made since the turn of the century.[5,6]

One of the interesting aspects of life span is its constancy through cultures. Dr. Leonard Hayflich of Stanford University's School of Medicine has noted that "indeed, regardless of the state of technological progress within a country, the human life span of 90 years or so is similar in all societies and appears to be fixed. What has changed is the probability of dying in younger age groups." [7]

Major advances now depend upon understanding and controlling the aging process. Again, this would have a relatively small impact on life expectancy as the major gains would come from starting treatment in early life, at about age 20.[8]

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4 Peter J. Bernstein, "Cancer Pollution Link is Seen," The Washington Post, February 16, 1975, p.kl.

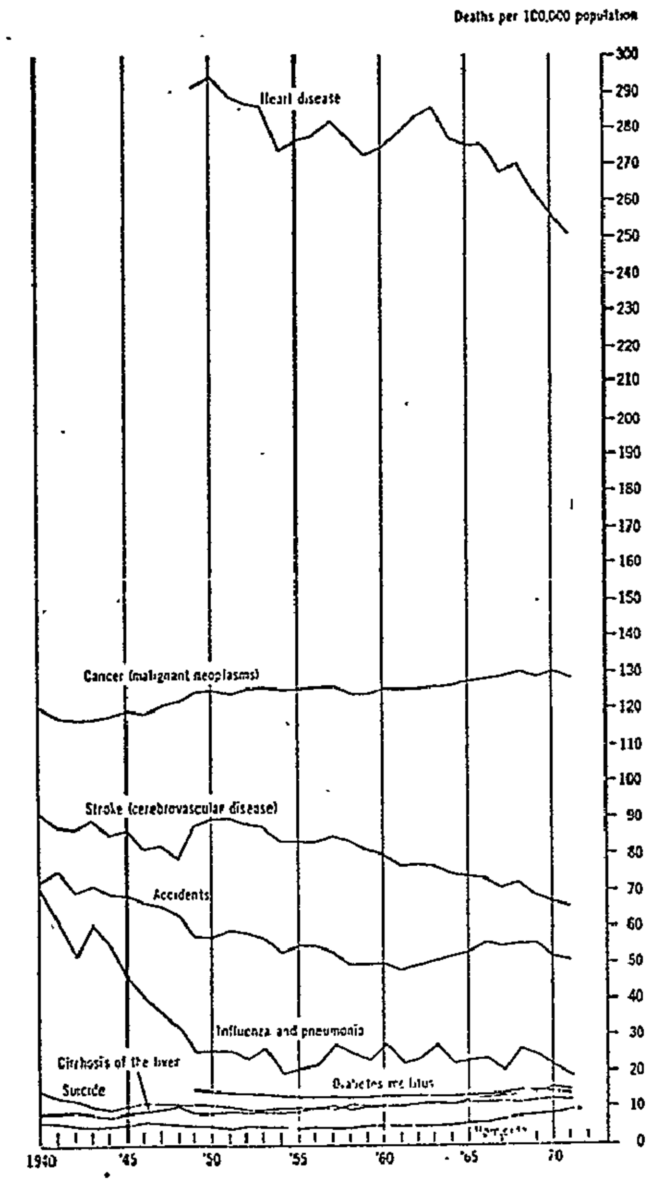
5 Johan Bjorksten, "Why Grow Old?" Chemistry, Vol. 37, No. 6, (June 1964) p.11.

6 "Scientists Weigh Facts; Theories on Aging," Chemical and Engineering News, (March 18, 1974), p.14.

7 Ibid.

8 Industrial Research, (November, 1971), p.9.

FIGURE 6
DEATH RATES, FOR SELECTED CAUSES: 1940-1971
(Adjusted to the age distribution
of the 1940 population)



SOURCE: Executive Office of the President: Office of Management and Budget Social Indicators, 1973 (Washington, D.C.: U.S. Government Printing Office, 1973), p.6.

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Clearly, considerable health and medical advances as well as advances in the basic biological sciences must precede any significant decline in mortality rates. Hence, effective and practical policies to influence population growth must essentially reduce fertility; that is, the ratio of the number of children born to the female population of child-bearing age.

There are two separate components of fertility, each of which is amenable to policy intervention. One aspect of fertility refers to the number of children *desired* by women and the second deals with the number of children actually *born* to these women. Figure 7 shows the disparity between these two numbers: the number born always exceeds the number desired. It is interesting to note that the degree of disparity between these two figures is a function of socio-economic characteristics. Upper income groups historically have been able to control their own fertility somewhat independently of the availability of technological means of contraception. As Figure 8 indicates, fertility decreases as education, income, and degree of urbanization increase. Responses to a fertility policy, as well, may differ with respect to these same variables.

Hence, population policies are largely directed towards influencing attitudes about child bearing (socio-economic incentives and educational programs) or towards influencing the technological means of controlling family size. These will be addressed separately.

<u>Attitudes About Child Bearing</u>: Demographic theory indicates that this may well be the most important item in determining a country's

FIGURE 7
THE NUMBER OF CHILDREN DESIRED VERSUS THE NUMBER OF CHILDREN BORN

Average number of children expected and wanted by married women, by wife's education and family income: 1965

Characteristic	Born	Desired	Difference
ALL WIVES IN STUDY	3.4	2.7	0.7
Wife's Education			
College 4	3.0	2.7	0.3
College 1-3	2.9	2.6	0.3
High school 4	3.1	2.6	0.5
High school 1-3	3.6	2.8	0.8
Less	4.5	3.2	1.3
Family Income			
$15,000 or more	3.0	2.6	0.4
$10,000-$14,999	3.0	2.6	0.4
$ 8,000-$ 9,999	3.3	2.8	0.5
$ 7,000-$ 7,999	3.3	2.7	0.6
$ 6,000-$ 6,999	3.4	2.7	0.7
$ 5,000-$ 5,999	3.5	2.8	0.7
$ 4,000-$ 4,999	3.7	2.8	0.9
$ 3,000-$ 3,999	4.1	2.8	1.3
Under $3,000	4.6	2.9	1.7

Source: Leslie A. Westoff and Charles F. Westoff, From Now to Zero: Fertility, Contraception and Abortion in America (Little Brown & Co: Boston) 1971, p. 231

FIGURE 8
RELATIONSHIP BETWEEN FERTILITY AND SOCIOECONOMIC VARIABLES

Average number of children ever born to women 35-44 years of age, by education, income, and residence: January 1969

ALL WOMEN	3.0
Education	
College 4	2.4
College 1-3	2.8
High school 4	2.8
High school 1-3	3.3
Elementary 8	3.5
Less	3.9
Family Income (dollars)	
$15,000 or more	2.8
$10,000-$14,999	2.9
$ 7,500-$ 9,999	3.1
$ 5,000-$ 7,499	3.3
$ 4,000-$ 4,999	3.7
$ 3,000-$ 3,999	3.8
Under $3,000	3.7
Farm Residence	
Non-farm	3.0
Farm	3.7
Region of Residence	
Northeast	2.8
North Central	3.2
South	3.0
West	3.0

fertility rate, irrespective of the technology available to control fertility. European countries demonstrate this principle. As a whole, the continent of Europe has birth rates which are lower than any comparable area in the world, and these conditions have existed for at least two generations. The European population is growing at a rate significantly less than 1 percent per year, even in the absence of modern contraceptives. The use of devices and availability of information are totally banned in several countries and largely restricted in others. Still, birth rates are as low in such countries as in those where information and devices are widely used and largely available.[9]

Richard A. Easterlin argues that fertility behavior is the result of household choices where resources are weighed against preferences. He cites three factors (income, tastes, and prices) as those most significant in determining household behavior.[10] This is a common explanation of the differences among socio-economic group fertility differences and is the basis for the Demographic Transition theory which argues that as economic development and wealth increase, fertility declines. It can be argued that growth in social security and other government and industrial-sponsored pension and retirement benefits, coupled with increases in real income, have reduced the "economic need" for children in this country and children are now viewed as economic costs. However, much of the recent success in achieving the present low fertility rate of 2.04 in the United States can be attributed to the advances in contraceptive technology in the late

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9 Paul R. Erhlich and Anne H. Erhlich, Population, Resources, Environment: Issues in Human Ecology (San Francisco, California: W.H. Freeman & Company, 1972) p. 318

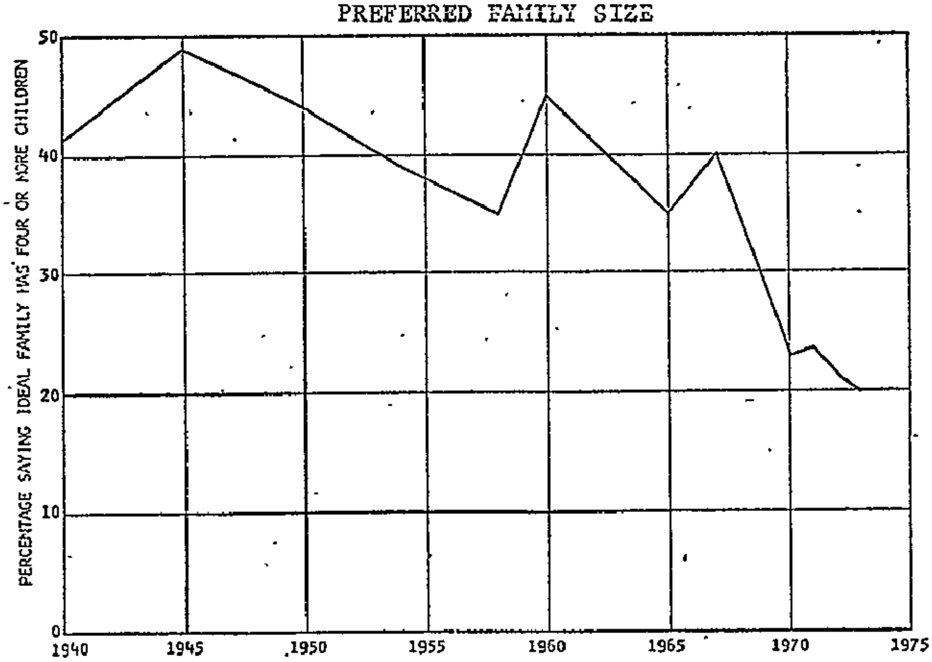
10 Richard A. Easterlin, "Towards a Socio-Economic Theory of Fertility: Survey of Recent Research on Economic Factors in American Fertility," in S.J. Behrman, Leslie Corsa, Jr., and Ronald Freedman (eds.), Fertility and Family Planning (Ann Arbor, Mich: University of Michigan Press, 1971), p. 128

1950's and early 1960's.

Other socio-economic factors previously mentioned affect attitudes about child bearing -- including the general educational level, degree of urbanization, the social status of women, opportunities for employment for women outside the home, costs of raising and educating children, and age of marriage. As the factors correlated with low fertility increase, fertility rates typically decline. In their aggregate, these trends all support maintenance of a continued low birth rate in the United States.

Recent public opinion polls support this hypothesis. Those preferring four or more children per family have declined about 60 percent since the end of World War II, with the bulk of this decline occurring in roughly the last decade, as shown in Figure 9 . These data are supported by a Census Bureau Survey of the number of children which married women in various age groups wish to have in their lifetimes. In the younger age groups, which are most important for future trends, the number of

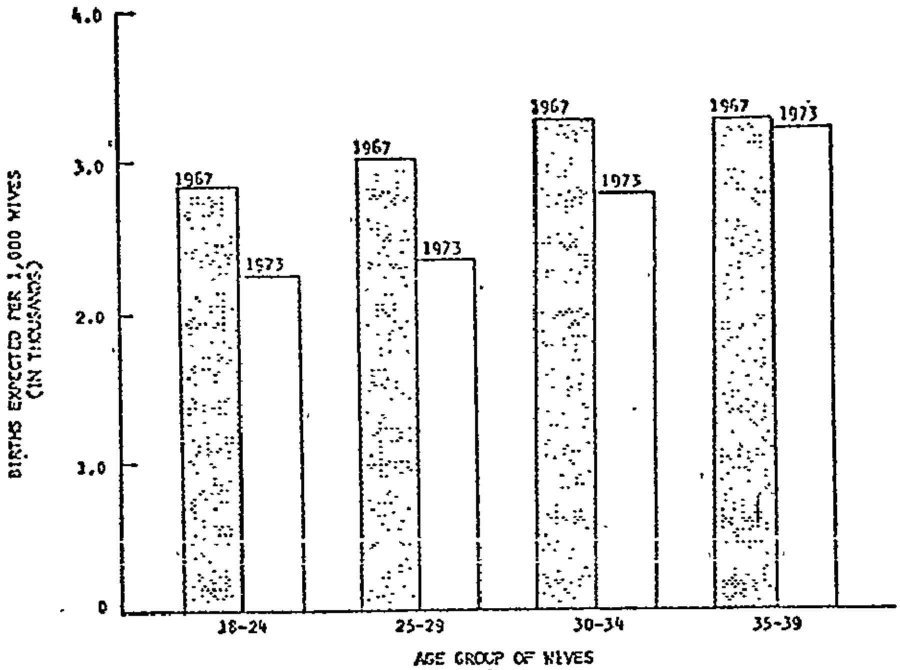
FIGURE 9
PREFERRED FAMILY SIZE



SOURCES: 1940-1970: GALLUP POLL PUBLISHED IN THE HARTFORD COURANT (FEBRUARY 21, 1971).
1971-1973: U.S. BUREAU OF THE CENSUS, CURRENT POPULATION REPORTS, SERIES P-20, (WASHINGTON, D.C.: U.S. GOVERNMENT PRINTING OFFICE, JUNE 1971, 1972, 1973).

children desired has declined considerably in the last several years, as shown in Figure 10.

FIGURE 10
LIFETIME BIRTH EXPECTATIONS OF WIVES 18 TO 39 YEARS OLD



Source: U.S. Bureau of the Census, Statistical Abstract of the United States, 1974 (Washington, D.C.: U.S. Government Printing Office, 1974), p. 54

However, there are two factors which may actually cause birth rates to increase. One refers to the effect of postponement of child bearing, the second to the role that career opportunities for women plays in attitudes toward child bearing.

It may well be that the decline in birth rates is only temporary as women may have merely postponed child bearing. Paul Jacobson, of Metropolitan Life, estimates that more than 2.25 million births were postponed between 1971 and 1975, and that about four-fifths of these will take place by the early 1980's. He points out that the gradual numerical rise in marriages which can be expected among the growing young adult group which represent the post-World War II baby boom, is likely to be followed by increases in the number of births. His overall prediction, however, is that "neither a return to the large families of former years nor zero population growth is on the horizon; the two or three child family will continue to be popular."[11]

It may also be that women are making an explicit choice of a career in lieu of child bearing. While female participation in the labor force has been increasing, the traditional female career areas -- teaching, clerical and sales -- are becoming saturated. Should presently male-dominated employment opportunities not become accessible to the female population on an equal basis, the difficulties associated with joining the labor force could discourage female attempts to enter the labor force. Frustration could persuade other women to leave. This could contribute significantly to an increase in birth rates.

Contraception and Abortion: Changing attitudes about child bearing in the United States have largely coincided with increased availability of information about and improvement in techniques of contraception, including abortion. The debate about contraception and abortion is certainly not new. In modern times the debate on these subjects can be traced to developments in England at the time of the Industrial Revolution. Francis Place, a labor leader and early advocate of limiting the size of families through contraception, believed that a limited labor pool would be likelier to win higher wages and better working conditions from employers than would an abundant supply of workers. His views were aired in Illustrations and Proof of the Principle of Population published in 1822.

In January 1971, Congress repealed the Comstock Law of 1873 (banning the mailing of birth control information as obscene). To date contraception

[11] Paul H. Jacobson, "Birth Trends in the United States," Statistical Bulletin, Metropolitan Life, Vol. 55 (October 1974), p. 6.

is legal for adults in every state (possibly with the exception of Massachusetts and Wisconsin, which require marriage of adults however, sales and advertising of contraceptives are widely regulated.

The debate on abortion is currently reaching new levels in the United States. The 1973 Supreme Court decision striking down anti-abortion laws in many states is coming under increased fire, especially in light of the recent conviction of a doctor in Boston on manslaughter charges. On balance, however, the availability and increased willingness to use means of preventing or terminating pregnancy are likely to continue to grow. Government policy appears to be contributing to such trends. The 91st Congress authorized the first significant federal expenditures for birth control, allowing the government to spend $235 million over a three-year period for establishment and expansion of family planning services operated by local agencies and by non-profit hospitals and other organizations. Research to seek better and cheaper methods of birth control were also funded at that time at a level of $145 million.[12]

Implications of a Changing Population Configuration: The following four age pyramids by Charles Westoff (see Figure 11 and 11a) illustrate the characteristic changes occurring in age group percentages as the population moves toward a stabilized growth rate,* depicted beyond the year 2000. The most apparent trend of the stable population is the aging of the population. As Westoff points out, those people over 65 years of age will represent 19% of the population instead of the present 11%, and the number

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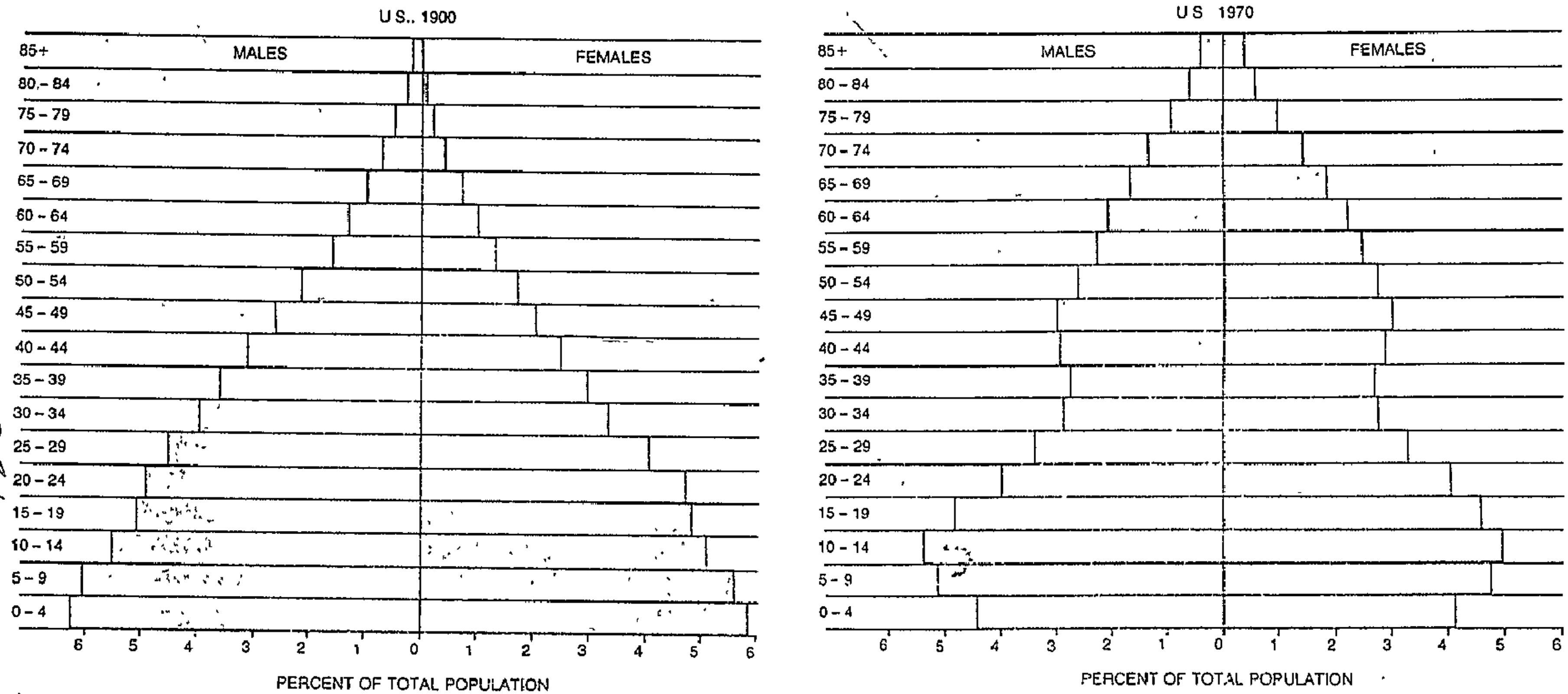
[12]Lawrence A. Mayer, "New Questions about the U.S. Population," in Eugene B. Jafe (ed.), Social, Cultural, and Economic Changes in the 1970's: Interpreting the Trends (Rochelle Park, N.J.: Edward E. Emanual and Co., 1972) p. 50.

*Note that "stabilized" population and "ZPG" population are synonymous.

FIGURE 11

CHANGING AGE DISTRIBUTION OF THE POPULATION



U.S. POPULATION OF 1900 had the age composition shown in this pyramid. Its shape is characteristic of a fast-growing population with high birth and death rates where the average life expectancy is under 60. A third of Americans were under 15 years of age.

U.S. POPULATION OF 1970 gave rise to a pyramid whose sides are pinched in because of the low birth rates that prevailed during the years of the Great Depression. The bulge centered on the 10-to-14-year-old age group is a consequence of the postwar baby boom.

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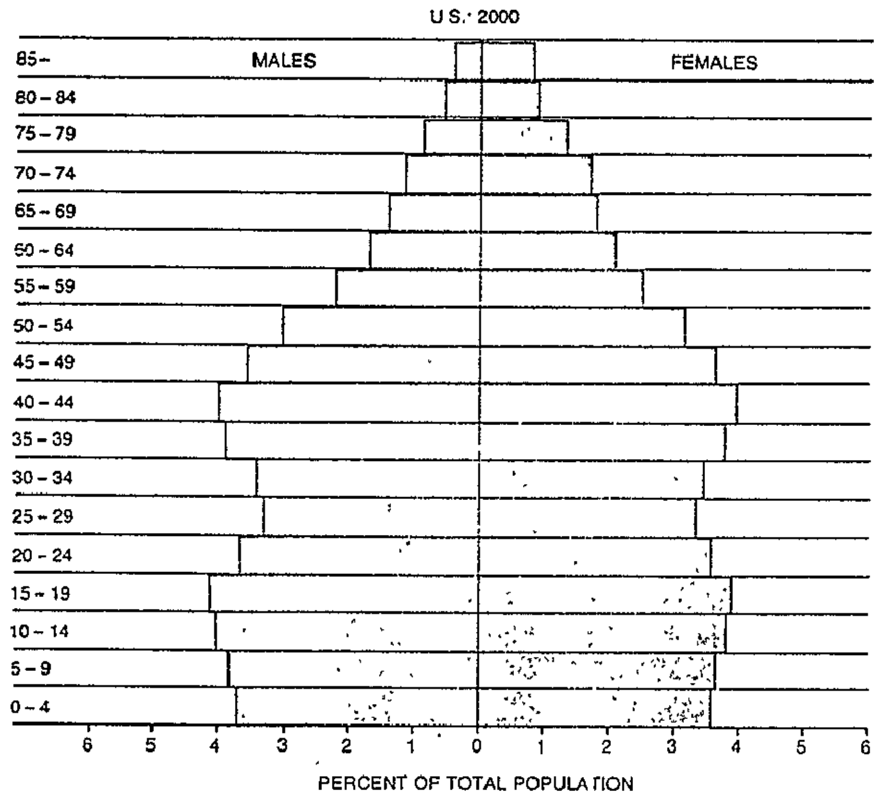
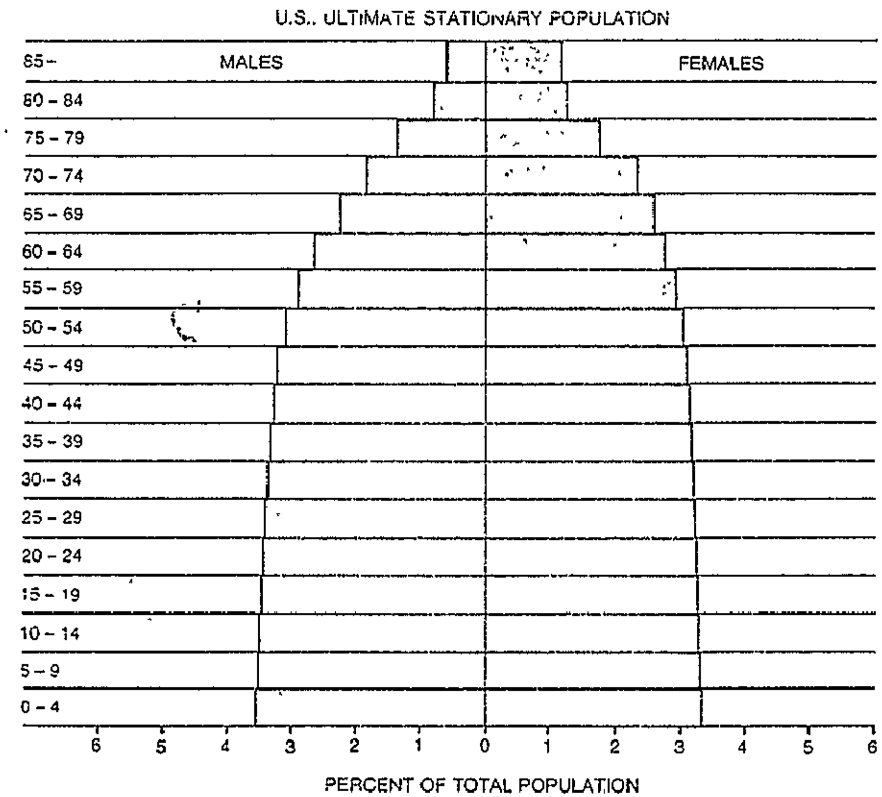
FIGURE 11a



U.S. POPULATION OF YEAR 2000 will form this age pyramid if fertility stabilizes at replacement levels from now until the end of the century. Five-to-19-year-olds of 1970, who will then be 30 years older, will have produced a second bulge of five-to-19-year-olds.



ULTIMATE STATIONARY POPULATION, if it is achieved in the U.S. during the next century, will have the age composition shown here. A third of the population will be under 25 years of age, a third will be between 25 and 50 and another third will be over 50.

Source: Charles Westoff, "The Population's of the Developed Countries," in Scientific American, September 1974.

of young people under 20 will decrease percentage-wise but because of the overall growth in population remain constant in terms of actual numbers. A stable population results in an approximate 40% of the population dependent on those actually in the labor force.

The impact of a 40% dependent population will be largely a function of the health of that population. Technological forecasters and demographers alike speculate on tremendous advances in gerontology that will increase the chronological longevity of man; some are predicting advances in the control of the aging process that would increase longevity by as much as twenty or thirty years. However, the impact upon society of this advancement will reflect whether chronological age is extended with or without a concomitant increase in functional age. This is an extremely important distinction with respect to the impact of an increasing aged population. As the population ages, the percentage of feeble and infirm will probably increase and present widely different problems than the younger cohort of the population which is alert and active. While it is likely that some improvements in lengthening functional life expectancy can be expected, it is also likely that an individual's period of relative incapacity may be extended. Hence, it is necessary to be cognizant of the issues associated with both the infirm and healthy of an aging population.

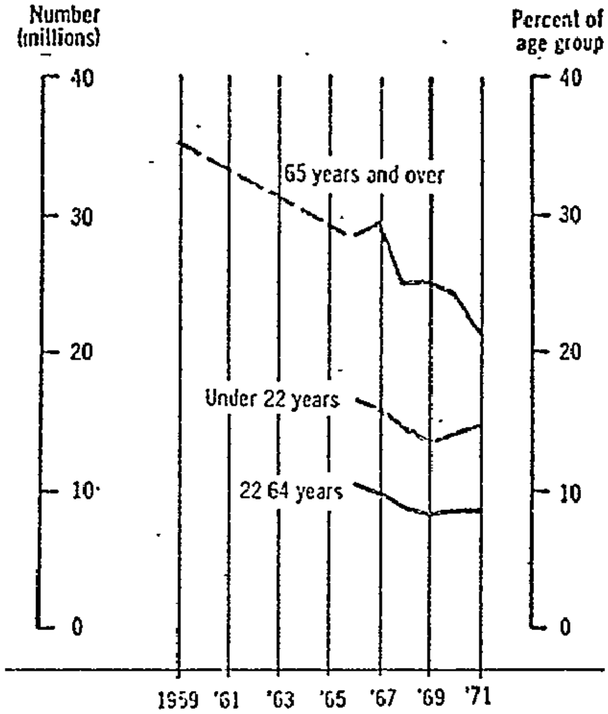
Caring for a large infirm and possibly dependent population may be a major societal problem. Serious problems will arise even if the aged are healthy and functional. Retirement is now mandatory in most organizations at age 65, and the trend is for earlier retirement at age 60 or 55 with full benefits. Should these trends continue, by 2050 as much as 27% of the population (those over the age of 55) might be in an unemployed or retired status.

The non-productive status of the aged may, in fact, be accelerated due to present employment policies which encourage early or require mandatory retirement. If retirement at age 55 is universal by 2050, fully 26% of the population might be in an unemployed or retired status. The political, economic, and social implications of having 33% of the nation's mature population dependent upon the rest could be considerable.

Concerns about the income, employment, and health problems of the aged are well founded as poverty is more prevalent among the elderly than any other age group. (See Figure 12) The income of the aged in the future is likely to be improved due to increased private retirement benefits and the large accumulated personal resources which have been possible as a result of the growth and affluence in America,and also due to the increased coverage through government insurance plans.

The aged will clearly have more political clout than they do today. The influence of the youth will be reduced in the coming decades, however, notwithstanding the recent reduction of voting age from 21 to 18. Assuming that the propensity to vote as a function of age-group remains constant, at current levels, and taking into account the new voting age of 18, the over-65 population will have 21% of the total vote versus 15% today; and those over 45 will have a clear majority of 54%.

FIGURE 12
PERSONS BELOW THE LOW-INCOME LEVEL, BY AGE: 1959-1971



Source: Dorothy P. Rice and Barbara S. Cooper, "National Health Expenditures 1929-1971," Social Security Bulletin, Vol. 35, No. 1 (January 1972), p. 6; and Barbara S. Cooper, Nancy L. Worthington, and Paula A. Piro, "National Health Expenditures, 1929-1973," Social Security Bulletin, Vol. 37, No. 2 (February 1974), p. 6.

Historical trends would suggest that this would be a conservative influence and that liberalizing efforts with respect to such things as the use of drugs, pornography, new forms of marriage, and so on, would meet resistance. Yet the elderly population of the first decades of the next century will include the "pill poppers" of today, so the "conservative/liberal" balance in conventional terms is unclear. What is clear is that political power will be increasingly in the hands of the older members of society.

In sum, the primary implication of ZPG is simply that the population becomes older and that the value and interests associated with age may become predominant. If older segments of the population exercise their political influence with some solidarity, there could be considerable shifts in both domestic and international policies.

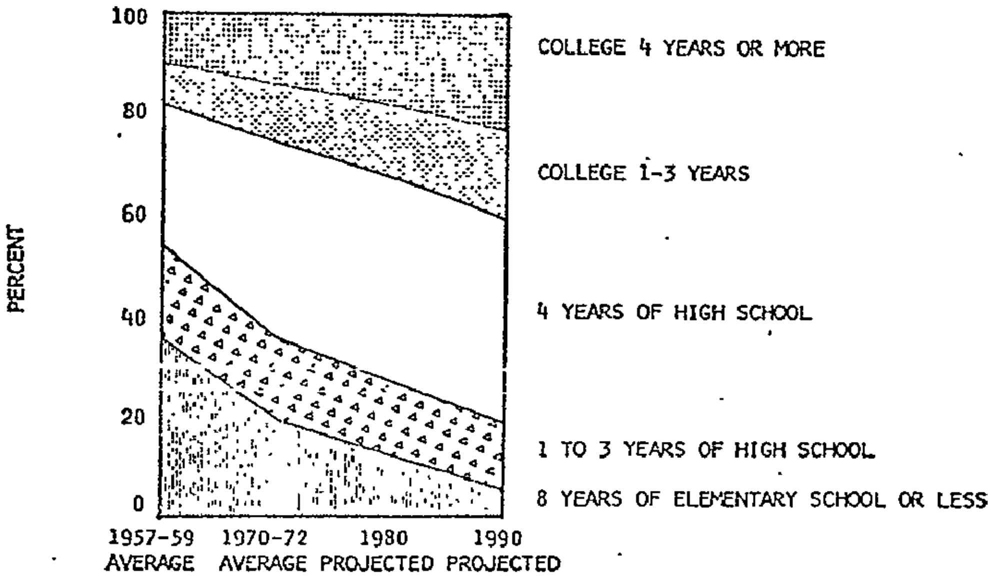
Employment and Labor Force Consequences: By the end of this century about 127 million people will be in the labor force, a growth of about 39 percent from the 1973 level. In the latter part of the 1970's and early part of the 1980's, the bulk of this growth will be comprised of those 20 to 34 years old, who largely represent the post-World War II baby boom children.

The stabilized labor force will be larger than today's by a factor of 1.3, while the projected population is larger by a factor of 1.6. The most significant consequence of a stabilized population upon the labor force is the expected increase in labor force participation by women and a decrease in participation by the older members of the population of both sexes. In aggregate terms, participation rates are projected to increase from 60.3% to 62% in the next few decades, and then decline to 59% by 2050.

The large increase in the number of younger workers will create competition among them for places in the labor force, especially in the later 1970's and early 1980's. Concomitantly, the educational level of the work force will be increasing. (See Figure 13) The less educated will then become increasingly concentrated in the older age groups. A problem of an over-educated, miseducated labor force would evolve into a body of workers with unneeded skills.

FIGURE 13

EDUCATIONAL ATTAINMENT OF THE CIVILIAN LABOR FORCE 25 YEARS OLD AND OVER



SOURCE: BUREAU OF LABOR STATISTICS, MONTHLY LABOR REVIEW, NOVEMBER 1973

An increased percentage of younger, higher educated workers is likely to have significant impacts on the work force, resulting in greater demands for a satisfying job.[13] A recent Department of Health, Education and Welfare study concludes that a large number of workers are dissatisfied with their work because they are dull and meaningless jobs without challenge. The study contends that there is a revolutionary change in attitudes, particularly among the young, minority groups, and women, and that they are putting less emphasis on material rewards and more on the challenge and interest of their work.[14]

The declining participation by older workers that would occur if trends toward earlier retirement continue may have substantial negative impacts. The nation may undergo a shortage of experienced and productive

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[13] "Volvo Bets on Team Assembly," Business Week (April 20, 1974), p. 78C.

[14] Hiroshi Imamura, "How Can Automation Be Applied in Shipbuilding?" The Motor Ship, Vol. 51, No. 605 (December 1970), p. 45

skilled workers, professionals, and managers. Because of the forecast increase in the average years of schooling, entry into the labor force is likely to occur at a later age than at present. This could further exacerbate the shortage of experienced personnel. However, if older workers are encouraged to remain in the labor force, particularly in areas of high-status and high-earnings, younger workers may perceive that their opportunities for advancement are limited. This could, perhaps, result in antagonisms between the younger and older segments of the population, particularly if older members protect their advantageous positions through political influence.

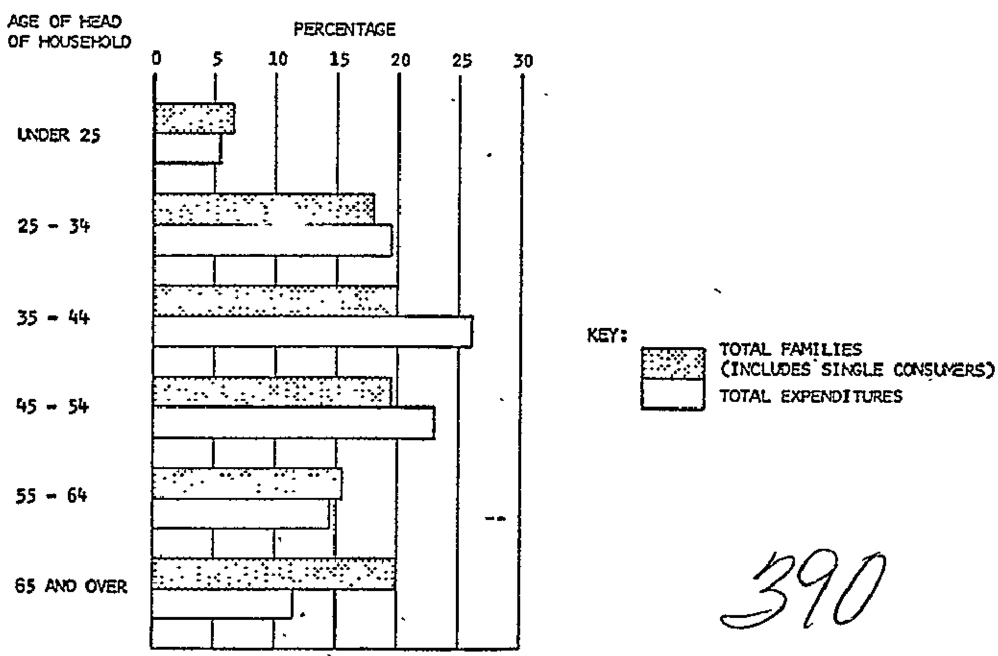
The increase in labor force participation by women is based upon the assumption that the positions and opportunities which are made available to men will increasingly be available to women. An argument has been advanced which suggests that much of the recent decrease in fertility is due to either the availability of career opportunities for women or the expectation that such opportunities will occur. This is thought by some to be an acceptable and desirable alternative to bearing several or many children. For the next few decades, women can be expected to continue their demands for protection against discrimination through demands for legislation, court actions, and regulatory decisions. At a lower level of impact, perhaps, efforts are underway to protect pregnant women, whether married or unmarried, from employment discrimination and to require that group medical insurance should pay for child birth for unmarried women and legal abortions.

Another development affecting our labor force is the projected decline in the availability of low-skilled jobs for women, especially those that can be re-entered upon completion of child raising. These jobs include retail clerks, typists and desk clerks. Many of these jobs are being eliminated due to technological advances. Some professional jobs, which permit exit and entry according to family pressures, such as teachers, may also be adversely affected by technological advances. The reduction of these jobs due to technological advances emphasizes the need to guarantee worthwhile career opportunities for women.

<u>The Impact of Youth -- Past and Future Generations</u>: The post-World War II baby boom had a major impact on institutions and lifestyle in America. Enormous demand was created for housing, education, and products and services to satisfy teenage needs. The age group of those families who are supporting children historically has represented a contribution to spending in America which was proportionately larger than their contribution to the population. (See Figure 13)

FIGURE 13

AGE DISTRIBUTION AND SPENDING - 1966



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SOURCE: THE CONFERENCE BOARD, INC., A GUIDE TO CONSUMER MARKETS, 1971/1972, CONFERENCE BOARD REPORT NO. 528 (NEW YORK, 1971), P. 149.

By the early part of 1974 enrollment in elementary schools had declined for three consecutive years as a result of the reduction of birth rate. Public school enrollment had dropped to the level of 1966 and total enrollment in elementary schools had declined over 7 percent from its high in 1970. This downward trend in elementary school enrollment is expected to continue until at least into the early part of the 1980's, or until the post-World War II baby boom children begin having children of their own. Dr. William Farris, Executive Director of the National Association of Elementary School Principals, noted that potential savings from reduced enrollment might be offset by demands for higher teachers' salaries.[15] In contrast to the serious teacher shortage of the 1950's, the United States is faced with a greater number of teachers than the present system can utilize.

The post-World War II baby boom children are now about to place new demands on America -- household formations. It is anticipated that 1.5 million households will be formed each year until about 1985. These new household formations will require new housing, which in addition to the need to replace older housing stock, will aggravate the current under-supply of housing.

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15 "Reduced Birth Rate Cuts Enrollments in Lower Grades," The New York Times (March 26, 1974), p. 37.

WORLD CONCERN: ENVIRONMENT

Introduction:

While concern with degradation of the environment and the global ecosystem is not new, recognition of the complex and possibly synergistic relationships among a host of seemingly disparate activities and variables is.

It was only a few decades ago that the internationally recognized symbol of economic progress and wealth was the sight of clouds of smoke and steam billowing forth from tall smokestacks. The health consequences of inadequate municipal waste and water treatment have been known for centuries. The civilization of Crete first established municipal water and sewage systems almost 5000 years ago. It is only recently that research has discovered the far reaching health, ecological and climatic effects of continuous and unregulated disposal of wastes into the global environment. The health effects of such materials as lead, mercury, and carbon monoxide have been known for some time. As early as 1923 the Journal of the American Medical Association warned: "The contamination of the air in the more congested streets of American cities during hours of heavy traffic reaches the upper limit and for a shorter period even exceeds the upper limit of well-founded health standards." Research is continually identifying new materials which are toxic or carcinogenic; concern for polyvinyl chlorides, abestos, chlorinated hydrocarbons and many others is recent. As research progresses, the hysteria generated by the press further enflames and confuses the issue -- witness the present controversy over the destruction of the protective ozone layer by unregulated use of aerosol propellants.

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[1] Statement of Dr. Handler in Proceedings of the Conference on the Health Effects of Air Pollutants, Assembly of Life Sciences, National Academy of Sciences (October 3-5, 1973) prepared for the Committee on Public Works, U. S. Senate, November 1973.

Recognition of the health consequences of widespread environmental contaminants has led to legislative restriction. The history of federal environmental protection is not long; it essentially began in 1963 with a congressional mandate to identify pollution related health problems. Since then the legal and regulatory position of the federal government has evolved. Recognition of the problem has led to the establishment of the President's Council of Environmental Quality and the Environmental Protection Agency as well as a host of quickly imposed restrictions and regulations. Originally, concern was with cleaning up the "most" polluted areas at a price that industry was willing to pay. Meanwhile environmental quality continued to deteriorate as industry and government battled it out.

In 1969-1970, the approach was drastically changed, based on the recognition that the concept of economic feasibility had become an excuse for doing nothing, and the dangers to health were sufficiently grave to warrant regulation based solely on the degree of control needed to protect the public health. The National Environmental Policy Act of 1969 has mandated the preparation of Environmental Impact Statements in connection with every major action which may significantly affect the environment -- *in advance* of that action. Despite the protests of industry, conservationists and consumers alike, some advances have been made in improving environmental quality. Discharges of some polluting wastes into both water and air in some parts of the country have been reduced. Yet the recency of the issue and the inadequate state-of-the-art of control, abatement, measuring and monitoring technology as well as inadequate insight into the chemical and biological basis of the interactions, are retarding efforts to mount an effective campaign for environmental protection. In short, despite the household familiarity with the "ecology movement" of the early 70's (community improvement programs, recycling emphasis and general awareness of the supposedly new problem), the U.S. still is faced with a mammoth issue: how effectively and quickly can we control pollution when industry alone contributes some 55,000 individual water polluting substances?[2]

One school of thought advocates a laissez faire attitude until research effectively proves a causal relationship between a given pollutant and an undesirable health or ecological consequence. The second school of thought is willing to admit that the current biological and chemical understanding is inadequate, yet the recognition of at least correlational evidence between unregulated waste disposal and health consequences is sufficient to warrant regulation and restriction. This latter school of thought has dominated environmental protection policy for the last several years. However, there is some concern that the "proof of cause" advocates may be gaining dominance especially during this current era of energy, material and capital shortages.

The recent controversy over the use of catalytic converters in automobiles is used as evidence for almost all sides of the environmental argument. Recognizing that the discharge of carbon monoxide into the atmosphere is a significant health hazard, the Clean Air Act of 1970 mandated that automobile emissions be restricted at increasingly high standards to help meet a national goal of "clean air" by 1975. The automakers have long argued that the technological state-of-the-art was so inadequate that a vastly inferior and expensive "band aid" approach would have to be used: the catalytic converter. Despite a one year delay, the devices were mandated at an admitted cost of reduced gas efficiency and, some argue, engine

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[2] Allen V. Knuse and Charles L. Schultze, Pollution, Prices and Public Policy (Washington, D.C., 1975), Chapter 1.

reliability, and at increased unit costs. It has recently been discovered that, while the catalytic converter may reduce the level of carbon monoxide and carbon dioxide, it also emits a fine bath of sulfuric acid which may have more persistent and drastic long term effects than the original problem of carbon monoxide.

This, then, becomes *prima facie* proof for both sides of the argument: that the Environmental Protection Agency did not know what it was doing; or that the automobile industry had no intention of significantly addressing the problem. The current slump of the automobile industry is further proof, so the argument goes, that environmental protection legislation is inherently bad for the country and contributes to recession and inflation.

Many events are likely to occur in the next few years which may further threaten environmental protection. A pervasive notion in the country is that environmental protection is economically non-productive and expenditures in this area are likely to reduce further the economic competitiveness of American industry *vis-a-vis* other nations. Such arguments, however, overlook the creation of a pollution abatement/control industry which in turn creates its own multipliers in the economy in the form of employment, salaries, demand for support industries and the like. It also overlooks the social overhead costs as well as costs to the firm of *not* protecting the environment -- costs associated with reduced productivity, increased medical costs, increased absenteeism, etc. However, the argument is currently being used by advocates of relaxing the current restrictions to permit exploitation, for instance, of domestic supplies of high sulfur fuel. The Environmental Protection Agency has already relaxed the clean air standards for the U.S. automakers, both as an incentive to the industry and as a response to recent concerns over the sulfuric acid production of catalytic converters.

There is no question that the goal of environmental protection will be attacked as never before in the next few years as the nation attempts to adapt to fundamental changes in global economics. During the same time period research undoubtedly will identify other environmental contaminants which are toxic, mutagenic or carcinogenic, generating additional pressure for environmental protection. However, the end of the era of cheap energy, together with global economic change and increasing shortages of basic materials and minerals, will continue to threaten efforts to protect the environment. As current international economic conditions remain impervious to traditional economic prescriptions, pressures will mount to relax stringent restrictions upon pollution control and abatement in the name of economic recovery. It is likely that at least temporary relaxation of regulations will occur -- witness the recent relaxation of automobile emission standards.

Environmental degradation is related to the level of industrialization and the size and rate of population growth. Industrialization *per se* is not the sole cause of pollution,as pre-industrial societies are usually characterized by inadequate or absent sewage treatment and agricultural run-off problems contributing to waterborne infectious diseases. However, the most persistent and difficult pollution problems are associated with high levels of industrialization. Industrialization and economic growth appear to have a strong positive correlation with energy consumption, which in turn is often highly polluting. In fact, a recent Environmental Protection Agency sponsored study identified the exploitation of new energy sources as the single most pressing environmental problem for this country.[3]

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[3] James E. Finn and R. S. Reimers, Development of Predictions of Future Pollution Problems (Environmental Protection Agency: Government Printing Office, March 1974.

There is no question that industrialization is the major cause of air pollution. Those things most highly associated with increasing standards of living and economic growth (such as transportation systems, industrial processes and energy generation) are the primary sources of air pollutant emissions. Simultaneously, industrial processes and sewage sludge contribute a substantial portion of water pollution.

It is also important to note the role of population and population density in the generation of problems of environmental degradation. A region could better sustain a given population if that population were evenly distributed over the land rather than heavily concentrated in a small portion of the region. This concentration of activity is one of the fundamental causes of environmental degradation in this country.

The environment is able to accept a substantial amount of waste materials and "cleanse" itself. However, this naturally occurring cleansing process cannot and will not suffice if either the effluent is inherently toxic (such as radioactive wastes) or a given region has exceeded its "carrying capacity." Carrying capacity is a concept borrowed from the study of ecology and essentially refers to the population that a given region can sustain -- that region's "carrying capacity." A simple example will illustrate the concept. A single acre of grassland can support only so many cattle; the number is constrained by either the available food and water supply, or the ability of the region to handle the animal wastes without harm to the animals. The carrying capacity is by no means fixed; it can be increased easily through the application of technology. Introduction of improved grass, grain feedings to reduce demand for grass, sophisticated waste treatment facilities, additional water supplies, automated barns, and the like would all increase the number of cattle that could be sustained on the original acre. Likewise, failure of the grass crop, drought, abnormally foul weather, etc., could reduce the carrying capacity. But even with technology, the carrying capacity of the region cannot be infinitely increased, the effects of technology being subject to the law of diminishing returns.

The carrying capacity concept then helps to relate the level and kind of population that a region sustain: the mix of transportation, commercial, utility, and industrial activities that can coexist within the ecological constraints imposed by the region, and the technological limits imposed by the current and expected state-of-the-art. What environmental protection and planning tries to do, then, is to identify the most stringent limits to the carrying capacity and then negotiate, engineer, and plan ways of operating within these most rigid constraints.

Do economic growth and improvement in the material standard of living necessitate environmental degradation? Quite clearly, they do not. But this does imply that extensive capital investment will be required to remedy pollution mistakes of the past and prevent future degradation of the environment. The Council on Environmental Quality has estimated that the nation will spend almost $200 billion from 1973 through 1982 for environmental improvement as a result of Federal legislation,or about 1% of GNP annually.[4] As the nation has always made some expenditures for environmental quality even in the absence of Federal mandates (for instance, garbage collection and municipal sewers), this estimate does not reflect

[4] Council on Environmental Quality, Fifth Annual Report on Environmental Quality - 1974, (Washington, D.C." Government Printing Office) p.173. (hereafter called Environmental Quality, 1974).

the total expenditures for pollution abatement. The CEQ estimated "total" expenditures include expenditures for air and water pollution, noise prevention, radiation and nuclear power plant safeguards, solid waste disposal and land reclamation programs. The CEQ's "total" estimate of pollution control expenditures from 1973 to 1982 is $325 billion (in 1973 dollars) as shown in Figure 1.[5] This estimate is provided only to give the reader insight into the magnitude of the domestic environmental protection problem. To permit comparison, consider that the Federal government has spent only $18.2 billion in the 1965-1974 time period for this purpose.[6]

Undoubtedly, the regulations and requirements will change as further research gives additional insight into the long term consequences of environmental degradation and human ingestion of industrial, agricultural and household wastes. It is likely that the expenditures required could escalate considerably. As the state-of-the-art in pollution control and abatement technology progresses, cost reductions and economies of scale may occur.

Failure to address adequately the domestic environmental degradation issues can contribute to increasing international conflict. While the problem of the lack of international agreement over shared resources is discussed elsewhere, it is important to note here the global problem of environmental degradation. Many of the climatic changes of the last several decades which are now aggravating the global food situation are

[5] Ibid., p.221.

[6] U. S. Bureau of the Census, Statistical Abstract of the United States 1974, (Washington, D. C.: Government Printing Office) (hereafter Statistical Abstract 1974).

being related to acts of man in the industrialized world. The country cannot be an environmental isolationist. Even if this were determined to be an effective or desirable policy, the global ecosystem will not permit "exporting" of pollution. As more is learned about the global biosphere and climatic change the interrelatedness among actions, decisions and consequences is likely to become much more clear.

This investigation of the environment has identified four primary issues which we believe to be the fundamental environmental problems facing this country:

- Deterioration and modification of the biosphere leading to irreversible climatic change of the global ecosystem.
- Destruction of the recreational aesthetic agricultural, conservation, preservation and residential uses of the land leading to inadequate or misallocated supplies of land for sustenance of human and animal life.
- Contamination, misuse and abuse of the global oceans leading to ecosystem destruction and damage, health consequences and international conflict.
- Pollution and contamination of the domestic environment leading to detrimental, long run and possible irreversible effects upon human and animal health and longevity.

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FIGURE 1

ESTIMATED TOTAL POLLUTION CONTROL EXPENDITURES

(In billions of 1973 dollars)

Pollutant/medium	1973			1982			Cumulative -- 1973-82		
	O&M[1]	Capital Costs[2]	Total Annual Costs[3]	O&M[1]	Capital Costs[2]	Total Annual Costs[3]	Capital Investment	O&M[1]	Total Annual Costs[3]
Air pollution									
Public	0.1	0.1	0.2	0.5	0.2	0.7	1.7	3.8	5.4
Private									
Mobile	1.2	0.2	1.4	8.4	4.9	13.3	31.3	49.9	74.4
Stationary	1.1	1.1	2.2	4.7	3.1	7.9	21.4	35.3	62.6
Total	2.4	1.4	3.8	13.6	8.2	21.9	54.4	89.0	142.4
Water pollution									
Public									
Federal	0.2	NA	NA	0.2	NA	NA	1.8	NA	NA
State and Local	1.4	4.1	5.4	4.2	8.3	12.5	50.6	27.4	88.5
Private									
Industrial	0.9	1.1	2.0	2.8	2.2	5.0	16.5	21.6	40.4
Utilities	NA	NA	0.01	0.4	0.3	0.7	4.4	2.2	3.5
Total	2.5	5.2	7.4	7.6	10.8	18.2	73.3	51.2	132.4
Noise	NA	0.1	NA	NA	1.0-1.4	NA	6.0-8.7	NA	NA
Radiation									
Nuclear power plants	NA	NA	NA	0.05	< 0.05	0.07	0.3	0.08	0.3
Solid waste									
Public	1.1	0.3	1.4	1.9	0.5	2.4	4.2	15.5	19.3
Private	1.9	< 0.05	1.9	3.0	0.1	3.1	0.4	25.2	25.6
Total	3.0	0.3	3.3	4.9	0.6	5.5	4.6	40.7	44.9
Land reclamation									
Surface mining[4]	0.3	0	0.3	0.6	0	0.6	0	5.0	5.0
GRAND TOTAL[5]	8.2	6.9	14.8	26.7	19.7	46.3	132.6	185.9	325.0

[1] Operating and maintenance costs.

[2] Interest and depreciation.

[3] O&M plus capital costs.

[4] Includes only coal mining.

[5] Does not include noise control

Source: Council of Environmental Quality, Fifth Annual Report on Environmental Quality - 1974, (Washington, D.C.: Government Printing Office), p.221.

ENVIRONMENT: THE ISSUES

Deterioration and Modification of the Biosphere Leading to Irreversible Climatic Change of the Global Ecosystem

Pollution and Contamination of the Domestic Environment Leading to Detrimental, Long Run and Possible Irreversible Effects Upon Human and Animal Health and Longevity

Contamination, Misuse and Abuse of the Global Oceans Leading to Ecosystem Damage and Destruction, Health Consequences and International Conflict

Destruction of the Recreational, Asthetic, Agricultural, Wildlife Conservation and Preservation, and Residential Uses of the Land As a Result of the Abuses of the Manufacturing, Commercial, Extractive, Construction, and Transportation Industries

Accumulation of Potentially Harmful Substances in the Food Chain Leading to Disease and Genetic Defects in the Population

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N76-18975

POLLUTION AND CONTAMINATION OF THE DOMESTIC ENVIRONMENT LEADING TO DETRIMENTAL, LONG RUN AND POSSIBLE IRREVERSIBLE EFFECTS UPON HUMAN AND ANIMAL HEALTH AND LONGEVITY

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The Issue:

Thorough understanding of the diverse negative impacts of widespread waste disposal into the domestic environment remains at an early stage even though man has for some time shown concern about municipal garbage disposal, sanitation treatment and contaminated drinking water. The advent of industrialization certainly brought concern and documentation of the occupational hazards of working in close contact with toxic and carcinogenic materials. However, it is only recently that fear has been expressed that widespread dispersion of these materials in the air and water environment may be hazardous as the regional and individual impacts from pollutants. Man now recognizes that his basic abundant resources of air, water and land cannot absorb infinite amounts of polluting materials. This recognition that environmental degradation, once thought only to be aesthetically offensive, poses health concerns has lead to the establishment of the Environmental Protection Agency, the Council on Environmental Quality and the National Environmental Policy Act.

Immediate concern with rehabilitating the domestic environment largely manifested itself in the Clean Air Act of 1970, which required establishment of national standards of ambient air quality; primary standards to protect health and secondary standards to protect the public welfare, specifically property, vegetation and aesthetics. These standards provide the basis for state implementation plans. A second law governing rehabilitation of the nation's waters, the Federal Water Pollution Control Act and Amendments of 1972, requires every "point source" discharge of pollutants to obtain a permit specifying the amount and constituents of the effluents.

Dimensions of the Domestic Problem of Air and Water Pollution:

In general, the problems of air, water and land pollution are largely associated with the disposal of wastes from a variety of man-based activities such as industrial processes, fuel combustion in stationary sources (energy generation), transportation, agricultural and solid waste disposal. There are not many alternatives available for waste disposal: it can be dumped into the nearest body of water, burned, buried or chemically transformed.

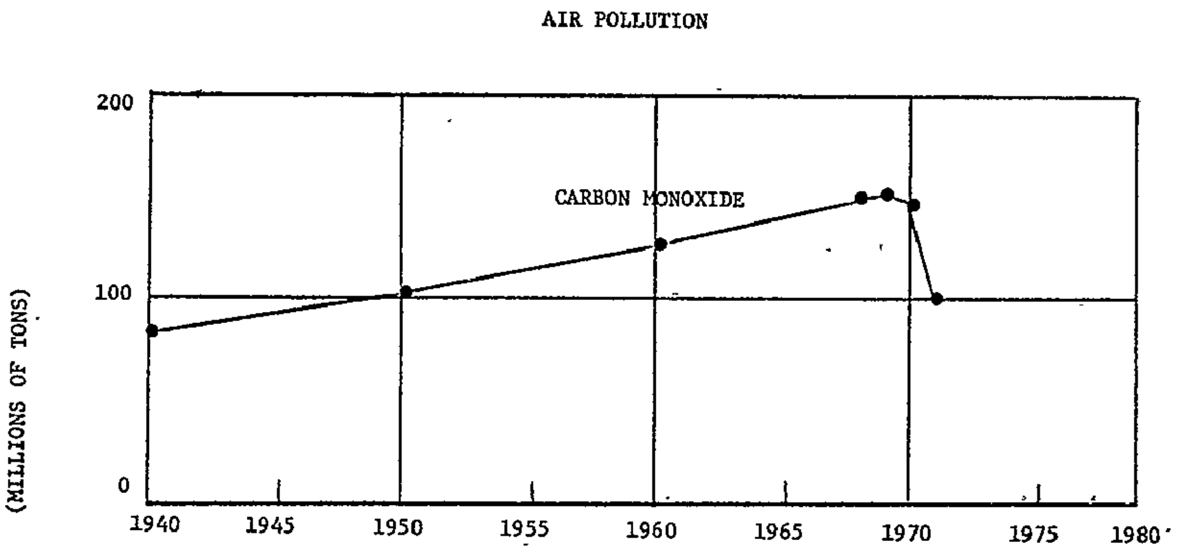
This section will briefly discuss the quality of the air and water environment, the long term impact of this quality, the determinants of air and water quality, and finally, the origins of air and water pollution.

Quality of the Air: As Figure 1 shows, there has been some improvement in limiting air pollution; however, poor air quality is still common place and the air quality of some regions is actually deteriorating. In fact, despite legal mandates to the contrary, the Environmental Protection Agency estimates that by mid-1975 (the original target date of the Clean Air Act of 1970 for "clean air") at least 75% of the U.S. population will be experiencing levels of sulfur dioxide and/or particulate pollution in excess of the ceiling necessary to protect health.[1]

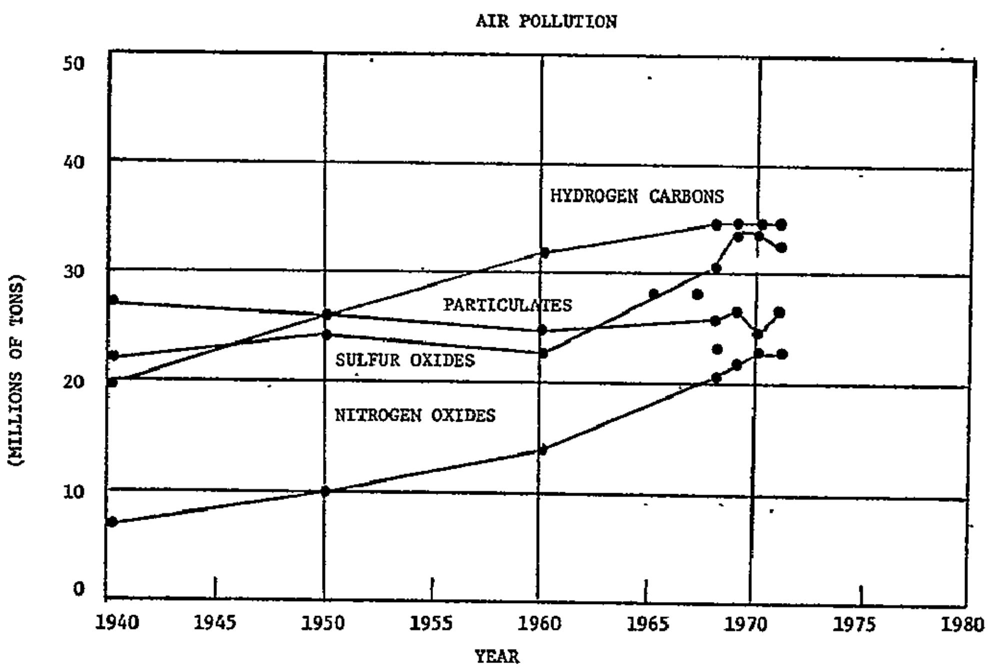
In discussing air pollution trends, a distinction must be made between "air quality" and "emission trends." There are two levels of federal air quality standards: a primary ambient air standard, that level necessary to protect human health; and a secondary air standard, that level necessary to protect the public welfare (economic losses

[1]Environmental Protection Agency, The National Air Monitoring Program: Air Quality and Emission Trends, Vol. 1, 1973, p.170.

FIGURE 1



Source: EPA, Nationwide Air Pollutant Emission Trends 1940-1970 (1972).

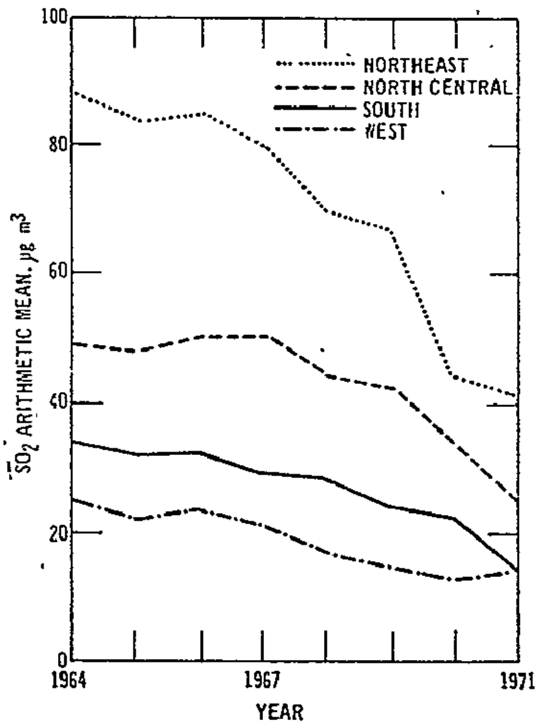


Source: EPA, Nationwide Air Pollutant Emission Trends 1940-1970 (1972).

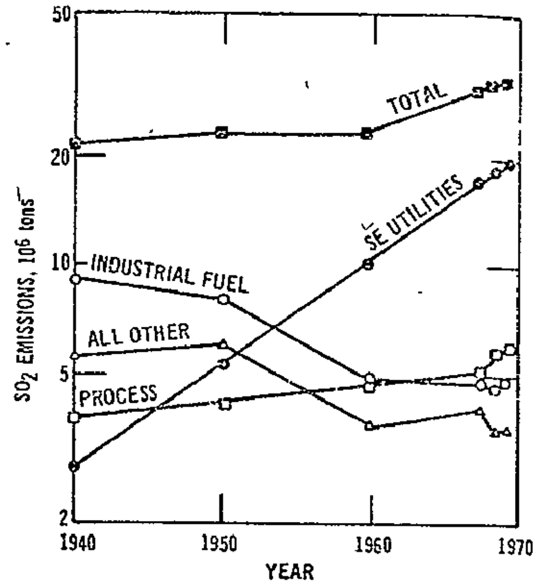
from recreation days lost, for instance). The emphasis is on the ambient concept -- which refers to localized concentrations of given pollutants. Specifically, ambient air quality standards exist for suspended particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), photochemical oxidants (O_x), hydrocarbons (HC) and nitrogen (NO_x), which are monitored by the collection of data at different times of the day in specific center city locations. Generalizations about national or even regional air quality trends *cannot* be made from these data: only assessments of the individual sites can be made.

To draw conclusions about air quality at a national level requires investigation of the nationwide emissions data. These data, prepared on a nationwide basis are *not* the result of direct measurement, but rather are inferential. They are largely based upon emission factors but include estimating a majority of the emissions on a point-by-point basis, using such parameters as fuel rates, process rates, control equipment efficiencies, motor vehicle emissions, vehicle miles of travel, average vehicle speeds, population, and distribution and age of the motor vehicle. It is the ambient air standard (the concentration of a pollutant at a given site) that is particularly health threatening; however, it is the emissions trends that normally causes the ambient air standard to be exceeded. However, it is possible for these indices to move in opposite directions.

Consider, for example, a comparison of the measured average central city sulfur dioxide concentrations (which has been decreasing) with the level of nationwide SO_2 emissions (which has been increasing), (see Figure 2).



Regional comparisons of composite annual arithmetic mean sulfur dioxide concentrations at urban NASN stations.



Nationwide SO_2 emissions (1940-1970).

FIGURE 2

Source: EPA, The National Air Monitoring Program: Air Quality and Emission Trends, p. 1-12, 1-14.

Let us examine this apparent contradiction. SO_2 emission rates in central cities have been decreasing largely due to the absence of coal combustion and the reliance upon cleaner fuels, such as natural gas and distillate fuel oil. While this does not contribute substantially to the nationwide pattern of SO_2 emissions, it does positively effect localized air quality. Another contributing factor is that large point sources of SO_2 -- such as electric power plants -- cannot locate in or near the central city. Hence, the problem on a national level could be deteriorating, while improvements are seen at a local level.

Figure 3 presents the estimated total nationwide emission levels for the period 1940-1970. While inferential, EPA has stated that "these estimates provide fairly reliable representations of nationwide emission totals."[2] This data shows that total CO emissions have increased at a compound annual rate of 1.1% over the thirty year period, while CO from automotive sources have increased at an annual rate of nearly 4%. Hydrocarbon emissions increased about 1.7% over the thirty years; again automotive sources contributed at a greater rate, about 3.3% increase annually. For the same period growth rates of NO_x emissions were similar -- 4.8% annually for motor vehicles and 3.7% for stationary fuel combustion sources. But over the last 10 years, NO_x emissions from steam electric power plants increased at an annual rate of 7.4%[3]

In contrast, investigation of air quality measures at particular center city sites is more encourging. Figure 4 indicates the time series data for these on-site measurements of carbon monoxide. Again, these are

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[2] Environmental Protection Agency, The National Air Monitoring Program: Air Quality and Emission Trends, Vol. 1, 1973, p.170.

[3] Ibid., p.1-9, 1-15.

FIGURE 3

ESTIMATED TOTAL NATIONWIDE EMISSION LEVELS, 1940-1970

(10^6 tons/yr)

	SO_2	PM	CO	HC	NO_x
1940 Controllable	22.2	19.2	42.5	10.1	5.5
Misc. (uncontrollable)[a]	0.6	25.7	30.5	6.5	1.0
Total	22.8	44.9	72.5	16.6	6.5
1950 Controllable	24.3	20.8	62.3	15.6	8.2
Misc. (uncontrollable)	0.6	12.4	20.6	6.2	0.6
Total	24.9	33.2	82.9	21.8	8.8
1960 Controllable	22.6	21.0	79.3	18.8	10.9
Misc. (uncontrollable)	0.6	8.9	19.3	7.0	0.5
Total	23.2	29.9	98.6	25.8	11.4
1968 Controllable	30.5	22.5	93.4	22.1	19.1
Misc. (uncontrollable)	0.6	5.9	18.0	7.6	0.4
Total	31.1	28.4	111.4	29.7	19.5
1969 Controllable	31.9	22.8	97.6	21.9	20.6
Misc. (uncontrollable)	0.2	12.2	17.5	6.8	0.5
Total	32.1	35.0	115.1	28.7	21.1
1970 Controllable	33.3	22.3	96.0	22.5	22.0
Misc. (uncontrollable)	0.1	3.2	4.7	4.8	0.1
Total	33.4	25.5	100.7	27.3	22.1

[a]Uncontrollable sources include forest fires, structural fires, coal refuse banks, some agricultural burning, and some solvent evaporation.

Source: EPA, The National Air Monitoring Program: Air Quality and Emission Trends, p. 1-12, 1-14

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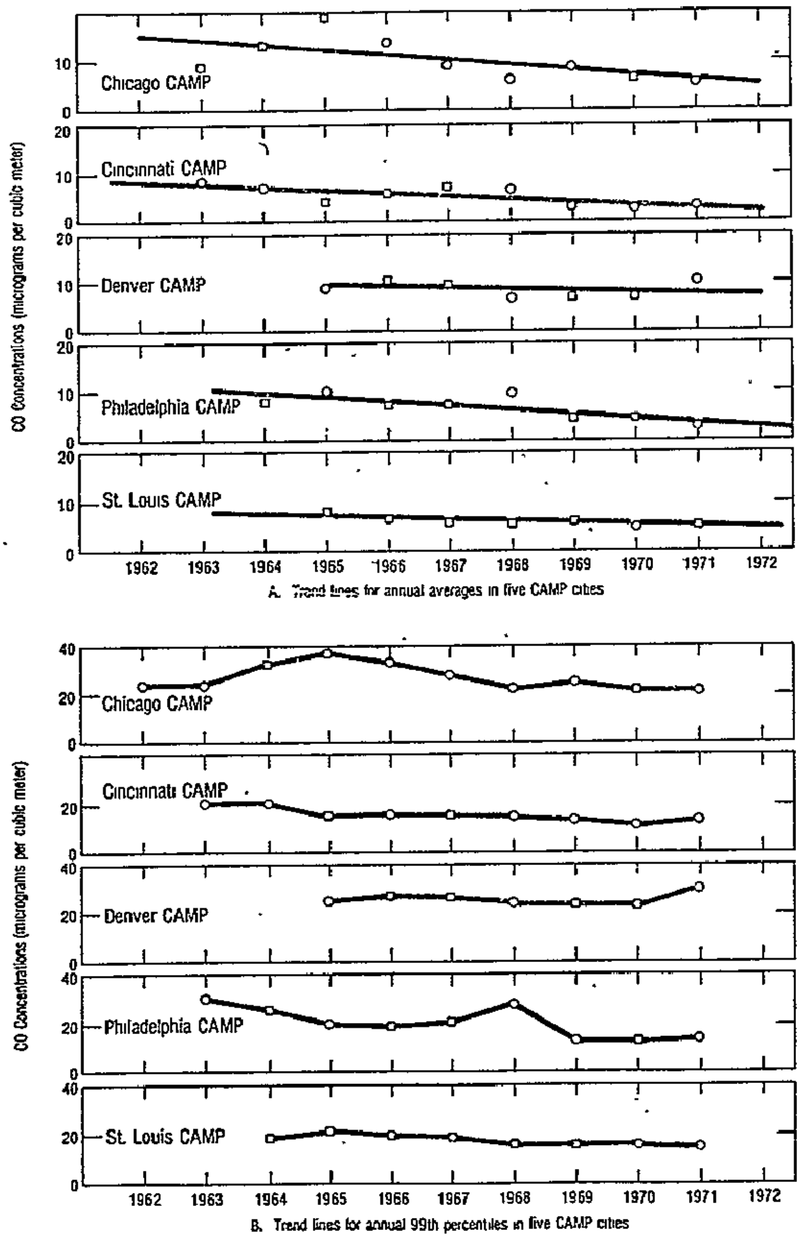
FIGURE 4

TRENDS IN CARBON MONOXIDE CONCENTRATIONS, 1961-72, CONTINUOUS AIR MONITORING PROGRAM (CAMP) CITIES



[1] O indicates invalid average (average based on incomplete data).

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Source: EPA, The National Air Monitoring Program: Air Quality and Emission Trends (1973), Figures 4-14 and 4-18.

assessed by the measurement of changes in specific pollutant concentrations on a pollutant-by-pollutant basis. Urban areas show a long term trend of decline in total suspended particulates and a marked decline in the last decade of sulfur dioxide and carbon monoxide. However, analysis of the levels of nitric oxide, nitrogen dioxide and the oxides of nitrogen indicates for most cities an increase in the annual average concentration with time.[4]

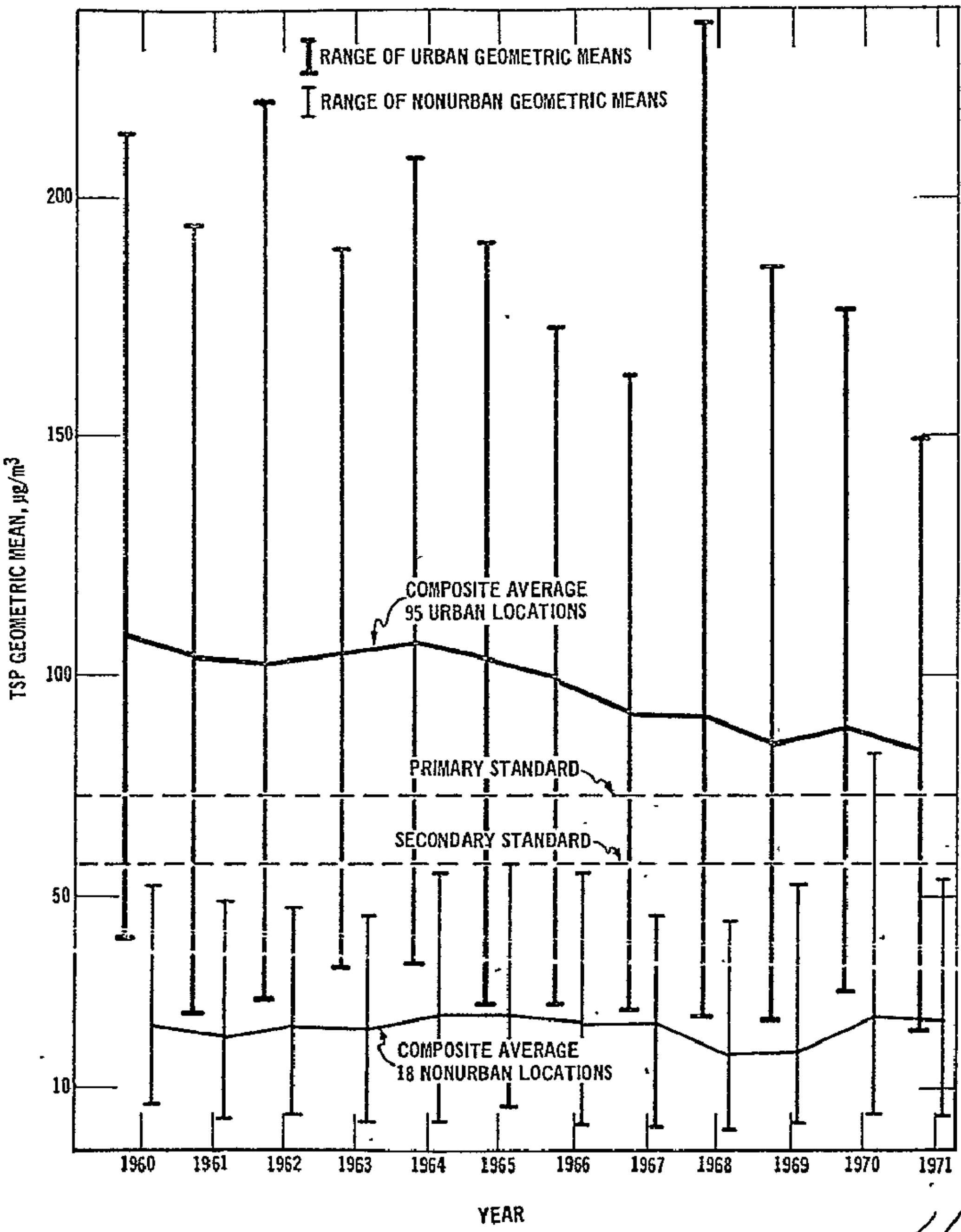
What does this mean? We have indicated that emissions of pollutants are increasing but air quality may be improving. Examination of the data suggests that while environmental improvements are being made, many of the reporting stations are still reporting concentrations in excess of the primary ambient air quality standard, see Figure 5. Should the *average* concentration over the year not exceed the primary standard, the range of the geometric mean is sufficiently wide to ensure that primary health standards are still exceeded some portion of the time. The fact that emissions trends show a consistently upward path indicates that the problem is by no means under control.

Improvements in the TSP and SO_2 concentrations were primarily found in areas where pollution concentrations had been the highest. However, environmental degradation and substantial pollution was found in those areas where there had been no significant air pollution or the environment previously had met the primary ambient air quality standard. Clearly, the environmental problem of air quality is not solved.

[4] Ibid., Chapter 4.

FIGURE 5

COMPOSITE ANNUAL MEANS OF TOTAL SUSPENDED PARTICULATE
AT URBAN AND NONURBAN NASN STATIONS



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Source: EPA, <u>The National Air Monitoring Program: Air Quality and Emission Trends</u>, Figure 1-1, p.1-9.

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OF POOR QUALITY

The impact of such air pollution upon human health is not well understood, and the number of citizens whose health is affected is not clearly known. Gross estimates suggest that health damages from air pollution affects at minimum 50 million U.S. citizens at an annual cost of over $6 billion.[5]

The biology and chemistry of the effects of air pollution on human health are not well understood. What is known is that the complexity and the interaction of the pollutant with other environmental factors may well render the pollutant more hazardous than the pollutant acting by itself. One of the concerns of environmental scientists is the possible synergistic effects among groups of pollutants. For instance, many gases interacting with particulate pollution present much more serious health hazards than either one acting alone. Secondly, the impact of weather factors may effect the hazardousness of a pollutant. For instance, a given pollutant in the presence of humidity, specific termperatures and catalysts may cause significant health damages. As an example, SO_2 in concentration typical of urban areas presents only slight hazards to the lung. However, under certain temperature and humidity conditions when it combines with wet aerosal, its hazards increase significantly. Because of SO_2's ability to oxidize into SO_3 and then to form H_2SO_4, it is a particularly dangerous sulfur compound.[6]

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[5] T. S. Waddell, The Economic Damages of Air Pollution (Washington, D.C.: Environmental Research Center: EPA, May, 1974).

[6] R. Frank, et al., Sulfur Oxides and Particles: Effects on Pulmonary Physiology in Man and Animals," Proceedings of the Conference on Health Effects of Air Pollutants, (Washington, D. C.: National Academy of Sciences, National Research Council, prepared for the Committee on Public Works, United States Senate, November 1973).

Historical examples of the health effects of acute periods of high pollution provide the clearest and most substantial evidence of the relationship between health and air pollution. The massive inversions and "killer fogs" that have occurred in the Meuse Valley, Donora, New York City, London and elsewhere resulted in an increase in mortality from the very first day of the episode. The excess deaths were attributed to bronchitis, pneumonia, cardiac and respiratory diseases, influenza and the like.

It is interesting to note that despite advances in chemotherapy, the introduction of broad spectrum antibiotics and biochemistry innovations the death rate from such diseases as heart disease, cancer, pneumonia, bronchitis, emphysema and asthma have remained constant or actually increased since 1950.[7] These diseases, of course, are the ones most prominently associated with environmental pollutants. Research also has determined that the main effect was exacerbation of existing disease rather than initiation of illness.[8] Comparison of the death rates for chronic respiratory disease between urban and rural areas (which typically demonstrates the effects of a reduced level of atmospheric pollution) for several countries reveals substantially higher mortality rates for the urban area. Similarly, differences can even be found within the same city and are shown to be correlated with point sources of pollution.[9]

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[7] U.S. Bureau of the Census, Statistical Abstract of the United States: 1974, 95th Edition, (Washington, D.C.: Government Printing Office, 1974), p.62.

[8] I.T.T. Higgins & B. Ferris, "Epidemiology of Sulfur Oxides and Particles," Proceedings of the Conference on Health Effects of Air Pollutants, (Washington, D.C.: National Academy of Sciences, National Research Council, prepared for the Committee on Public Works, United States Senate, November 1973).

[9] Higgins and Ferris, op.cit., p

There is increasing concern that polluted community air may be carcinogenic. The evidence of some occupation/lung cancer connections is substantial; indicating that prolonged occupations such as radioactive ore mining and smelting, coke oven operations, gas works, chromium and nickel ore refining, and asbestos mining all cause significantly increased rates of lung cancer. Experiments with animals suggest that many common community air pollutants may cause lung cancer. Among these are radionucleides, hydrocarbons, fluorocarbons, sulfur dioxide, hydrocarbons, and polyurethane dust.[10]

Recent evidence has been accumulated to suggest that it is not just workers who suffer from the health effects of these toxic materials, but also workers' families and neighbors of the industrial sites. A medical team from Mt. Sinai found that 35% of asbestos workers' families had lung abnormalities comparable to men who had worked in the actual asbestos factory. Other examples of the spread of occupational hazards are common:

- autopsy findings indicate that 100% of the urban population has asbestos fibers in their lungs;
- people who live near orchards where lead arsenate is used as an insecticide have 20% more cases of lung cancer than would be expected from the general population;
- people living near a beryllium processing plant are dying of berylliosis, a lung disease similar to black lung disease.[11]

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[10] Paul Kotin, "Mutagenic and Carcinogenic Problems Associated with Air Pollutants," Proceedings of the Conference on Health Effects of Air Pollutants, (Washington, D.C.: National Academy of Sciences, National Research Council, prepared for the Committee on Public Works, United States Senate, November 1973).

[11] Stuart Auerbach, "Job-Caused Cancers are Found Spreading to Workers' Families," Washington Post (March 25, 1975) p.1.

The number of people so affected is unknown. Because the effects of pollution are likely to be exacerbations of existing conditions or symptoms and ill defined conditions; it is, of course, difficult to ascribe causality. However, a crude estimate has been made which suggests that a minimum 50 million people -- one quarter of the American population -- may be affected by pollution (see Figure 6).

Health effects of air pollution are just the primary problem. Secondary problems include economic costs associated with air pollution damages to man-made materials, vegetation, agriculture, and property values. One study estimated that the total costs of air pollution damages in the U.S. in 1970 ranged from $6.1 billion to $18.5 billion.[12]

Sources of Air Pollution: Any reader of the daily paper knows the primary contributors to air pollution: the automobile, combustion of fuel for steam electric plants, and industrial processes. Figures 7 and 8 show the sources of air pollutant emissions. Transportation and fuel combustion are clearly the leading contributors to the pollution problem. Figure 9 shows their contribution over time.

The recent energy shortages have emphasized once again the close relationship between energy consumption and environmental protection. Fuel combustion at stationary sources (including power plants, factories, residential and commercial heating) accounts for almost 80% of SO_2 emissions and over 25% of particulate emissions. Automobiles and other forms of transportation contribute over 75% of CO and over 50% of nitrogen oxides.[13]

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[12]Waddell, Op. Cit.

[13]Council on Environmental Quality, Energy and the Environment (1973), p. 9-10.

FIGURE 6

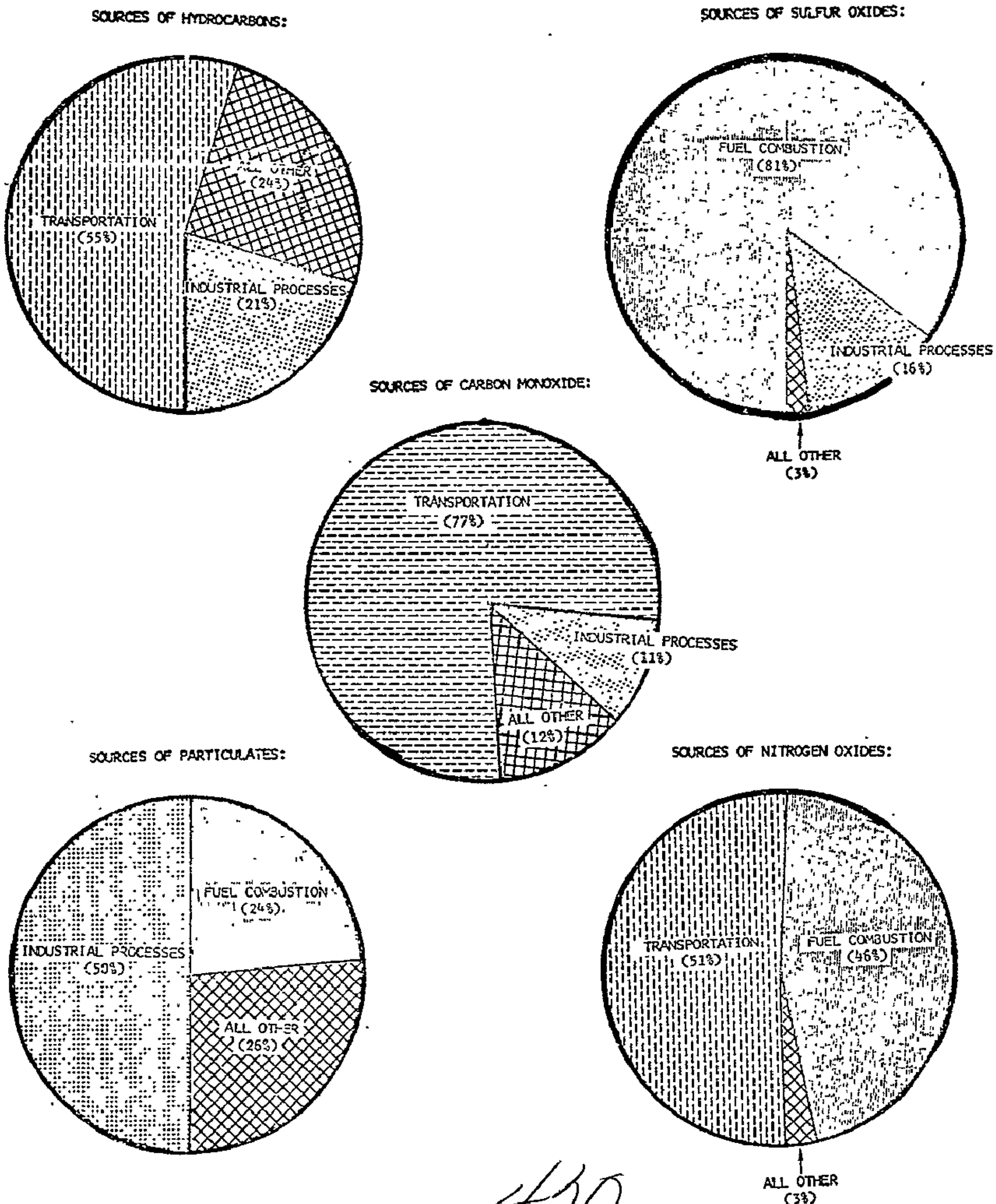
ROUGH ESTIMATES OF SOME HEALTH BENEFITS THAT CAN BE REALIZED BY THE CONTROL OF SULFUR DIOXIDE, SUSPENDED SULFATES, AND SUSPENDED PARTICULATES

Health effect	Rough estimate of population affected,[a] million people	Estimated possible change	Rough estimate of annual health benefits, $ million
Irritation symptoms arising from acute air pollution episodes	50	Symptoms 75-100% eliminated	Not known
Impairment of ventilatory function	50	Subtle improvement[c]	Not known
Symptom aggravation in the elderly	4	On the average 10-30% fewer would report a worsening of symptoms[d]	150-800[e]
Asthma attacks	4	On the average 10-50% fewer asthmatics might report an attack[f]	50-300[g]
Acute lower respiratory	50	Reduction in restricted activity days by 10-40% and physician visits by 20-50%[h]	400-1500[i]
Chronic bronchitis	6	Reduction in prevalence by 20-40%[j]	300-600[k]

Source: EPA, The Economic Damages of Air Pollution, Table 8, p.1-9.

FIGURE 7

SOURCES OF AIR POLLUTION EMISSIONS



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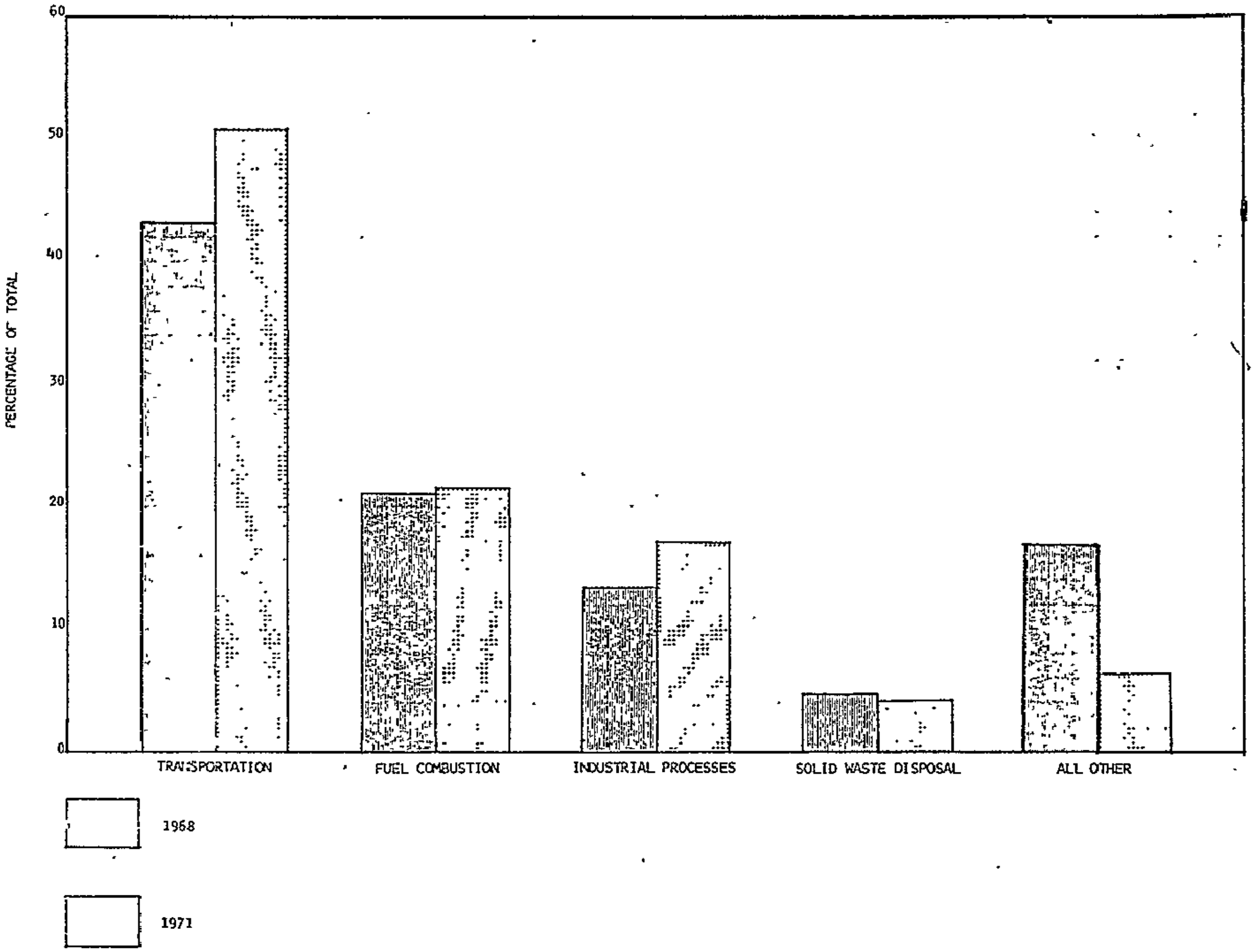
SOURCE: U.S. ENVIRONMENTAL PROTECTION AGENCY.

Figure 8

AIR POLLUTION EMISSIONS BY SOURCE



SOURCE: U.S. ENVIRONMENTAL PROTECTION AGENCY.

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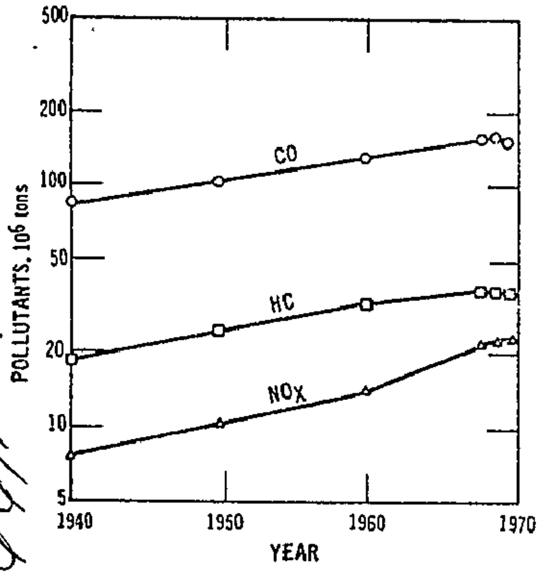
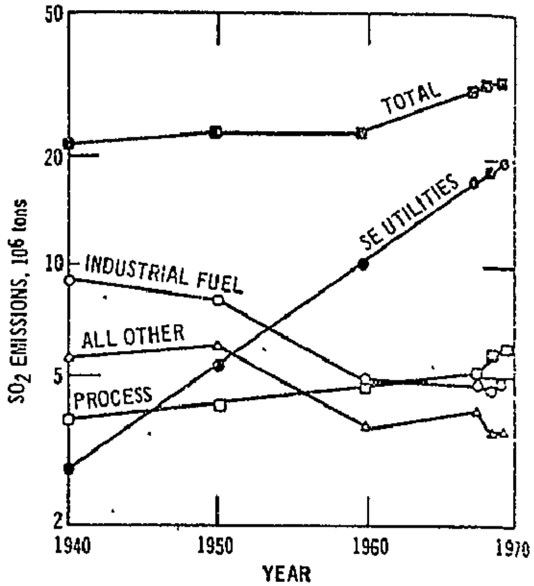
FIGURE 9

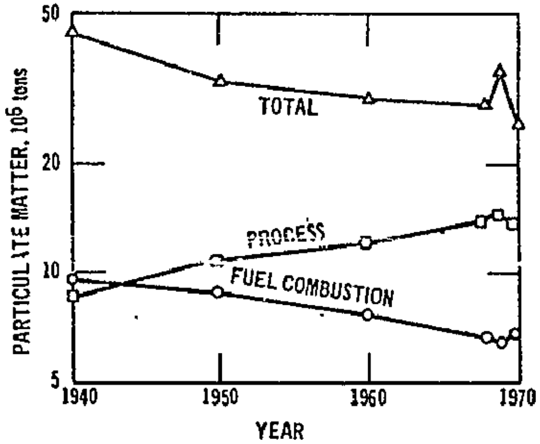
SOURCES OF AIR POLLUTION EMISSIONS



Nationwide emissions for HC, CO, and NO_x(1940-1970)



Nationwide SO_2 emissions (1940-1970)



Nationwide particulate matter emissions (1940-1970)

Source: EPA, The National Air Monitoring Program: Air Quality and Emission Trends (1973), Figures 1-7, 1-8, and 1-9, p.1-14.

In an effort to meet the energy shortages some areas were permitted to use high sulfur fuels. It appears that these variances may have had almost immediate impact upon the ambient air quality. Philadelphia, for instance, experienced a marked upward trend in ambient SO_2 soon after a number of sulfur fuel variances were granted in the winter of 1973-1974 [14] (See Figure 10). Energy policy cannot be formed in the absence of environmental policy. In fact, a recent EPA study identifies the impacts of new energy initiatives as the highest ranking health and intermediate term pollution problem.[15]

While energy policy has a host of environmentally related issues (witness: the Alaska pipeline, deep water ports, nuclear power plant siting, stripmining of coal, etc.), we are primarily concerned here with the combustion of fuel for steam electric plants, largely a controversy over sulfur dioxide emissions. Several strategies have been used in the recent past to cut back on utilities' generation of sulfur dioxides -- prohibitions on high sulfur fuel (coal), requirements for "scrubbers" to remove the SO_2 from the air, or fuel desulfurization. The present controversy is over the use of scrubbers (EPA wants the utilities to spend $7.5 billion on scrubbers by 1980[16]), the questionable scientific basis (so argue the utilities) for the alleged health dangers of sulfur dioxide, and the soaring demands for energy in the face of declining or unavailable low sulfur supplies.

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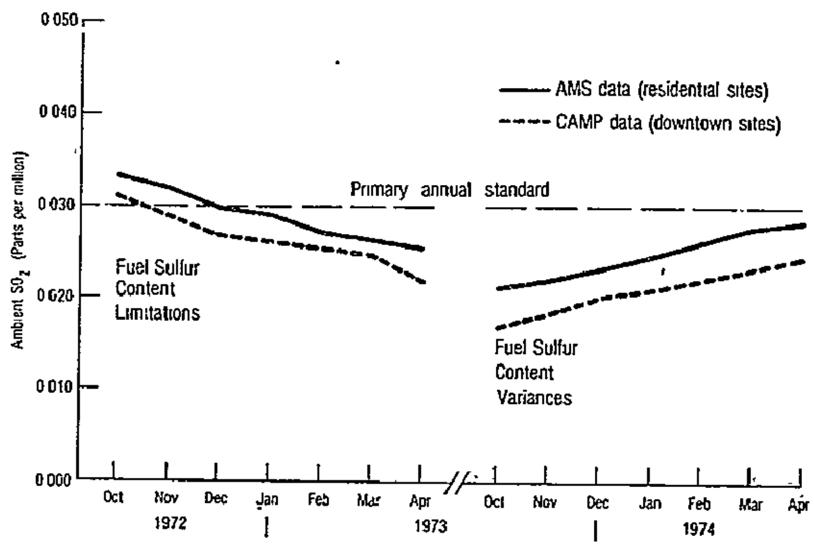
[14] Council on Environmental Quality, Fifth Annual Report on Environmental Quality - 1974, (Washington, D.C.: Government Printing Office), p. 277.

[15] EPA, Development of Predictions of Future Pollution Problems (March 1974).

[16] Paul H. Weaver, "Behind the Great Scrubber Fracas," Fortune (February 1975), p.105.

FIGURE 10

PHILADELPHIA: FUEL SULFUR CONTENT VS AMBIENT SULFUR DIOXIDE (12-MONTH MOVING AVERAGES)



Source: Based on data from Air Management Services, City of Philadelphia, Pa.

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Until recently, the bulk of the country's utility firms have relied upon naturally low sulfur fuel: natural gas basically has none, oil has little -- and both of these fuels have essentially run out, at least for the short run. At the same time, the domestic supply of high sulfur coal is essentially unlimited. In fact the U.S. reserves of coal, oil shale and uranium vastly exceed the world's proved reserves of crude oil. The coal reserves are estimated to be 1600 billion tons, compared to the 1970 consumption of 322 million tons.[17]

The environmentalists argue that coal smoke is half the nation's air pollution problem (motor vehicle exhaust being the other half) and that any use of coal requires extensive desulfurization. The utilities argue that it is not a proven health hazard. Of all their arguments, this appears to be the weakest. As mentioned previously, the synergistic effect of SO_2 acting in concert with a wet aerosals can produce deadly H_2SO_4. The second argument from the utilities sector is based on the cost of removing sulfur dioxide. The cost is substantial ($7.5 billion for utilities by 1980), occurring at a risky financial period for the utilities and at a time when they are required to expand capacity, as well as find and develop new fuel sources.

The utilities final argument rests on technology. Fuel desulfurization (removal of the sulfur in advance of burning) has been used routinely for oil for some time, but the technology for coal is not commercially available and some estimates suggest that it will not be available until the mid-1980's. The available alternatives now are scrubbers or tall stacks. The utilities argue that the dilution method, reducing sulfur

[17] David Rose, "Energy Policy in the U.S.," Scientific American (January 1974), p.25.

dioxide concentrations through the use of extremely tall stacks, effectively controls the SO_2 problems at ground level. However, despite the utilities advocacy of this system, in lieu of scrubbers, recent research seems to indicate that dilution is *not* enough and does not adequately meet health standards.

Hence, the scrubber technology remains. A scrubber essentially removes the SO_2 before the smoke from combustion is allowed to enter the atmosphere. The sulfur dioxide is absorbed by a slurry and reacts with limestone to form the precipitates calcium sulfate and calcium sulfite. The utilities argue that scrubbers are a new and untried technology, they create their own environmental problems (i.e., sludge disposal) and they decrease the efficiency of generating systems.[18]

While there has not been a change in EPA policy, selective relaxations have been allowed and have thereafter clearly demonstrated the impact of high sulfur fuels upon the environment, as discussed previously. It is quite likely that in the energy short months to come, the utilities will win at least a short run reprieve which may result at least in temporary degradation of the environment. In the long run, however, it is more likely that the Environmental Protection Agency will be able to enforce its restrictions and regulations, especially as scrubber technology improves.

The second major contributor to air pollution is the automobile. Automobiles contribute the bulk of the carbon monoxide, hydrocarbon, and nitrogen oxide pollution. As the number of registered automobiles is expected to almost triple by the year 2000, (see Figure 11), the

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[18] Ibid.

FIGURE 11

ITEMIZATION OF THE AUTOMOBILE TOTALS INCLUDING QUANTITIES REPLACED AND NET ADDITIONS FROM 1950 EXTRAPOLATED TO 2000[2,3,4,5]

Year	Total Registered Autos (Thousands)	Net Replaced Demand (Thousands)	Net Replaced Percent of Total	Total Purchases Total (Thousands)	Total Purchases Percent of Total	Net Additions Total (Thousands)	Net Additions Percent of Total
1950	40,334	2,700	7	6,500	16	3,800	9
1955	52,092	4,000	8	7,700	15	3,700	7
1960	62,258	5,000	8	7,000	11	2,000	3
1966	80,106	5,556	7	9,028	11	3,472	4
1967	82,367	6,076	7	8,337	10	2,261	3
1968	85,793	6,230	7	9,565	11	3,426	4
1969	89,156	6,219	7	9,582	11	3,363	4
1970	90,978	6,575	7	8,397	9	1,822	2
1971	92,799	8,426	9	10,247	11	1,821	2
1980	120,000	9,600	8	14,000	12	4,400	4
1990	170,000	13,600	8	19,700	12	6,100	4
2000	244,000	19,500	8	28,800	12	9,300	4

problem will clearly not go away by attrition. Here, there is no question whatsoever about the hazards of automobile exhaust. The contribution of automobile exhaust to urban smog has been experimentally verified and was apparent as early as the late 1950's in this country.[19] The Clean Air Act originally mandated that regulated emissions from automobiles be reduced by 90% from 1970 levels by 1975. Since the original mandate, auto manufacturers have been granted two delays; early in March they were granted the third. Now the goal is 1978. The efforts have concentrated on emission control devices, new gasoline formulations, improved gasoline efficiency (meaning smaller cars), and the long run solution, a substitution for the internal combustion engine.

The controversy has centered over the implementation of the catalytic converter. The function of the catalytic converter is to oxidize hydrocarbons (HC) and carbon monoxide (CO) to the harmless materials water (H_2O) and carbon dioxide (CO_2). Originally, the technological barrier was the development of a catalyst which was 1) effective, 2) available and 3) inexpensive. The chosen catalysts, platinum coated aluminate and precious-metal-coated aluminate, may not completely meet these criteria.

The arguments against implementation of the catalytic converter were similar to those used against the scrubber: too expensive, technologically unsound, unknown consequences, economic costs too high, and so forth. The health effects of automobile exhaust are well known; there has not been an argument on this point. Despite automobile manufacturers assertions to the contrary, EPA research as well as that of the

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[19] Development of Predictions of Future Pollution Problems, op.cit., p.56.

the National Academy of Sciences indicate that achievement of statutory emissions is currently technically feasible.[20]

Regardless of the public relations, the anti-catalytic converter arguments are founded largely on notions of the "public welfare." The auto industry contributes 16% of the GNP, and a large number of materials producers (i.e., lead, synthetic rubber, malleable iron, zinc) are dependent upon the automobile industry. The current postponement of the standards is largely a consequence of fears for the economy. There is no question that the automobile manufacturers are somewhat responsible for their own inability to respond to the law more quickly and effectively. Similarly, it is equally apparent that the catalytic converter will be improved; one would be horribly surpised if improvements were not possible.

Researchers are in agreement, there are no technological -- nor real economic -- barriers to meeting the existing standards. The question then becomes one of presumed priorities.

Quality of the Water: The problem of water pollution is no less pressing. The Federal Water Pollution Control Act Amendments of 1972 require that every "point source" discharger of pollutants obtain a permit which specifies the allowable amount and constituents of the effluent. The basis for the permit for a point source discharger is both a technology-based effluent standard and a water quality standard. At a minimum the water treatment must be the best practicable control technology. If that is insufficient to meet the water quality standard necessary for good health, then further pollution reduction will be required. By 1977, municipal treatment plants must provide secondary treatment (and thus

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20. "Auto Emissions: EPA Decision Due on Another Clean Up Delay," Science Vol. 187, (March 7, 1975), p.818.

create further sewage sludge disposal problems), and all industrial point dischargers must meet standards based on "best practicable control technology currently available." For 1983 the standards are more stringent: municipalities must provide the "best practicable waste treatment technology" and industrial point sources must comply with guidelines prescribing the "best available control technology economically available."[21]

The EPA is progressing with establishing effluent standards -- such as the maximum monthly average discharge of BOD, suspended solids, fecal coliforms and pH level. Simultaneously, the agency is developing and promulgating standards for individual industry sectors.

The objective of the water law is "to restore and maintain the chemical, physical, and biological integrity of the nation's waters." This has been interpreted as requiring standards which will protect indigenous aquatic life and permit secondary contact recreation such as fishing and boating. Water of this quality will be sufficient for use as public water supply, agricultural and industrial use, and navigation.

Much of the discussion elsewhere relating to the misuse of the oceans are relevant to this discussion and will not be repeated here. This discussion will center largely on the fresh water problems of the country. Specifically, the following discussion will explore the quality of the nation's water and the prognosis for the future.

Demands for the nation's water resources are expected to increase substantially through the remainder of this century. While agriculture uses of water have traditionally been the dominant consumer of fresh water resources, steam electric power uses of water will grow the fastest

[21] Environmental Quality - 1974, op.cit.

and become the major consumer of water by early in the next century. Two projections of water requirements are presented in Figure 12. Water consumption, like demand for any other commodity, is related to population, technology efficiencies, reuse possibilities and the level and extent of economic and industrial activity. Steam electric power plants, expected to provide over 90% of U.S. electrical generation by the year 2020, are the fastest growing consumer of fresh water. They are projected to increase their fresh water withdrawals from 63 billion gallons per day to 411 billion gallons per day by 2020. This is in addition to saline demands of 504 billion gallons per day.[22]

Despite demands such as these, it is the contention of many experts that the problems are not those of water quantity but of water quality.[23] The Resources for the Future study indicated that "the degradation of water quality and the related environment is a serious threat to well being but also poses the possibility that a serious physical limitation (dissolved oxygen concentrations) will prevent achieving a high quality water environment. ...high quality water is likely to be available only if the output of raw waste per unit of GNP is reduced by either changing the nation's product mix or by changing production processes."[24] The study indicates, however, that this pessimistic prognosis could be rendered incorrect by either a dramatic decline in the costs of desalination or in water transportation and delivery costs. Likewise, technological improvements that reduce the amount of wastes generated by production of a given output level would significantly perturb this forecast.

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[22] Water Resources Council, The Nation's Water Resources (Washington, D.C.: 1968), p.1-11 - 1-12.

[23] Nathaniel Wollman and G. W. Bonem, The Outlook for Water: Quality, Quantity and National Growth published for Resources for the Future, (Baltimore, Md.: Johns Hopkins Press, 1971) p.32.

[24] Ibid.

FIGURE 12

ESTIMATED WATER USE AND PROJECTED REQUIREMENTS, BY PURPOSE, UNITED STATES

(Million gallons daily)

Type of use	Used 1965	Projected requirements 1980	Projected requirements 2000	Projected requirements 2020	Used 1965	Projected requirements 1980	Projected requirements 2000	Projected requirements 2020
		Withdrawals				*Consumptive use*		
Rural domestic	2,351	2,474	2,852	3,334	1,636	1,792	2,102	2,481
Municipal (public-supplied)	23,745	33,596	50,724	74,256	5,244	10,581	16,478	24,643
Industrial (self-supplied) ...	46,405	75,026	127,365	210,767	3,764	6,126	10,011	15,619
Steam-electric power:								
Fresh	62,738	133,963	259,208	410,553	659	1,685	4,552	8,002
Saline	21,800	59,340	211,240	503,540	157	498	2,022	5,183
Agriculture:								
Irrigation	110,852	135,852	149,824	160,978	64,696	81,559	89,964	96,919
Livestock	1,726	2,375	3,397	4,660	1,626	2,177	3,077	4,238
Total	269,617	442,626	804,610	1,368,088	77,782	104,418	128,206	157,085

Source: The Nation's Water Resources, Table 1-1, p.1-8.

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FIGURE 10

OVERALL SCHEMA OF WORLD FOOD PROBLEM

Underlying factors & problem elements	Direct relevance and/or applicability of food technology	
	YES	NO
I. *Ecological-geographic factors*		
1. Production/population imbalance	x	x
2. High dependence on climatic conditions		x
3. Soil depletion & water shortage	x	
4. Lack of diversification	x	
II. *Economic factors*		
5. High capital/output ratio which inhibits investment		x
6. Long time horizon needed to recover investment		x
7. Need for large initial investments		x
8. Large ratio of sunk investment to total investment		x
9. Low productivity of labor		x
10. Low yield per acre of land	x	
11. Poor credit facilities		x
12. Limited domestic purchasing power (demand)		x
III. *Socio-economic factors*		
13. Uneconomic use of capital due to small size holdings		x
14. High indebtedness by small owners		x
15. Inadequate employment opportunities		x
16. Inadequate transportation		x
IV. *Socio-technological factors*		
17. Low level technology	x	
18. Inadequate tools and facilities	x	
19. Insufficient application of research findings		x
V. *Psychosocial factors*		
20. Lack of individual motivation		x
21. Increasing expectations of outside support		x
22. Increasing dependency on outside support		x
IV. *Traditional social factors*		
23. Ignorance of organizational principles		x
24 Institutional rigidity and inertia		x
25. Lack of adequate local information (empirical & quantitative) to guide policy		x
26. Ignorance of input/output dependence between agriculture and other sectors		x
27. Unhealthy dietary habits		x

Source:

Hasan Ozbekhan, "The Role of Goals and Planning in the Solution of the World Food Problem," in R. Jungk and J. Galtung, Eds., Mankind 2000 (International Peace Research Institute: Oslo) 1969 p.127.

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Essentially, all strategies reduce to two: either improve agricultural productivity (measured as output per acre) or increase the land under cultivation. As the previous discussion indicated, in many countries all usable land is, in fact, under cultivation and to bring any more land under cultivation would require substantial capital and time investment. Hence, for the short term anyway, most strategies resort to attempts to increase agricultural yields per acre. Because of the general problem of hidden unemployment and agricultural underemployment, in lesser developed countries, output per acre is a more meaningful measure of productivity than output per manhour.

<u>High Yield/Special Purpose Strains</u>: Recently, the successes attributed to high yielding species of wheat, rice, and corn generated a hope that much of the world's food shortages would be alleviated through utilization of improved strains. Indeed, acreage devoted to such crops increased by several orders of magnitude in just a few years. In various developing countries, yields due solely to the application of improved varieties increased markedly. As was mentioned previously, in areas where specific plants were developed for specific regions the results were dramatic and yields per acre comparable to the developed world have been achieved. From 1965 to 1977, India, using the new varieties, increased its wheat production from 11 million tons to 27 million tons -- an increase unprecedented by any other country in history.[38]

However, these same varieties, because they are more genetically uniform than the native strains they replace are extremely vulnerable to epidemics.

[38] In the Human Interest, op.cit., p.52.

What are the components of water quality? Biochemical oxygen demand (BOD) is a significant pressure levied by municipal and industrial wastes upon a fresh water system. Degradation of these wastes is accomplished largely through biological degradation of the wastes; hence, the greater the waste load, the greater the oxygen required for the oxidation process. This oxygen demand is expressed in "population equivalents" -- 0.25 pounds of oxygen per day required to oxidize the waste of an average urban person. If the oxygen is depleted through waste degradation, then aquatic organisms die, leaving the waterways to anaerobic bacteria which produce hydrogen sulfide and methane gas -- traditional smelly "swamp gas." The amount of oxygen required to decompose materials varies from material to material, but often extremely large amounts are required. For instance, the dissolved oxygen in 320,000 gallons of air saturated sea water is required to oxidize one gallon crude oil completely.[25]

Another particularly troublesome pollutant is high concentrations of nutrients such as phosphates and nitrates. These materials cause bio-simulation, that is, the accelerated fertilization of plant life. When the excessive number of plants die, the oxygen necessary to support marine life is depleted in their decomposition. This process indirectly changes the entire bio-community of a waterway and may contribute to its "death," which is known as eutrophication. It is this process which has so choked Lake Erie and reduced the fish population so dramatically. Thusly, the BOD and nutrient problem can be seen to aggravate each other in causing eutrophication. Despite the fact that the polluting problems of phosphates have received a great deal of national attention lately, a recent study

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[25] Council on Environmental Equality, <u>Ocean Dumping: A National Policy</u> (Washington, D.C.: October 1970) p. 14

by the Environmental Protection Agency shows a disturbing growth in the level of nutrients in the nation's waterways. Eighty-four percent of the areas analyzed exceeded phosphorous and phosphate levels associated with potential eutrophication, and up to 54% of the areas indicated increased phosphorous levels over the earlier years.[26]

In addition to the problem of eutrophication, nitrates in the nation's waterways present the additional threat of toxic nitrites. While nitrates themselves are not particularly dangerous, they can be converted into highly toxic nitrates in the presence of certain bacteria in the digestive tract.[27]

One of the major concerns in water abatement is the level of hydrocarbons in the water, some of which may be carcinogenic. While there has not yet been an instance of identifiable cause and effect between consumption of tainted water or fish and resulting human cancer,[28] the fact that cancer in fish exposed to hydrocarbons has been found suggests the dimensions of the hazards.

What is the present quality of the nation's water? To a large degree water quality and quantity is a local problem and cannot be viewed from the aggregate national level without distorting the issues. The results of the major investigation into the water quality of the nation's fresh water supplies is presented in Figure 13. As is readily seen, the results are mixed. Some pollutants show marked improvement, others show deterioration.

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[26] Environmental Protection Agency, National Water Quality Inventory, Report to Congress (Washington, D.C.: Government Printing Office, 1974), p.

[27] Ehrlich, op.cit., p.158.

[28] Council on Environmental Quality, Ocean Dumping. A National Policy, Op. Cit.

FIGURE 13

MAJOR WATERWAYS: REFERENCE LEVEL VIOLATIONS, 1963-72

Parameter	Reference level and source[1]	Percent of reaches exceeding reference levels		
		1963-72	1968-72	Change
Suspended solids	80 mg/1-aquatic life	26	14	−12
Turbidity	50 JTU-aquatic life	28	28	0
Temperature	90°F-aquatic life	0	0	0
Color	75 platinum-cobalt units-water supply	0	0	0
Ammonia	0.89 mg/1-aquatic life	16	6	−10
Nitrate (as N)	0.9 mg/1-nutrient	12	24	+12
Nitrite plus nitrate	0.9 mg/1-nutrient	18	26	+8
Total phosphorus	0.1 mg/1-nutrient	34	57	+23
Total phosphate	0.3 mg/1-nutrient	30	41	+11
Dissolved phosphate	0.3 mg/1-nutrient	11	22	+11
Dissolved solids (105°C)	500 mg/1-water supply	25	18	−7
Dissolved solids (180°C)	500 mg/1-water supply	28	12	−16
Chlorides	250 mg/1-water supply	12	9	−3
Sulfates	250 mg/1-water supply	12	12	0
pH	6.0-9.0-aquatic life	0	0	0
Dissolved oxygen	4.0 mg/1-aquatic life	0	0	0
Total coliforms (MFD)[2]	10,000/100 ml-recreation	24	13	−11
Total coliforms (MFI)[2]	10,000/100 ml-recreation	50	30	−20
Total coliforms (MPN)[2]	10,000/100 ml-recreation	23	20	−3
Fecal coliforms (MPN)[2]	2,000/100 ml-recreation	45	21	−24
Fecal coliforms (MPN)[2]	2,000/100.ml-recreation	17	43	+26
Phenols	0.001 mg/1-water supply	86	71	−15

[1] With the exceptions that follow, reference level designations are from *Guidelines for Developing or Revising Water Quality Standards*, EPA Water Planning Division, April 1973; for ammonia, chlorides, sulfates, and phenols, *Criteria for Water Quality*, EPA, 1973 (Section 304(a)(1) guidelines); and for nitrate (as N), *Biological Associated Problems in Freshwater Environments*, FWPCA, 1966, pp. 132-33.

[2] Membrane filter delayed, membrane filter immediate, most probable number.

Source: Environmental Protection Agency, *National Water Quality Inventory: Report to Congress* (1974), Table II-3.

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Regionally, improvements can be seen. For instance, improvements in decreasing the phosphate loading of the Detroit River have been made (see Figure 14); and as this river feeds into Lake Erie, its improvement may have substantial impact.

There are fundamentally two kinds of water pollution problems, those associated with running stream water and those associated with underground water tables. The former is considerably easier to deal with as there are many naturally occurring cleansing mechanisms that can maintain the quality of the water if the level of effluents is in accordance with the size of the water body. Once pollutants enter the underground water tables, the situation changes drastically. There are no such naturally occurring processes, and the underground water tables are clearly not as amenable to technological intervention.

Protection of the watershed regions is related in large part to protection of the total land resources. Much of the pollution of watersheds occurs through rainwater, waste water and agricultural runoff picking up, collecting and concentrating dangerous levels of effluents in the water. These pollutant-laden waters then seep into the land contaminating underground water sources or are dumped into surface water. Hence, efforts to improve water quality cannot realistically be undertaken without effective land use planning.

One of the problems with municipal water supplies is their contamination by external pollutants. One major pollutant source is the use of salt spread on U.S. roadways in the winter to melt snow and ice. Over one tenth of all the salt produced in the world is spread on the nation's streets, an amount equal to 12-15 million tons annually.[29] Concomitantly, chloride

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[29] I. C. T. Nisbet, "Salt on the Earth," Technology Review, May 1974, p.61.

FIGURE 14

DETROIT RIVER (RIVER MILE 3.9), AVERAGE TOTAL AND SOLUBLE PHOSPHORUS, 1966-73

[In milligrams per liter]

Year	Total phosphorus	Soluble phosphorus
1966	NA	0.309
1967	NA	0.175
1968	0.186	0.072
1969	0.144	0.083
1970	0.133	0.062
1971	0.067	0.036
1972	0.079	0.029
1973	0.058	0.015

NA—Not available.

Source: Michigan Water Resources Commission, *Annual Report to International Joint Commission* (average concentrations computed from 10 sampling stations crossing the river).

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in drinking water have been increasing at a similar rate and many urban water systems are approaching the upper levels of the Public Health Department. At least one town had reportedly had to close their well and begin purchasing water from other sources because of chloride contamination of their municipal water supplies.

It is commonly thought that since the bulk of the nation's population is served by treatable municipal water that some contamination of well water can be tolerated. This assertion is incorrect in both parts. While the percentage of the U.S. population served by municipal supply systems has indeed increased from 75% in 1960 to 82% in 1970, there is still a substantial portion of the population that relies on direct well water for their water use.[30] More importantly, even if no one relied on well water, contamination of ground water would still be of serious concern. Ground water aquifers supply about 27% of the withdrawn water, and obviously, provide the base flow of streams. The Water Resources Council has noted that ground water aquifers may be expected to grow in importance as underground reservoirs and as regulators of water supply through techniques of artificial recharge, artificial storage and induced infiltration.[31] Their size and, hence, potential value is enormous as well. It has been estimated that their total storage capacity greatly exceeds the volume of all five Great Lakes and that the usable portion is 150 times the amount of water used in this country in 1965.[32]

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[30] Development of Prediction of Future Pollution Problems, op.cit., p.109.
[31] The Nation's Water Resources, op.cit., p.327.
[32] Ibid.

Despite the assurances of an aggregate level of water supplies, there will be regional difficulties, most significantly in the South and Far West. For instance, the lower Colorado region has been experiencing a water supply deficiency and projections of economic and population growth for that region indicate that this deficiency will increase in the future.[33] This same region will be experiencing extremely high water demands because of recent energy demands. Additionally, the National Academy of Sciences has concluded that "not enough water exists for large-scale conversions of coal to other energy forms."[34] Mining of shale oil (presently contemplated for the water deficient areas of Colorado and Utah) would require an estimated three barrels of water for each barrel of oil.[35]

Sources of Water Pollution: What are the origins of water pollution? The origins, of course, are related to the uses of the nation's water supplies. The following is a projection of uses through the year 2000:

Use Category*	1965	1980	2000
Agriculture	41.8%	31.2	19.0
Steam Electric	31.4	43.7	58.5
Industrial	17.2	16.9	15.8
Municipal	8.8	7.6	6.3
Rural Domestic	.8	.6	.4
TOTAL USED/BGD	260.6	442.6	804.6

*From The Nation's Water Resources, op.cit., p.1-8.

[33] The Nation's Water Resources, op.cit., p.1-27.

[34] Les Gapay, "Far West's Shortage of Water May Break Many Energy Schemes," Wall Street Journal, (December 16, 1974) p.1.

[35] Ibid.

While there is some slight discrepancy between these figures and those later produced by Resources for the Future,[36] the Water Resources Council figures are proportionately the same and the aggregate numbers fall midway between RFF's "medium" and "high" scenario. In any event, it is likely that these figures accurately reflect the general trends in water use.

Agriculture has traditionally been the major consumer of water in this country and one of the major pollutant sources. The dominance of agricultural land in this country is shown in Figure 15 illustrating the dramatic increase in the amount of irrigated land. While only 10% of the U.S. farms practice irrigation, these farms produce 20% of the value of U.S. farm crops.[37] Most of the technological advancements in agriculture such as pesticides, herbicides, fungicides, hybrid seed, etc. are predicted on the availability of even and controlled humidity and precipitation. Hence, the greatest productivity increases can be achieved only in those regions with the most favorable weather conditions or with irrigation. The water scarce Western region is the greatest consumer of irrigation water, accounting for about 95% of irrigation water uses.[38]

The problems of irrigation stem from its role in increasing the salinity of the freshwater. As the freshwater is extracted by the plants and then evaporated into the air,it results in increasingly high salt concentrations. These saline waters are then returned either to the stream or underground water aquifer, further increasing their salinity. In order

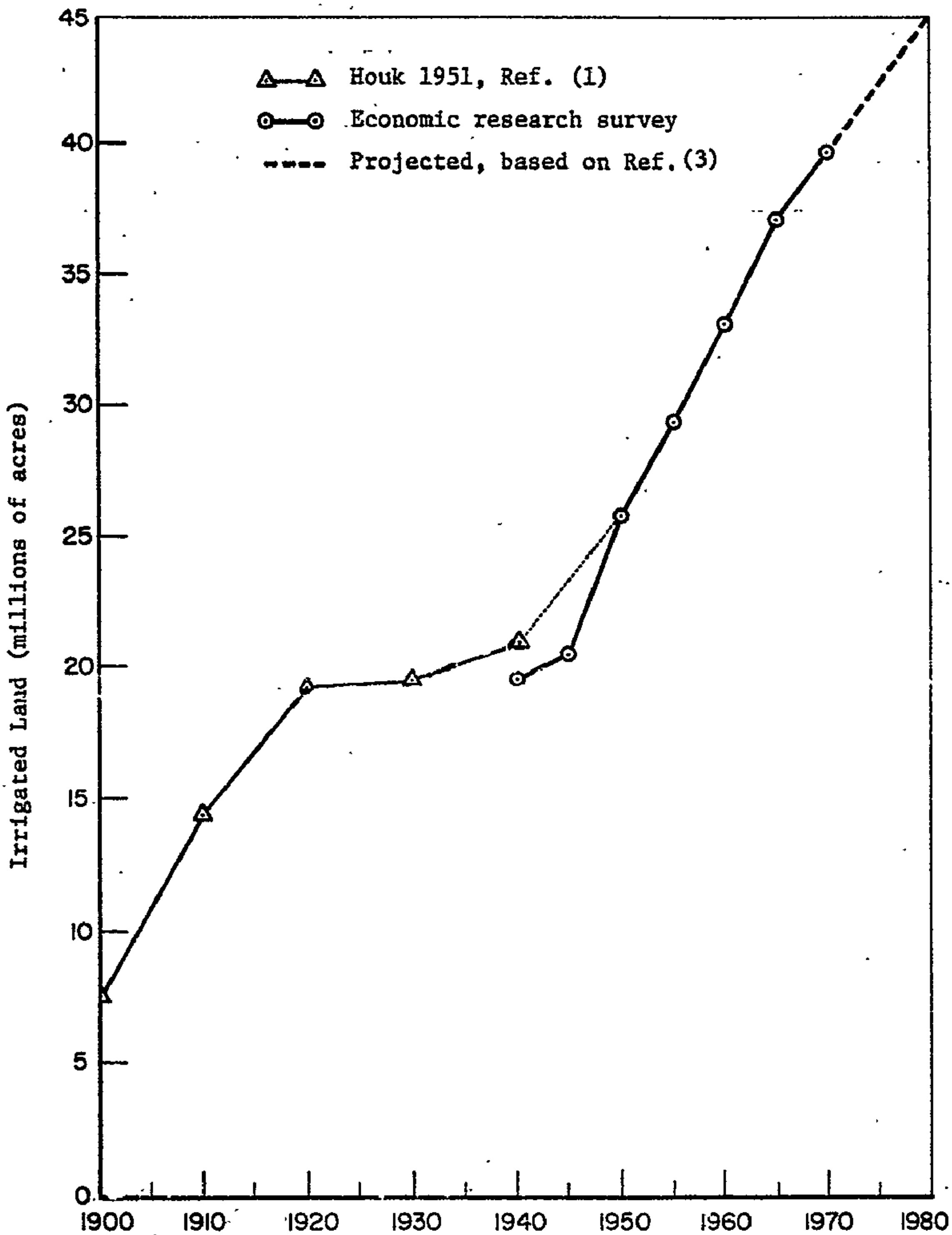
[36] The Outlook for Water, op.cit.

[37] The Nation's Water Resources, op.cit., p.4-41.

[38] Ibid, p.4-42.

FIGURE 15

IRRIGATED LAND IN THE UNITED STATES



Source: EPA, Development of Predictions of Future Pollution Problems, Figure 4, p.117.

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to meet demand, particularly in water deficient areas (such as the Western regions), either the application of desalination technology or use of irrigation water of lower quality may be required. However, reliance upon irrigation water of uncertain quality may have unforeseen health consequences, resulting from the ingestion of contaminated food.

Other agricultural concerns revolve around the problems of the persistence of pesticides, especially of DDT, has had a long and extensive history; and its use continues to increase, even since 1966. Introduced during World War II, it no doubt was responsible for the tremendous increase in agricultural efficiency and the elimination and/or reduction of many insect borne diseases. However, it is also an extremely stable compound which breaks down very slowly in the environment. It is found in the fatty tissues of man the world over and has been found even in the tissues of Antarctic penguins.[39] While it is unclear what the long run impact on man is, it is known that it attacks some animal species by wiping out the entire species through interference with reproduction. While the highest concentrations have been found in carnivorous birds (up to 1600 parts per million), concentrations in man have been found across the world ranging from 2 to 20 parts per million.[40]

While the cause and effect relationship of DDT and other chlorinated hydrocarbon pesticides is not completely understood, examination of autopsy data has suggested a correlation between concentrations of DDT in fatty tissues and certain causes of death. The concentrations of DDT in fat tissues of patients who died of softening of the brain, cerebral hemorrage, hypertension, portal cirrhosis of the liver, and various cancers are higher

[39] George M. Woodwell, "Toxic Substances and Ecological Types," Scientific American (Vol. 216, No. 3), March 1967, p.30.
[40] Ibid.

than in groups of patients who died of infectious diseases. Further study of the patients showed that high concentrations of DDT were strongly correlated with heavy home use of pesticides.[41]

The problems of nitrates have been mentioned previously, as have their role in eutrophication and toxic nitrate formation. Extensive use of nitrate fertilizers has already rendered drinking water of some rural areas nonpotable. Toxic nitrate illnesses are most likely to be found in infants; through reaction with the red blood hemoglobin, the illness may cause suffocation. Hence, in the case of extreme nitrate pollution of lakes, streams and wells as in central California, bottled water is relied upon, especially for infants. The problem is also severe in other areas such as Missouri, Illinois and Wisconsin. The city of Elgin, Minnesota was forced by nitrate pollution to abandon its water supply and find a new source.[42]

The quantity of water needed for energy in the future is another serious problem ahead. Use of water by steam electric plants presently consumes about 35% of total water used, but by the year 2000 this is expected to reach almost 60% (as projected by both the Water Resources Council and Resources for the Future). This, then will be the greatest single use of water and will use both fresh and saline sources of water. The greatest growth in water demand will come from nuclear fission plants, which currently requires about 50% more condensed water for a given temperature rise than fossil fueled steam plants of equal size, due to unequal plant efficiencies.[43]

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[41] Ehrlich and Ehrlich, <u>op.cit.</u>, p.162-163.
[42] <u>Ibid</u>, p.158.
[43] <u>The Nation's Water Resources</u>, <u>op.cit</u>.

By 1990 it has been estimated that at least 492 new power stations will be required, some of which will require cooling ponds of 2000 acres or more.[44]

The amount of water required is indeed substantial. One to two cubic feet per second are required for every megawatt of installed capacity, and the water is warmed by from 12^{o} to $25^{o}F$ in the cooling process. Hence, one of today's large steam electric plants could feasibility require the entire flow of a moderate sized stream.[45]

The primary concern, however, is over the impact of thermal pollution. Thermal pollution has two seemingly contradictory problems associated with it. First, there is the substantial and rapid temperature change, which often results in fish and marine life kills, merely as a result of shock. The second problem is associated with the more gradual warming of the waters which contributes to biostimulation, which in turn results in the depletion of dissolved oxygen in the water and contributes to eutrophication in much the same way as influxes of the nutrient nitrates and phosphates do. The consequences of such artificial warming are a reduction in species diversity (either dying immediately or becoming more susceptible to contaminants and disease) and a reduction in the ability of the water to absorb organic wastes, since oxygen is a necessary prerequisite for the oxidation of organic wastes.

While much of the publicity has revolved around fish kills, this could be muted through more gradual cooling. The biostimulation effect, which potentially is extremely hazardous to the viability of the watershed environment, will occur even within the limits of "gradual warming."

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[44] U. S. Environmental Protection Agency, Environment Facts, June 10, 1973, p.1-2.

[45] Ehrlich and Ehrlich, op.cit., p.235

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Industrial uses of water are around 16-17% of total water use and will not be reduced below 14-15% by 2000. With the introduction of the point source permit system, combined with the requirements of the Federal Water Pollution Control Act, improvements have been made in the sources and control of industrially caused water pollution. Despite the improvements, industrial wastes are the source of some of the most hazardous of the water pollutants including inorganic compounds (witness the controversy over asbestos -- a possible carcinogen -- loading of a local Minnesota water supply from the taconite tailings discharged into Lake Superior) such as mercury, nitrates, organic compounds including known carcinogens such as PCB's. EPA has identified 12 chemicals used in manufacturing as toxic water pollutants, including the pesticides, aldrin, dieldrin, endrin, DDT, DDE, and DDD, toxaphene and cadimium, mercury cyanide, benzidine and PCB (polychlorinated biphenyls). Effluent standards are being studied for possible inclusion on the list. These include among others, arsenic, selenium, chronmium, lead, asbestos, zinc, beryllium, nickel and camphor.[46]

Industrial water pollution consists of the BOD stress placed on the water as well as the sediment and suspended solid effluents, the toxicity of which varies. Five industry groupings are responsible for the majority (88%) of water withdrawals and, hence, pose the greatest environmental threats. These include food and kindred products, pulp and paper, chemicals, petroleum and coal products and primary metals.

While industrial uses of the water supply are only 17% and are expected to decline, water pollution from industrial sources is the principal source of toxic pollutants. Figure 16 shows the kind of

[46] Environmental Quality - 1974, op.cit., p.154-5.

FIGURE 16

ESTIMATED VOLUME OF INDUSTRIAL WASTES BEFORE TREATMENT, 1963

Industry	Wastewater	Standard Biochemical Oxygen Demand	Settleable and Suspended Solids
	Bil. gal.	Mil.lbs.	Mil.lbs.
Food and kindred products................	690	4,300	6,600
Textile mill products	140	890	Not Available
Paper and allied products	1,900	5,900	3,000
Chemical and allied products................	3,700	9,700	1,900
Petroleum and coal........	1,300	500	460
Rubber and plastics.......	160	40	50
Primary metals............	4,300	480	4,700
Machinery.................	150	60	50
Electrical machinery......	91	70	20
Transportation equipment..	240	120	Not Available
All other manufacturing...	450	390	930
All manufacturing.........	13,100	22,000	18,000
For comparison:			
Sewered population of U.S..................	[1] 5,300	[2] 7,300	[3] 8,800

[1] 120,000,000 persons x 120 gallons x 365 days.

[2] 120,000,000 persons x 1/6 pounds x 365 days.

[3] 120,000,000 persons x 0.2 pounds x 365 days.

Source: Council on Environmental Quality, Fifth Annual Report on Environmental Quality - 1974, p.320.

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pollutants from different industries in 1963. The Water Resources Council has estimated that when considering criteria for strength and volume, wastes from industrial sources are about three times as great as the wastes associated with sewage. They also expect that the volume of industrial pollution will increase about three times as rapidly as population.[47] The effluents from sewage and industrial wastes are not at all in common. The major problem associated with sewage sludge is the BOD stress it places on a waterway and the potential contribution that this has to the eutrophication process. However, this is an essentially biological process that can be reversed;and it does not involve toxic materials *per se*, witness the progress being made in the restoration of Lake Erie. However, the problem with industrial wastes is the level of toxic,carcinogenic,and mutagenic materials that are in the the wastes. Often these materials do not degrade but persist in the water,accumulating into higher and higher concentration levels. Because the chemistry and physiology of these materials in the human health process is largely unknown, the persistent dumping of such wastes may be contributing to an unknown public health time bomb. It is likely that all industrial waste compounds in sufficient concentrations and for exposure periods of sufficient time are toxic. The public health question is to determine what these thresholds are.

The point source permit program is only semi-successful. Its success depends upon the availability of economically feasible technology.

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47 The Nation's Water Resources, op.cit., p.

This distinction enables industry to postpone some pollution abatement improvements. Secondly, if point source emissions are explicitly prohibited, then the industry often has the option of discharging his wastes directly into the municipal water system which merely transfers the problem to another entity.

The final major category of water use and misuse is municipal drinking water and sewage systems. The basic environmental problem here is the potential intermingling of these two systems. The expenditures for municipal sewage systems are substantial, and about 85% of the population is served by a municipal water supply system.[48] Every year another 1000 communities outgrow their sewage treatment facilities.[49] Gross municipal wasteloads as measured by person equivalents of BOD are expected to increase substantially as shown in Figure 17. This projection, while a gross estimate, does assume that all urban populations were served by a sewer system by the year 1973. The problems of sewage sludge are substantial in terms of the level of nutrients they possess, their role in eutrophication, and the increasing level of toxic contaminants found in sewage sludge, as urban industries increasingly rely on municipal sewage systems for disposal of their wastes.

The difference in different levels of sewage treatment is the amount of BOD that is removed in the treatment process. As Figure 18 shows, the increasingly stringent regulations have reduced the BOD of the sewage wastes. Hence, after more than fifteen years of effort the sewage sludge is now the same quality as it was in 1957.

[48] Development of Predictions of Future Pollution Problems, op.cit., p.109.

[49] The Nation's Water Resources, op.cit. p.5-3-1.

FIGURE 17

GROSS MUNICIPAL WASTE LOADS[1] IN THE CONTINENTAL UNITED STATES

(Millions of population equivalents)[2]

Region	1962	1980	2000	2020
North Atlantic	45.8	71.2	94.6	128.0
South Atlantic-Gulf	11.4	35.9	54.1	77.4
Great Lakes	15.6	41.5	54.5	72.8
Ohio	14.4	29.8	38.5	51.0
Tennessee	1.3	5.1	7.1	9.8
Upper Mississippi	15.7	18.0	24.4	33.0
Lower Mississippi	3.6	7.1	9.7	13.2
Souris-Red-Rainy	0.9	0.9	1.2	1.6
Missouri	6.3	12.0	17.2	24.6
Arkansas-White-Red	5.5	11.0	14.9	20.2
Texas-Gulf	6.9	15.4	22.8	32.6
Rio Grande	1.4	3.2	5.2	7.6
Upper Colorado	0.2	0.5	0.9	1.3
Lower Colorado	1.2	3.7	6.0	9.0
Great Basin	0.9	2.2	3.6	5.4
Columbia-North Pacific	3.7	9.3	12.9	18.0
California	14.7	35.0	54.3	80.6
Continental United States	149.5	301.8	421.9	587.0

[1] Biochemical oxygen demand (BOD).

[2] A population equivalent is the quantity of water in terms of biochemical oxygen demand (BOD) produced by one person, approximately 16/ pound per day.

Source: Water Resources Council, The Nation's Water Resources, (Washington, D.C.: 1968), p.5-5-3.

FIGURE 18

EFFECT OF SANITARY SEWAGE TREATMENT

[In millions of pounds of BOD_5 per day]

Year	Collected by sanitary sewers[1]	Reduced by treatment[2]	Discharged after treatment
1957	16.4	7.7	8.7
1962	19.8	10.8	9.0
1968	23.3	15.0	8.3
1973	27.1	18.5	8.6

[1] Based on 0.167 pounds of BOD_5 per sewered person per day.

[2] Based on the distribution of treatment facilities and on estimates of removal efficiency.

Source: Environmental Protection Agency.

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Obviously, the sewage problem is intimately associated with the population, population density, level of and kind of industrial activity and the geographic limitations of a region. Water pollution from sewage is an unusual example of *diseconomies* of scale occurring with increasing population sizes. As the population increases, the waste degrading ability of the water stream decreases, increasing the degree of elaborate and expensive sewage and/or water treatment facilities required. In summary, the greater the population in a given watershed, the higher the *per capita* costs of water pollution control and abatement will be.[50] It is a problem that is never solved as population growth necessitates ever increasing system capacity. Disposal of sewage sludge becomes a severe constraint both because of population pressures and increasingly stringent pollution requirements. When discharged into water, sludge increases the eutrophication process (e.g., Lake Erie), may spread waterborne diseases or encourage increase in disease vectors (i.e., mosquitos), or may add toxic impurities to the water. The bulk of the sewage sludge in the country is either incinerated (therefore, transferring a water pollution problem to the air) or used for land fill. An excellent potential use for sewage sludge lies in its use in land reclamation for stripmined lands, and its potential as a nutrient rich fertilizer.

Some Potential Actions:

Perhaps to a greater degree than even the air quality problem, water quality is not well understood. The mechanisms of persistence, the cleansing ability of the water, the flow of pollutants through the underground water table, and the toxic effects and impacts of persistent public

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[50] Ehrlich and Ehrlich, op.cit.

exposure to pollutants is not understood. Hence, an essential step which is currently being undertaken is extensive research into the biological and chemical aspects of water pollution. A concomitant part of the effort is the development of more adequate data bases for accurate monitoring and sensing of the flows of pollutants and the effect of these pollutants.

A second problem in the development of any agenda for action is the interrelationships between water pollution strategies and air pollution strategies and a host of other environmental and economic variables. There are essentially three low cost options available for waste disposal: it can be burned, it can be dumped into the nearest body of water, or it can be buried -- all three of which have untold environmental impact. This interrelationship becomes confused; in the interests of contributing to water quality improvements, air quality is degraded. An example is the impact of the point source effluent permit program. Prohibited from discharging industrial wastes directly into a body of water, some firms are instead discharging the wastes into the municipal waste treatment plants which currently handle only biological wastes -- it is then either burned, dumped into the nearest body of water, or buried. Hence, this strategy merely rearranges the pollutants rather than controlling or reducing them.

Waste disposal into a nearby waterbody is by all measure the most economical method of waste disposal for the firm. Assuming that technological capability is available, and most experts suggest that the problem of water pollution is NOT technology, then government incentives, regulations, and legislation can be applied to alter the economies of water pollution abatement. If pollution control is uneconomical, the easiest way to alter the cost picture is to make water pollution more uneconomical through a system of elaborate fines and penalties. Such a sliding scale would most penalize those who generated the highest level of effluents of the greatest toxicity for the greatest period of time. Concomitantly, such a scale should take into account the volume of business that is being conducted at a given site. For instance, a small producer should not be allowed to generate a higher level of pollution per level of output than a larger firm merely because the aggregate level of pollution generated would be less. Such a scale if nationally and rigidly applied could provide the necessary incentive to develop and install the latest technology by making it bad business sense not to implement pollution control equipment. Such a sliding scale could be combined with a host of tax and investment credits, small business loans, capital gains and tax depreciation benefits to further encourage the installation.

Several U.S. regional test cases and European areas where industries have been charged for every unit of BOD not removed indicate that the "effluent charge" method is preferable and more realistic for future control of pollutants than the present regulatory laws.[51] Charges for emitted effluents may be set at increasingly higher rates over the years to attain the level of desired pollution relative to the technological possible alternatives. Furthermore, the effluent charge may be adopted to automobiles as well, in the form of a "smog ratings," resulting in a "smog tax" levied with the purchase of gasoline.[52]

Simultaneously, the implementation of such charges to industry should be not so rigid and heavy handed as to practically guarantee the bankruptcy of small and/or obsolescent firms. A recent study by McGraw-Hill suggests

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[51] Allen V. Knuse and Charles L. Schultze, Pollution, Prices, and Public Policy (Washington, D.C., 1975), Chapter 7.

[52] Knuse and Schultze, Chapter 7.

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that a substantial portion of the plant and equipment of these industries is outmoded, unproductive and obsolete with respect to the state-of-the-art.[53] Their overall estimate for manufacturing plants and equipment is 14%. While this seems high, another section of this document will argue that in fact this number is low, by as much as a factor of two; and in some industries it may be low by a factor of four. For instance, twenty percent of the iron and steel industry's plant and equipment is rated obsolete by that industry (estimates of the capital required to modernize the industry approach $15B). This level of obsolescence, no doubt, contributes to the inability to effectively control pollution. The steel industry, because of its high level of obsolescence and increasingly non-competitive stature with foreign steelmaking entities is especially hard hit. Even the compromise of installing the "best practicable technology" available as suggested by EPA would cost the nation's four largest steelmakers $80-100 million.[54]

If increasingly uncompetitive plants and mills are to remain competitive at all in the world markets, massive capital investments will be required to replace obsolescent plant and equipment. Requiring current or advanced SOTA pollution abatement equipment to be implemented in technologically and economically obsolescent plants is not a good economic or environmental protection decision.

[53]"The Rising Toll of Obsolence," Business Week, November 30, 1974, p.27.
[54]"Steel: Clean Up or Close Up?" Business Week, April 6, 1974, p.72.

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CONTAMINATION, MISUSE AND ABUSE OF THE GLOBAL OCEANS LEADING TO ECOSYSTEM DAMAGE AND DESTRUCTION, HEALTH CONSEQUENCES AND INTERNATIONAL CONFLICT

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ISSUE: CONTAMINATION, MISUSE AND ABUSE OF THE GLOBAL OCEANS LEADING TO ECOSYSTEM DAMAGE AND DESTRUCTION, HEALTH CONSEQUENCES AND INTERNATIONAL CONFLICT

The Issue:

Concern and conflict over use of the oceans is not new; in fact, it may be as old as fishing and sailing. What is relatively new is the recognition that man's use of the oceans may indeed have severe negative consequences and that unregulated uses of the oceans may threaten the global ecological balance, alter plant and animal life and significantly impact the global climatic systems. Recent plans to locate large scale structures on the oceans and to exploit the mineral riches of the seas pose even greater risk to the ecological system. Finally, increasing use of the oceans for large scale transport greatly enhances the probability of collision, polluting spills and international conflict.

The issue basically revolves around potential degradation and abuse through unregulated use of the oceans. The uses that present threats include:

- Resource exploitation -- fishing, mariculture, ocean mining
- Recreation -- swimming, beaches, offshore boating, and recreational sites
- Waste dumping -- industrial wastes, waste treatment, effluent and sewage disposal, dredging spoils
- Transportation -- world merchant shipping including supertankers, deep water ports and offshore ports
- Energy development -- offshore exploration and exploitation of gas and oil, nuclear/electrical power plant siting and cooling

The increasing use of the oceans raises questions concerning the biological, chemical, ecological, physical, social and aesthetic impacts of these activities.

Dimensions of the Problem:

The significance of the oceans is not limited to the dominant role they play in the world's environment -- the oceans cover over 70% of the earth's surface. Over 60% of the nation's population resides in coastal areas. In addition, over 99% of the U.S. trade (by weight) is dependent upon marine transportation. The oceans play a substantial role in the global food chain. While on the global scale fish provide only a small percentage of world caloric intake (or about 40 pounds annual per capita consumption), the consumption of fish varies significantly from country to country; hence, so does its importance. Fish provide 20% of the global animal protein. In Japan, fish are consumed at almost twice the rate of the world average and provide one and a half times the protein provided by agriculture. The importance of fish is not limited to human consumption; in fact, one third of the world fish catch is used as animal feed.[1,2]

Furthermore, the oceans play a substantial role in the climate formulation of the planet. It is the interaction of the oceanic ecosystem with the atmospheric and stratospheric dynamics that essentially determines climate and weather patterns.[3]

Viability of the oceans, then, is clearly essential to the commercial vitality of the world as well as to the global food chain. Each of the uses of the ocean will be explored below.

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[1] Paul R. Ehrlich and Anne H. Ehrlich, Population, Resources, Environment, (W. H. Freeman and Co.: San Francisco) 1972, p.133.

[2] Lester R. Brown, By Bread Alone (Praeger: New York) 1974, p.147-149.

[3] National Academy of Sciences, The Ocean's Role in Climate Prediction (National Academy of Sciences: Washington, D. C.) 1974.

Transportation: The increasing reliance upon the oceans for bulk transportation is putting severe pressures on the world merchant marine system: the world merchant vessel fleet has been increasing at 2500 vessels a year, each one at ever increasing tonnage and the total fleet size is expected to continue to increase 15% annually[4] (see Figure 1). The volume of trade carried by ship is enormous as well; imports and exports of the U.S., carried by ship, amounted to 581 million short tons in 1972, representing an increase of 27% since 1965 and equaling over 99% (by weight) of total U.S. trade.

Not only have the number of vessels and the volume of waterborne freight increased but the individual ocean vessels have been increasing in size with a concomitant increased risk associated with their use. As a consequence of economies of scale, the supertanker (greater than 100,000 dead weight tons) is the most efficient way to carry oil. The oil shortages have provided an impetus for construction of ever larger supertankers; currently enough construction is underway to double the world's tanker fleet capacity within the next few years. The recent growth in supertankers is shown in Figure 2. The bulk of the supertanker construction is in the 200-400,000 dead weight ton class, but even one million dead weight ton ships have been proposed.[5] By 1983, over 5% of the world fleet is expected to be of "supertanker size," that is, in excess of 100,000 dead weight tons.[6]

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[4] Frost and Sullivan, Commercial Navigation and Air Traffic Control Market, New York: February 1974.

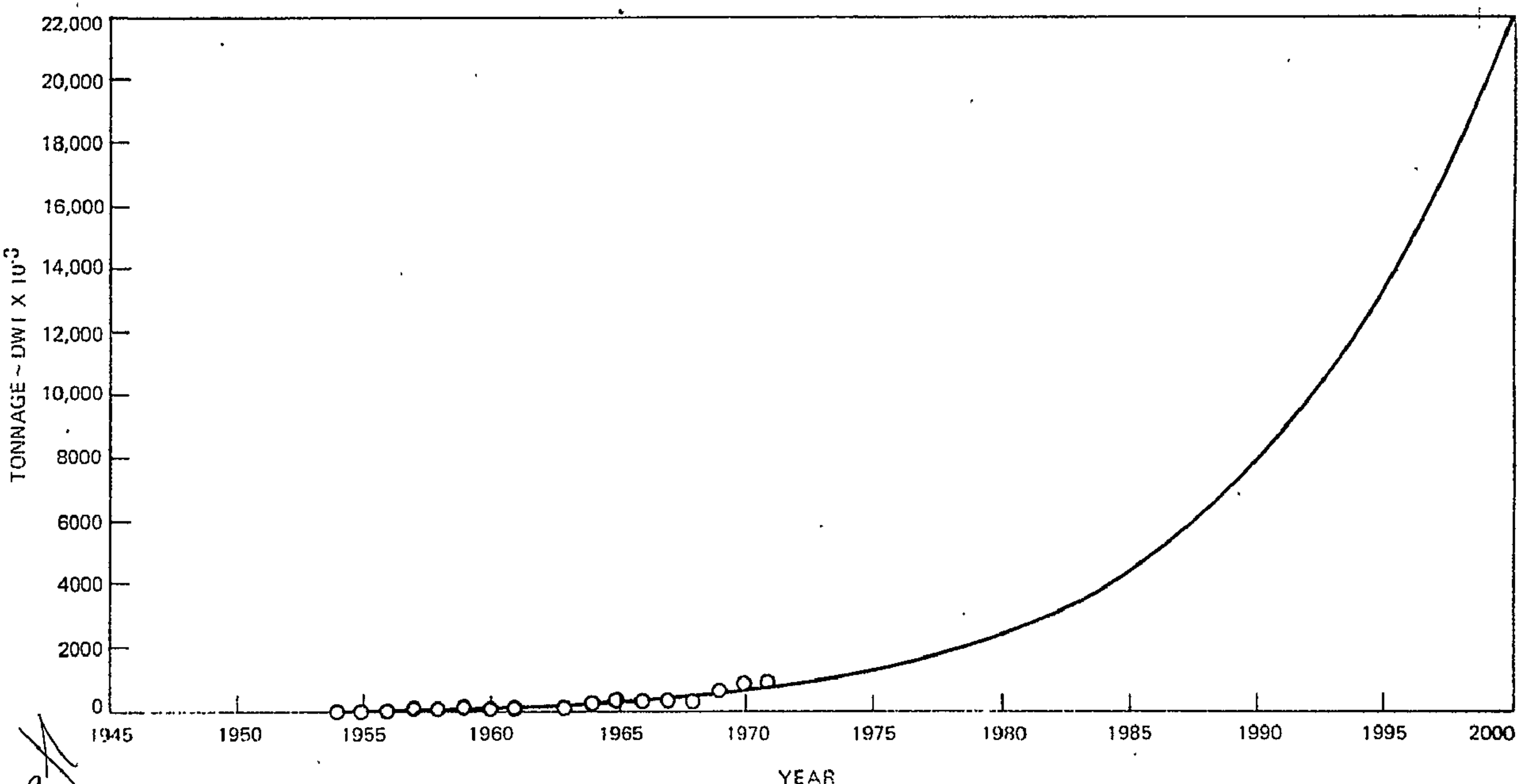
[5] "The Oil Push Sets Off a Supertanker Boom," Business Week (July 27, 1974), p.62-66.

[6] Frost and Sullivan, op.cit.

FIGURE 1

TOTAL TONNAGE OF TANKERS

LOG Y = 9.844 LONG (YEAR - 1990) - 15.356



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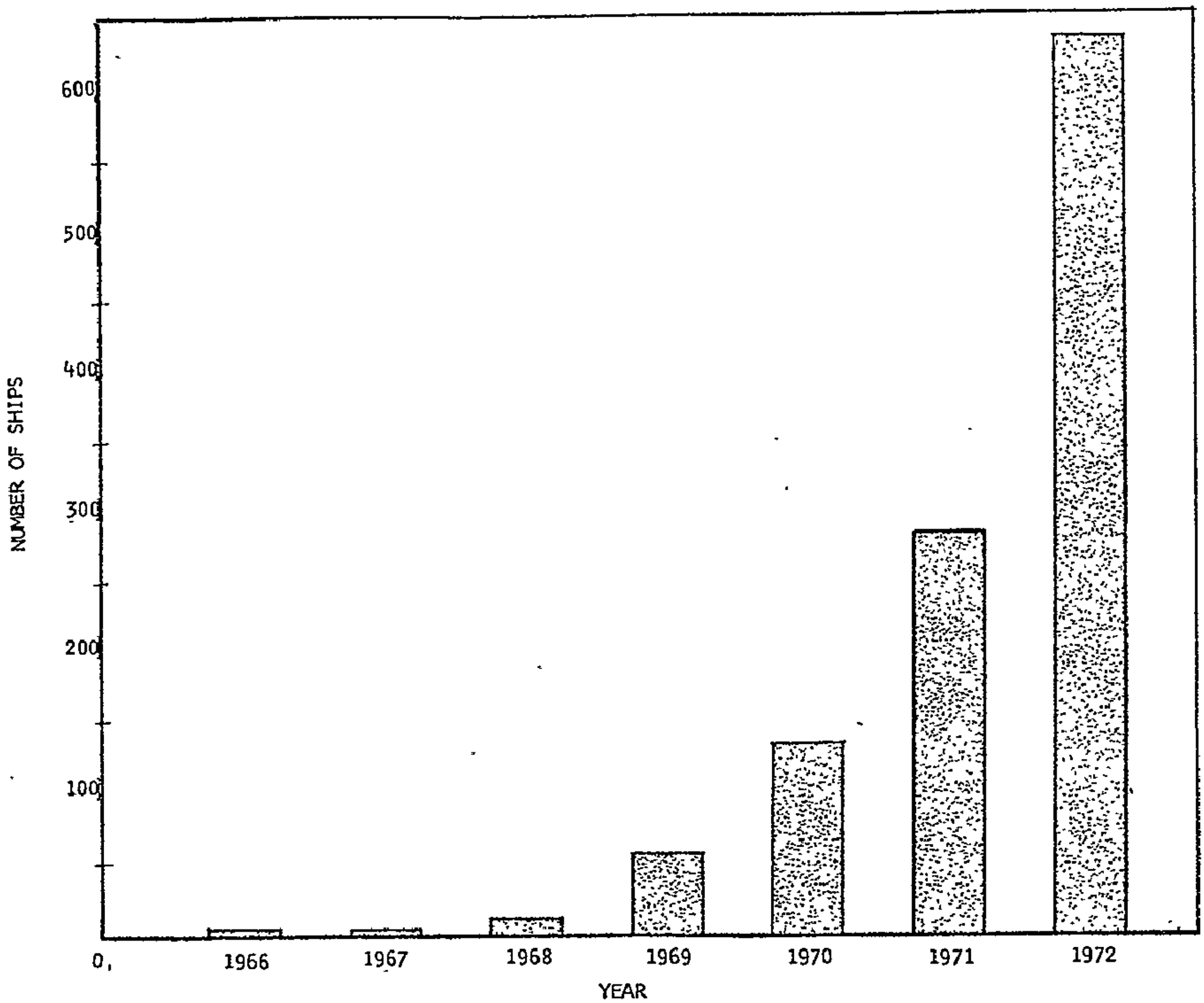
Source: United Aircraft Research Laboratories, U.S. Ocean Shipping Technology Forecast and Assessment: Final Report, Vol. IV, (U. S. Department of Commerce, Maritime Administration) July 1974.

FIGURE 2

GROWTH OF SUPERTANKERS;NUMBER OF SHIPS UNDER CONSTRUCTION OR ON ORDER OVER 200,000 TONS



SOURCE: HENRY S. MARCUS "THE U.S. SUPERPORT CONTROVERSY," TECHNOLOGY REVIEW.

Much of the enormous effort in supertanker construction is a result of the recognized inequitable distribution of world petroleum supplies and the need to redistribute these supplies. However, because of the economies of scale that accrue from these huge ships, it is likely that the pressure to build increasingly large supertankers will continue. Economies of scale in oil transport are such that even allowing for terminal and transshipment costs, an increase in tanker size from 65,000 tons to 325,000 could reduce the overall transportation cost of Persian Gulf oil by 25%.[7]

However, there is recent evidence to suggest that shipbuilders vastly overestimated the capacity that would be required. Worldwide tanker operations are so seriously depressed by the reduction in the worldwide flow of oil that foreign shipyards are receiving massive cancellations of orders. Until the global energy/food situation stabilizes, it is thought that the shipbuilding will be in a state of flux.[8]

The growth in world merchant shipping has indeed been enormous, but the U.S. has lagged behind international growth. The U.S. merchant fleet carries only 5% of our waterborne trade, down from 40% in 1950. While the U.S. presence in merchant shipping has decreased (total tonnage of U.S. merchant ships has declined to 14,818,000 tons, a decrease of 40% since 1960); world merchant vessel tonnage has been increasing at 7-10% annually to a total world tonnage of 289,532,000. In 1950 the U.S. had 33% of world tonnage but by 1960 this share had declined to 19%, and by 1973 it was barely 5%.[9]

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[7] Henry S. Marcus, "The U. S. Superport Controversy," Technology Review (March/April) 1973, p.49.

[8] "Shipbuilders Signal for Federal Help," Business Week (March 24, 1975), p.36-37. 460

[9] U.S. Bureau of the Census, Statistical Abstract of the United States, 1974.

The large number of vessels represent ever increasing safety problems. On a worldwide basis over three ships are lost or broken up *daily;* and if this rate of loss continues at the rate of increase of the last decade, it could reach 6 ships daily (2,350 annually by the year 2000).[10] Slightly over 75% of the collisions occur in harbors, and the largest cause of oil spillages (by volume spilled) is from collision and grounding of tankers.[11] While the environmental consequences of oil spills are discussed later, suffice it to say that aesthetically, ecologically, and commercially the damage is severe.

It is likely that oil spills resulting from collisions will increase -- as both numbers of vessels and the individual size of vessels increase. Major tanker accidents currently cause an average daily spill of 384 barrels of oil. World crude oil production is expected to double from the 1970 level of about 14 to 28 billion barrels,and transportation of crude oil will increase from 9 billion to 19 billion barrels by 1980. Should collisions and spills continue to occur at their present rate, oil pollution of the oceans could reach 70 million barrels annually.[12]

Accommodating a fleet of supertankers will require specifically equipped harbors -- superports. Without domestic superports petroleum will be shipped to neighobring superport facilities in the Maritime Provinces of Canada or the Caribbean and from there shipped by regular tanker to the coastal U.S. As a result, the U.S. would lose the advantage of economies of scale of supertankers and would be paying 25% more for Persian Gulf petroleum than countries with superport facilities. This could have a far-reaching economic impact for those industries dependent upon foreign sources of raw materials

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[10] United Aircraft Research Laboratories, U.S. Ocean Shipping Technology Forecast and Assessment: Final Report, Vol.IV: State of Society and Industry (prepared under Contract 3-36204 to U.S. Department of Commerce, Maritime Administration) July 1974, Figure IV, p.87.

[11] U. S. Coast Guard, Coast Guard Polluting Incidents In and Around U.S. Waters, 1970-1971.

[12] Don E. Kash, etal, Energy Under the Oceans, (University of Oklahoma Press: Norman) 1973.

and could render them internationally non-competitive. It might even force the relocation of individual industries (such as oil refineries) to those areas where superports are available.

Despite the economies of scale to be achieved through the construction of superports, there are four major obstacles to the development of supertanker capacity in the U.S.[13]

- One is the risk of collisions or groundings in congested harbors: 80% of the current tanker collisions occur as the ships are entering or leaving the harbor. This fact presents a fundamental barrier to supertankers and gives substantial cause for local opposition.

- A second problem is the environmental concern for damage resulting from oil spills. As the earlier discussions indicated, this is clearly a legitimate concern. The Coast Guard has calculated that the currents costs of annual oil spills from tanker collisions are about $40 million.[14]

- A third obstacle is the inadequacy of existing storage and transfer facilities for handling large bulk cargo carriers.

- A final obstacle is the shortage and increasing cost of waterfront land necessary for expanding terminal capacity.

In addition there is the environmental damage that would result from the actual construction of the superports. First, it is not at all clear that it is technically or economically feasible to dredge many of the existing harbors 30 or 40 feet below their present bottom because of underlying rock, harbor and river tunnels, and silt and sedimentation problems.[15] Assuming the channels could be dredged, what would be done with the dredging spoils? Ecologists are concerned that dumping such spoils may be creating

[13] As noted by Henry Marcus, op.cit.
[14] Ibid.
[15] Ibid.

"dead" areas of the seas. Such damage to tidal areas, marsh lands, etc., could have irreversible impact on the breeding and feeding grounds of fish and wildlife. Dredging in estuaries could change the salinity of the waters by affecting the flows of water in and out of the region. This could change the entire ecology of the region and seriously damage the commercial shellfish industry.

Because of these problems, the current planning for superports is to build offshore deep water terminals that would be constructed outside the 3-mile limit. Goods would then be transported to shore via pipeline (for petroleum products) or by smaller ship (for bulk cargo). Authorized by the Deep Water Port Act of 1974, later this spring (1975) the Department of Transportation will begin processing applications for licenses to build offshore crude oil superports. The most likely first superport efforts will be off Freeport, Texas and in the Gulf of Mexico off Lafourd Parrish, Louisiana. Because of environmental opposition and funding difficulties, plans to build offshore terminals on the East Coast are considerably less well developed.[16]

Waste Disposal: The oceans have traditionally been viewed as suitable areas for waste disposal, and presently domestic waste material is transported from U.S. coastal ports aboard barges or ships for disposal at sea. The oceans are able to accept substantial amounts of wastes and still cleanse and regenerate themselves. However, the ability of the oceans to accept these wastes without environmental harm is not infinite; and its capacity is currently being exceeded at the same time that the ocean

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[16] "U. S. Superport Plans Advancing," Chemical and Engineering News, January 27, 1975, p.10-11.

disposal of wastes is expected to increase substantially. These wastes are largely composed of dredge spoil, solid waste, incinerator residue, garbage, sewage sludge, chemical wastes, discarded military equipment and munitions, excavation debris and industrial, municipal and agricultural wastes. The chart below summarizes the waste disposal problem.

SUMMARY OF TYPE AND AMOUNT OF WASTES DISPOSED OF IN U.S. COASTAL WATERS FOR THE YEAR 1973[17]

Waste Type	Pacific Coast Annual Tonnage	Atlantic Coast Annual Tonnage	Gulf Coast Annual Tonnage	Total Annual Tonnage	Percent of Total Annual Tonnage
Dredging spoils	8,320,000	30,880,000	13,000,000	52,200,000	84
Industrial wastes					
Bulk	981,000	3,011,000	690,000	4,682,000	8
Cont.	300	2,200	6,000	8,500	
Refuse garbage	26,000			26,000	
Solid waste				240	
Sewage				5,429,400	
sludge		4,447,000		4,447,000	7
Miscellaneous	200			200	
Construction				1,161,000	
debris		574,000		574,000	1
Explosives		15,200		15,200	
Total	9,327,500	38,959,400	13,696,000	61,982,900	100

[17] U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Report to the Congress on Ocean Dumping and Other Man-Induced Changes to Ecosystems, October 1972 through December 1973. (Submitted in compliance with Title II of the Marine Protection Research and Sanctuaries, Act of 1972), March 1974.

Most ocean disposal of wastes that has occurred was because of significant cost differentials. In most cases, ocean dumping of solid waste, sewage sludge and dredge spoils was significantly cheaper than alternative land based systems. Since collection of the 1973 figure for waste disposals in oceans, much of the industrial ocean dumping has been suspended through both regulation and issuance of time limited ocean dumping permits.

Dredge spoils consist of the materials dredged to improve and maintain navigation channels and represents the largest category of ocean-dumped material. The Council of Environmental Quality has estimated that existing pollution abatement programs will be sufficient to curtail some sources of ocean-dumped materials, but the expansion of marine transportation and the requirements of ever larger shipping channels suggest that dredge spoils (largely sand, silt, and waste sludges) will become an increasingly severe problem.[18] The CEQ also estimated that up to one third of these dredge spoils were highly polluted from industrial and municipal wastes deposited on the bottom and that such spoils may be a serious source of ocean pollution.[19]

Industrial wastes, the second largest category of wastes, include acid wastes, refinery wastes, pesticides, paper mill wastes and other industrial wastes. The Environmental Protection Agency monitoring data suggests that this source of ocean dumping is decreasing, largely due to implementation of technological improvements, increasingly stringent pollution regulations and the ocean dumping permit program. However, permits are presently issued for

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[18] Council on Environmental Quality, <u>Ocean Dumping - A National Policy</u>, (U.S. Government Printing Office: Washington, D.C.), October 1970, p.11.

[19] Ibid.

waste dumping even though the dumping will exceed the criteria for public health simply because there is no feasible alternative for disposal.[20] In 1968, New York City alone accounted for over 57% of the industrial waste disposed into the oceans.[21] However, since then regulatory restrictions have forced 40 dumpers to cease dumping.[22] Pollution from industrial wastes is largely controllable (although not preventable) through regulatory restrictions and technology improvement.

Sewage sludge, the third largest category of waste dumping, appears to be largely the product of the New York Metropolitan area, as most other parts of the country dispose of the sewage sludge on land. This source of pollution is expected to increase as greater levels of sewage sludge will be produced by the higher levels of waste water treatment required under new stringent pollution laws.

Other wastes which are disposed of at sea (solid waste, military wastes, construction and demolition debris and radioactive wastes) represent minor components of the problem -- about 1% by weight of the total discharge. The problem for the future revolves around dredge spoils, sewage sludge and industrial wastes.

Marine pollution from ocean dumping has seriously endangered the environment and sporadically posed severe threats to the environment. Shellfish have been found with high concentrations of hepatitis and polio virus. Pollution of the marine environment through toxicity, oxygen depletion, biostimulation and habitat changes can seriously affect marine life. For instance, copper residues have caused fish kills similar to those caused by pesticides, as depicted in Figure 3.

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[20] Council on Environmental Quality, Fifth Annual Report on Environmental Quality - 1974, p. 149-150. (hereafter: Environmental Quality - 1974).

[21] U. S. Department of Commerce, NOAA, op.cit.

[22] Environmental Protection Agency, Annual Report of the Administration of the Ocean Pumping Permit Program, August 1973.

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FIGURE 3

FISH KILLS RESULTING FROM PESTICIDES

Year	Number of Reports	Total Kill Reported	Average Kill of Incidents Reporting Kill Totals
1963	60	401,415	10,849
1964	93	191,167	2,583
1965	74	770,557	12,039
1966	51	217,406	4,941
1967	43	329,130	7,654
1968	51	325,194	7,742

Source: <u>Wall Street Journal</u>, (May 7, 1973) p.22.

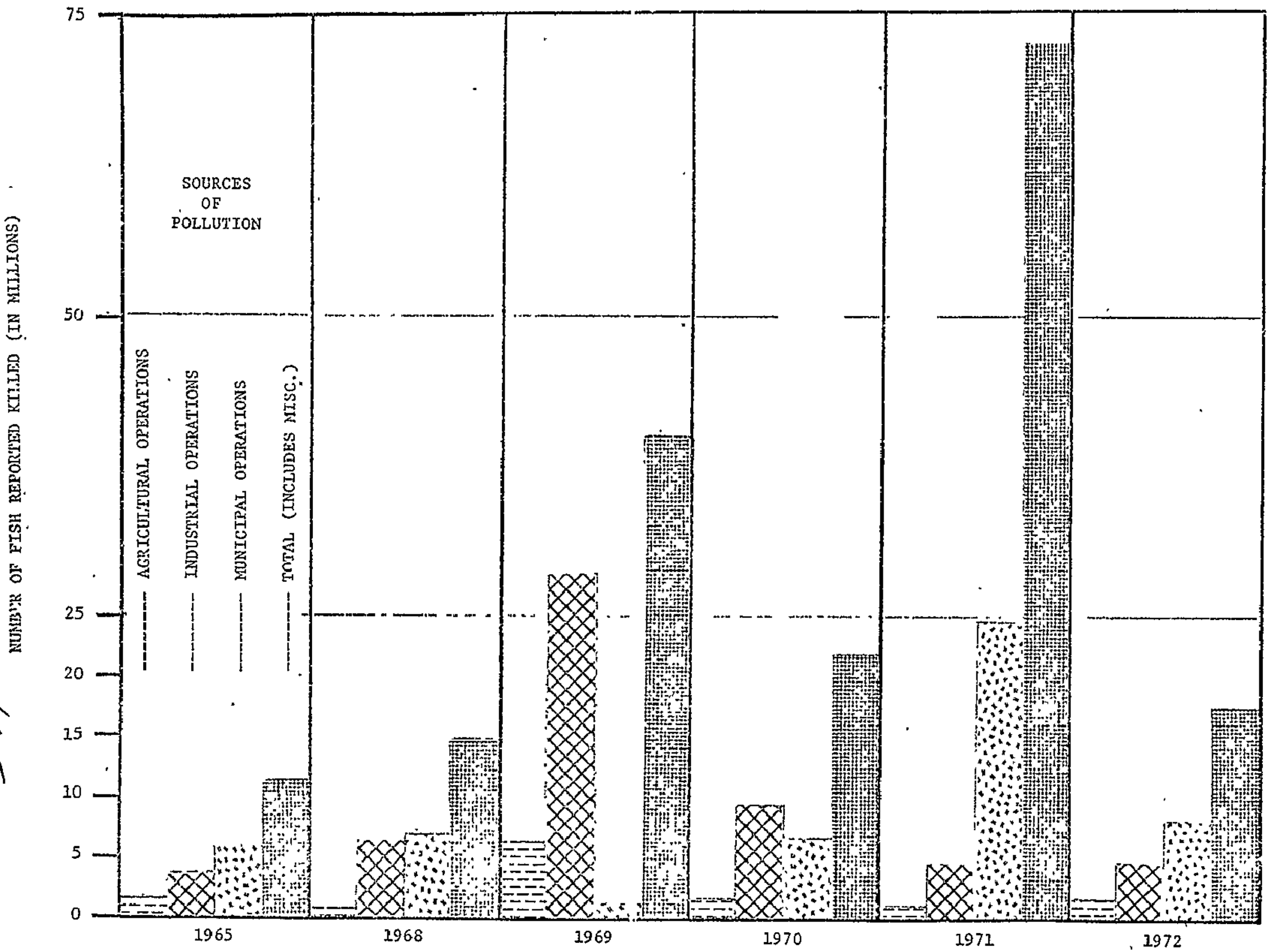
To date, human impacts upon the ocean have largely been economic and aesthetic with fortunately few public health crises. Occasional viral hepatiti outbreaks have been traced to consumption of contaminated raw shellfish, and significant economic losses have been incurred from ocean dumping. It has been estimated that the potential U.S. shellfish catch in 1969 was $320 million of which only $257 million was realized due to pollution losses.[23]

Despite the lack of direct human impact, the reports of fish kills that are at least indirectly attributable to pollution are substantial as shown in Figure 4.

[23] This discussion is drawn largely from Council on Environmental Quality, <u>Ocean Dumping: A National Policy</u>, <u>op.cit</u>.

FIGURE 4

POLLUTION CAUSED FISH KILL



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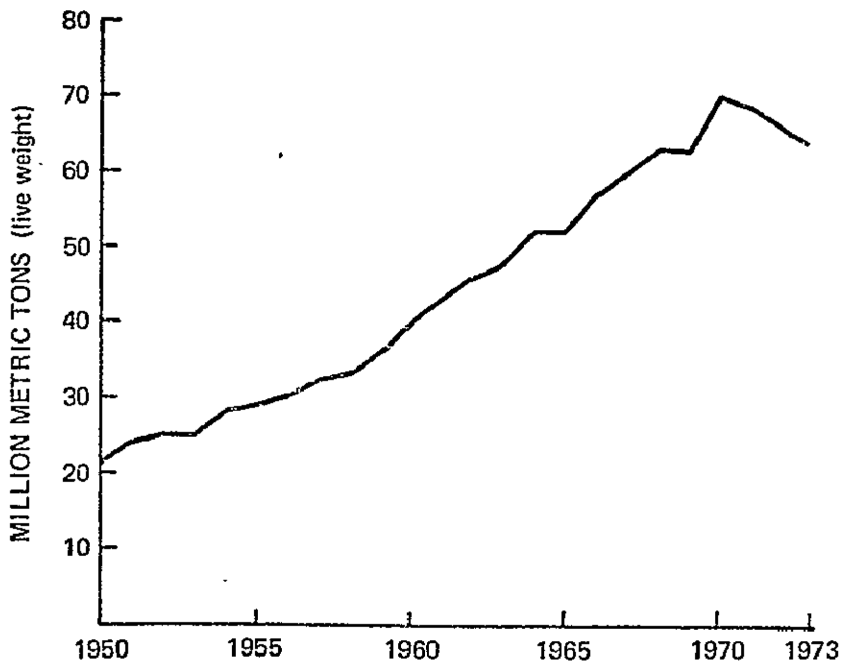
Resource Exploitation (Excluding Energy): This use of the oceans revolves largely around fishing and mining of ocean mineral deposits. While fish provide only a small percentage of world caloric intake, their contribution is very high in some countries and extremely important in providing the feed stock for agricultural animals. The issues associated with ocean fishing are largely the potential impact of over fishing and the international conflict that is generated by lack of agreement over these global resources. Here we will confine ourselves to the environmental questions.

After two decades of growth in the world fish catch to a 70 million ton annual yield, the yield has declined since 1970,[24] as shown in Figure 5 .

FIGURE 5

WORLD FISH CATCH, 1950-73



Source: Food and Agriculture Organization

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[24] Lester Brown, op.cit., p.149-150.

There is serious controversy concerning the possibility of substantially increasing the ocean fish yield. The dramatic growth of the 1950-1970 period was largely due to capital investment and technological advancements. The hugh productivity improvements so gained are unlikely to be repeated. Moreover, there is some controversy over this increase in fish production over the two decades. Ehrlich suggests that it may be due in part to more accurate and complete reporting of existing fish catch rather than from actual increases in yield.[25]

Estimates of the additional fish yields that the oceans could provide vary significantly. Recent investigations of the fish producing capabilities of the oceans reveal that the open seas (90% of the oceans) are essentially a "biological desert," producing a negligible fraction of the world fish catch at present with little or no potential for yielding more in the future.[26] Estimates of the productivity of the upswells and coastal regions vary, however. The Woods Hole Oceanographic Laboratory has estimated that the amount of fish available for sustained harvesting (that is, leaving an adequate reproductive population sufficient to sustain the species and continued harvesting) is approximately 100 million metric tons;[27] the F.A.O. suggests that upper limit may be 110 million tons;[28] and still another estimate suggests that the upper limit is 200 million tons.[29] To

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25 Ehrlich and Ehrlich, op.cit.

26 John H. Ryther, "Photosynthesis and Fish Production in the Sea," Science (Vol. 166, pp.72-76) 1969.

27 Ibid.

28 J. A. Gulland, The Fish Resources of the Oceans (United Nations Food and Agricultural Organization: 1971).

29 George A. Doumani, Science, Technology and American Diplomacy: Exploiting the Resources of the Seabed, Prepared for the Subcommittee on National Security Policy and Scientific Developments of the Committee on Foreign Affairs U. S. House of Representatives, by the Congressional Research Service (July 1971).

increase the yield by several tens of tons appears to be possible through exploitation of current species, productivity improvements and improved fish resource management. However, to substantially increase the production beyond this level does not seem possible. Ehrlich points out that "to surpass the potential annual fish production of 100-150 million metric tons would require moving down the food chain from the big fish ordinarily found in fish markets to the harvesting of plankton. All signs at the moment indicate that this will not be feasible or profitable in the foreseeable future, if ever. More calories of fuel and human energy would be spent on harvesting the plankton than could be gained, the expenditure of money would be colossal in relation to yield, and the product would require considerable processing to be made palatable as human food."[30]

It is generally agreed that overfishing of particular regions and/or of particular species has become a global problem. Many of the top "table fish" are below the sustainable harvest limit; that is, their reproductive capacity cannot maintain even the present level of catch over time.[31] Unfortunately, at the present time overfishing is not generally identified until the catch declines for a sustained period of time. The issue of overfishing may be exceedingly complex -- witness the problems associated with the failure of the Peruvian anchovy crop. The Peruvian anchovies were largely used as high protein feed for livestock production, supplying poultry feed for the industrialized world. In the late sixties (1967 - 1971) the anchovy beds were fished in excess of the estimated maximum

[30]Ehrlich and Ehrlich, op.cit., p.125-127.
[31]Brown, op.cit., p.150.

sustainable yield, resulting in a collapse of the harvest in 1972 - 1973.[32] Intervention of the Peruvian government in the form of nationalization and imposed management of fishing levels has turned the harvest around, although it is not yet up to its previous yields.[33] This collapse greatly exacerbated both the international and domestic food situation. At the same time the agricultural industry was experiencing fish meal shortages, to substitute animal feed; grain meals were also in short supply because of harvest failures. This contributed substantially to the inflationary forces upon U.S. consumer food prices.

Any sustained domestic or international program of improved fish management cannot take place without adequate pollution abatement and regulation. Contamination of the world fisheries through ocean dumping, transportation and offshore development are an integral part of the fishery management problems and can only be effectively implemented through some sort of international agreement.

Exploitation of the ocean's mineral deposits is at an early, exploratory stage. Commercial mining of ocean floor manganese modules is not expected before 1979 or 1980.[34] Estimates of the market value which the oceans' riches possess range up to $3 billion. Deposits in the Pacific Ocean are expected to yield 1.3 times the world's land reserves of copper, 13 times the land reserves of nickel and 10 times the land reserves of

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[32] Some climatologists believe that this failure was actually due to changes in water/air temperatures that occurred as part of the global climatic adjustments of the past several decades.

[33] Lester Brown, op.cit..

[34] "Ocean Mining Faces Environmental Hurdle," Chemical and Engineering News, (September 30, 1974), p.5.

manganese.[35] One study has estimated that the continental shelves of the world's oceans contain a world supply of phosphorite sufficient to last 1000 years at the 1965 rate of consumption.[36]

Technically feasible and economically realistic, ocean mining technologies are not yet operational. Further, the environmental impact of these systems is not well understood. Adequate investigation of the long term environmental impacts is just beginning.

While the environmental impacts of ocean mining are not fully known some of the potential problems can be identified. Involved in most schemes of ocean mining is the scooping up of large amounts of material and water from the bottom of the oceans and bringing it up to the surface vessel for preliminary sorting. The dumping of this obvious waste material back into the ocean can have profound environmental effects. Many parts of the ocean depths have lain essentially undisturbed for centuries if not millenia. Intermingling the soil and plankton from the lower depths, at their extremely cold temperatures, with the volatile sub-surface marine environment could have untold environmental consequences. Any processing of the material at sea could again have substantial environmental consequences.

Finally, ocean mining is likely to cause severe land based environmental problems as well. Problems of transporting large amounts of ocean bottom "gunk," disposal of the wastes(including large amounts of mineral tailings), air and water pollution from the processing itself, and site degradation from the processing center are but a few. The lack of insight into

[35] "Tapping the Lode on the Ocean Floor," Business Week (October 10, 1974).
[36] Doumani, op.cit.

potential environmental impacts could retard commercial exploitation of the seas if regulations are superimposed upon commercial mining equipment manufacturers requiring retrofit.

Energy Development: Exploitation of the oceans for outer continental shelf supplies of oil and gas and offshore siting of nuclear and electrical power plants is likely to play a fundamental role in the world's energy policies. It has been estimated that assuming maximum development of oil and gas, approximately 20% of oil per day and 30% of gas per year will come from offshore sources by 1985.[37]

The same study concludes that the only feasible alternative to increasing reliance upon the outer continental shelf is to increase oil and gas imports. Other studies indicate that total worldwide oil production could increase to 8,395 million barrels annually or 2.5 times the 1971 production level.[38]

The global needs for petroleum are likely to come in conflict with environmental concerns. The mass media concern with oil spills and the publicity of the Union Oil Company blowout off Santa Barbara have created intense opposition for offshore development. There is no question that further exploitation of offshore oil and gas sources will increase oil contamination of the oceans. In 1969-1970 offshore gas and oil operations accounted for about 4% (1.4 million barrels) of total direct oil pollution, a somewhat misleading figure because of the absence of abnormal discharges and accidents.[39] Major blowouts can drastically perturb this

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[37] Don E. Kash, op.cit., p.7-10.

[38] L. C. Weeks, "World Offshore Petroleum Resources," American Association of Petroleum Geologists Bulletin (49: 1680-1693), 1965.

[39] Kash, op.cit., p.275-277.

figure. The Union Oil blowout generated 18,5000 to 780,000 barrels, a blowout in the Persian Gulf in 1971, 200,000 barrels.[40] It is possible that should worldwide offshore production be as high as 12.8 billion barrels by 1980 (as some expect) and offshore pollution continues at the same rate as 1969-1970, then offshore production could generate four million barrels of oil pollution annually.[41]

The problem is that little is known about the impact of oil discharges into the oceans. It is thought that the greatest areas of concern are the estuaries and coastal embayments where dispersion is restricted and where many species undergo early development and may be especially vulnerable.[42] Environmental impacts, of course, will occur besides those associated with petroleum spills. Construction itself will have impacts, as well as pipelines, transportation, storage and refinery operations.

In fact, one study concluded that far greater concern to marine life and ecosystem stability was occasioned by the indirect effects of the petroleum industry effects than by oil spills themselves.[43] The same study questioned the food chain argument; that is, that petroleum hydrocarbons become magnified in concentration as they progressively move up the food chain. The evidence is strongest that direct uptake from the water of sediments is more important than the food chain.[44] This is not to minimize the effect petroleum has. Polycyclic aromatic hydrocarbons are carcinogenic and are known to be present in oils (albeit,

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[40] Ibid.

[41] Kash, op.cit., p.297

[42] Report to the Congress on Ocean Dumping and Other Man-Induced Changes to Ocean Ecosystems, op.cit., p.57-58.

[43] National Academy of Sciences, Petroleum in the Marine Environment, (Workshop on the Inputs, Fates and the Effects of Petroleum in the Marine Environment held under the auspices of the Ocean Affairs Board, Commission on Natural Resources, National Research Council), Washington, D.C.: 1975, p.89.

[44] Ibid., p.67.

they are also present in the smoke of cigarettes, burning refuse and motor vehicle operations). However, the National Academy of Sciences points out that knowledge of the properties of all the constituents of petroleum is not complete; therefore, there may be other dangerous materials present in petroleum that have not been identified.[45]

They conclude: "Conclusions regarding the effects of oil in the marine environment on human health are based on limited information. From our interpretations of this information, modest concern rather than alarm appears to be justified."[46]

In addition to accidental spills from collisions, groundings and blowouts, it is important to note that there is naturally occurring seepage of petroleum into the marine environment. While only a very few naturally occurring oil seeps are known and located, it is very likely that more will be found. In order to determine the relative role of man's activities in the hydrocarbon load of the oceans, it is necessary to quantify this seepage.

One estimate of such seepage suggests it is about 0.6×10^6 metric tons per year (or at most 60% of the total annual tonnage of spills caused by tanker collisions as estimated by the U.S. Coast Guard). Of this total, at least 40% is generated by the Pacific Ocean.[47]

Offshore location of power plants is currently contemplated as a means of providing adequate supplies of condenser water and avoids much of the local opposition to power plant installation.

Nuclear power plants can also be located in estuarial areas to take advantage of the easy availability of cooling water. Of the presently

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[45] Ibid., p.97.

[46] Ibid., p.99.

[47] R. D. Wilson, etal, "Natural Marine Oil Seepage." Science (V. 184, N. 4139), May 24, 1974 (p.857+).

installed nuclear power plants over 30% rely on saline or brackish water for cooling.

Present offshore designs would include a plant with a massive 30-60 foot protective breakwater 3 miles offshore with transmission lines buried in the seafloor. Obviously, the environmental impacts of such schemes are formidable. Discharge of heat into the oceans may be severe enough to kill fish. Accidental discharge of radioactive compounds could have untold impact. Construction of the site itself could be damaging. Many of these schemes must await further analysis.

Some Potential Actions:

As with the other environmental issues, the positive actions largely fall into three areas:

- *Regulatory* - regulations, restrictions, legislated incentives governing the uses of the oceans with mandatory sanctions if isolated.
- *Technological* -- implementation of or incentives to encourage development and implementation of advanced pollution abatement/control and waste disposal and treatment equipment.
- *Cooperation* -- integrated management and coordinated uses of the oceans on both a national and international scale.

Protection of the oceans adjacent to the United States received substantial support by passage of the Marine Protection, Research and Sanctuaries Act of 1972 which prohibits disposal of radiological, chemical and biological warfare agents and high level radioactive wastes into the oceans and regulates all other dumping through issuance of permits by EPA or U.S. Army Corp of Engineers. As stated previously, ocean disposal of waste has continued to increase. What other actions can be taken? One, permits can be refused or cancelled for ocean dumping and environmental degradation. To a large degree, where feasible alternatives exist, this is already done. Industrial entities are being prohibited from dumping wastes in New York to the degree possible. Yet in many locales there is no feasible economic or technological solution. In such a case, the EPA required the City of Philadelphia to move its sludge dump site 36 miles farther out into the Atlantic while an alternative measure was being developed.[48] In those cases where the EPA has tried to mandate compliance with regulations, court resistance or local fears of unemployment, industry moving and the like have effectively mooted the program. This suggests the need for public education programs concerning the environmental fragility of the ecosystem.

A most important positive action is the development of economically feasible technological alternatives. Current restrictions on ocean dumping are providing some incentive to do this, but more stringent legislation coupled with subsidized research, tax incentives and so on could encouage implementation. There is an implicit tradeoff between delaying stringent regulations on the grounds that there is no technologically/economically feasible alternative. Prohibition of present activities, or more reasonably, continuation of present activities at higher cost (e.g., fines and fees) suddenly provide incentives and renders alternatives more economically competitive. Let us examine some of the technological solutions being offered.

Sewage sludge is one of the greatest contributors to ocean pollution, and 1970 cost estimates of land based sewage sludge disposal were

[48] Environmental Quality - 1974, op.cit., p.149.

considerably higher than ocean-based.[49] However, most promising for the use of digested sewage sludge is for land and strip mine reclamation (current estimates of completely unclaimed stripped land reach 2 million acres or 3300 square miles) or as a supplemental crop fertilizer. Recognizing that sewage sludge is likely to increase both as a function of population pressures as well as more stringent waste treatment requirements, this would be not only a "feasible" and environmentally protective measure but would also contribute significantly to other issues discussed in this document. Solid wastes could also contribute to land reclamation. While little research has been done on the use of sewage sludge for fertilizers, preliminary research by the Metropolitan Sanitation District of Chicago suggests that it is odorless, safe and high in required nutrients.

Refinements and advancements in incineration techniques would assist in disposal of many otherwise polluting wastes. Currently, incineration techniques are more costly than disposal at 20 miles to sea; however incineration is likely to be a long term alternative.

Of foremost importance is research on the seas itself. The interaction of man's actions with the physical system of the sea is not at all well understood. The Council on Environmental Quality has stated that "A critical need is an effective monitoring system to gather data on the effects of dumping in the oceans, so that trends can be detected and actions taken to prevent degradation."[50]

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[49] Ibid, p.150.
[50] Ibid.

Finally, little can be done without an institutional forum for international cooperation. While this is discussed in detail elsewhere, suffice it to say that the United States is not alone in its abuse of the oceans. The United States is only the precursor to other nations; all industrialized nations will eventually experience similar waste disposal pressures. The current Law of the Seas Conference could play a substantial role in the future protection of the oceans.

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N76-18977

DESTRUCTION OF THE RECREATIONAL, AESTHETIC, AGRICULTURAL, WILDLIFE CONSERVATION AND PRESERVATION, AND RESIDENTIAL USES OF THE LAND AS A RESULT OF THE ABUSES OF THE MANUFACTURING, COMMERCIAL, EXTRACTIVE, CONSTRUCTION, AND TRANSPORTATION INDUSTRIES

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The Issue:

Explicit concern over land use and abuse is a fairly recent one and stems from the recognition of the negative impacts of unrestrained and unregulated economic, industrial, and population growth upon finite land resources. This comes at a time when the demand for land for agricultural, mineral extraction, residential growth, and industrial and power plant purposes is rising substantially. Only one quarter of the total surface area of the earth is land, and of that a large portion is uninhabitable. The present stresses upon the land include urbanization, urban sprawl and urban congestion; electrical, nuclear industrial park siting requirements; land degradation through stripping surface minerals; land degradation through disposal of radioactive wastes, sewage sludge, solid waste and other industrial wastes; rising demands for agricultural land; and the erosion and destruction of land through elimination of protective coverings such as forests, grasslands, and wetlands. Despite the large land mass of this country and the low national population density over 70% of all Americans live in metropolitan areas, over half in the suburbs alone.[1] (See Figure 1)

FIGURE 1

U.S. POPULATION, 1960 AND 1970

(in millions)	1960	1970	Percent Change
Total Metropolitan Area Population	120	139	17
Central City Population	61	64	5
Suburban Population	59	76	28

Source: U.S. Bureau of the Census, *Census of Population and Housing: 1970, General Demographic Trends for Metropolitan Areas, 1960 to 1970,* Final Report (Washington: U.S. Government Printing Office, 1971), p. 1-33 and p. 15.

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[1] Council on Environmental Quality, Fifth Annual Report on Environmental Quality - 1974 (Washington, D.C.: Government Printing Office, 1974) p. 3 (hereafter: Environmental Quality - 1974)

Figure 2 shows the uses of land in 1959-1969. One can see that the uses of land associated with urban areas and the support of urban areas have been increasing substantially. Simultaneously, the amount of land allocated to agricultural purposes has decreased. At the same time the Environmental Protection Agency has estimated that 7 million acres of agricultural land may be converted to recreation and wildlife areas, 5 million converted to public facilities, second home development and waste control projects, and 3.5 million acres for highways, airports and other transportation requirements by the year 2000.[2]

FIGURE 2

SELECTED USES OF U.S. LAND, 1959 AND 1969
(in millions of acres)

	Special Uses		
	1959	1969	Change
Urban areas[1]	27.2	34.6	7.3
Transportation areas[2]	24.7	26.0	1.3
Recreation and wildlife areas[3]	61.5	81.4	19.9
Public installations and facilities[4]	27.5	27.4	-.1
Farmsteads and farm roads	10.1	8.4	-1.7
Total	151.0	177.8	26.8

[1] Includes urbanized areas as defined by the Bureau of the Census, and other incorporated and unincorporated places of 1,000 or more population.

[2] Rural land in highway, road, and railroad rights-of-way, and airports.

[3] Federal and state parks and related recreation areas and Federal and state wildlife refuges.

[4] Federal land used for national defense and atomic energy purposes and state land in institutional sites and miscellaneous other uses.

Source: U.S. Department of Agriculture, Economic Research Service, *Major Uses of Land in the United States: Summary for 1969*, Agricultural Economics Report Number 247 (Washington: U.S. Government Printing Office, 1973.)

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[2] U.S. Environmental Protection Agency, Environmental Facts (June 10, 1973) p.1-2

In the broadest sense, the effective and efficient allocation of land resources affects all other pollution and environmental related issues. Much of the pollution problems that have occurred regionally have done so because of misallocation of the land resources. Many of the environmental problems occur simply because the carrying capacity of a given area of land is exceeded; that is, the level of population (whether that be an industrial, residential or commercial population) that a given area can sustain is exceeded. Once this carrying capacity is exceeded the ability of the environment to cleanse itself of pollutants is severely impeded. Therefore, land use policies offer one of the most beneficial strategies for ensuring the long run viability of the global biosphere. The location of human activities and the density and concentration of these human activities on the finite land resource may determine the environmental quality of the planet.

While land abuse is clearly an international problem, this issue largely deals with the land use and abuse in the United States. However, the inability of the underdeveloped and less developed countries to adequately protect their own land resources has placed greater demands on the United States land resources -- witness international demands for U.S. agricultural products. Like other resources, the allocation of valuable and nutrient rich land is highly inequitable. Just as some countries are energy rich and energy poor, others are land poor and land rich. The United States has a larger proportion of arable land than many other countries; and hence, we can expect continued international pressures upon the United States to contribute substantially to the world food supply.

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<u>Dimensions of the Problem:</u>

<u>Urbanization</u>: Urbanization, population congestion, and population density are major contributors to land abuse in the United States. Consider,

for example, the unequal population density of the country. Over 73% of the population lives on about 1.5% of the land! On the island of Manhattan in New York City, population density exceeds 67,000 per square mile; Chicago has a population density one quarter of that. Figure 3 shows the inequitable allocation of population in this country.

The statistics are somewhat misleading, however. While 13% of the nation's land is designated as being within the confines of standard metropolitan statistical areas (SMSA), and 10% of the SMSA's land is classified as "urban" (therefore only 1.3% of the national land would be called urban); this clearly understates the problem associated with urbanization.[3] One of the major problems associated with urbanization is not population density in a given location and a given area of land *per se* but urban sprawl -- "the hop, skip and jump" location of urban functions. The Environmental Protection Agency has estimated that 19.7 million acres may be consumed by urban sprawl by the year 2000, a land area that is approximately equivalent in size to the states of New Hampshire, Vermont, Massachusetts and Rhode Island combined.[4]

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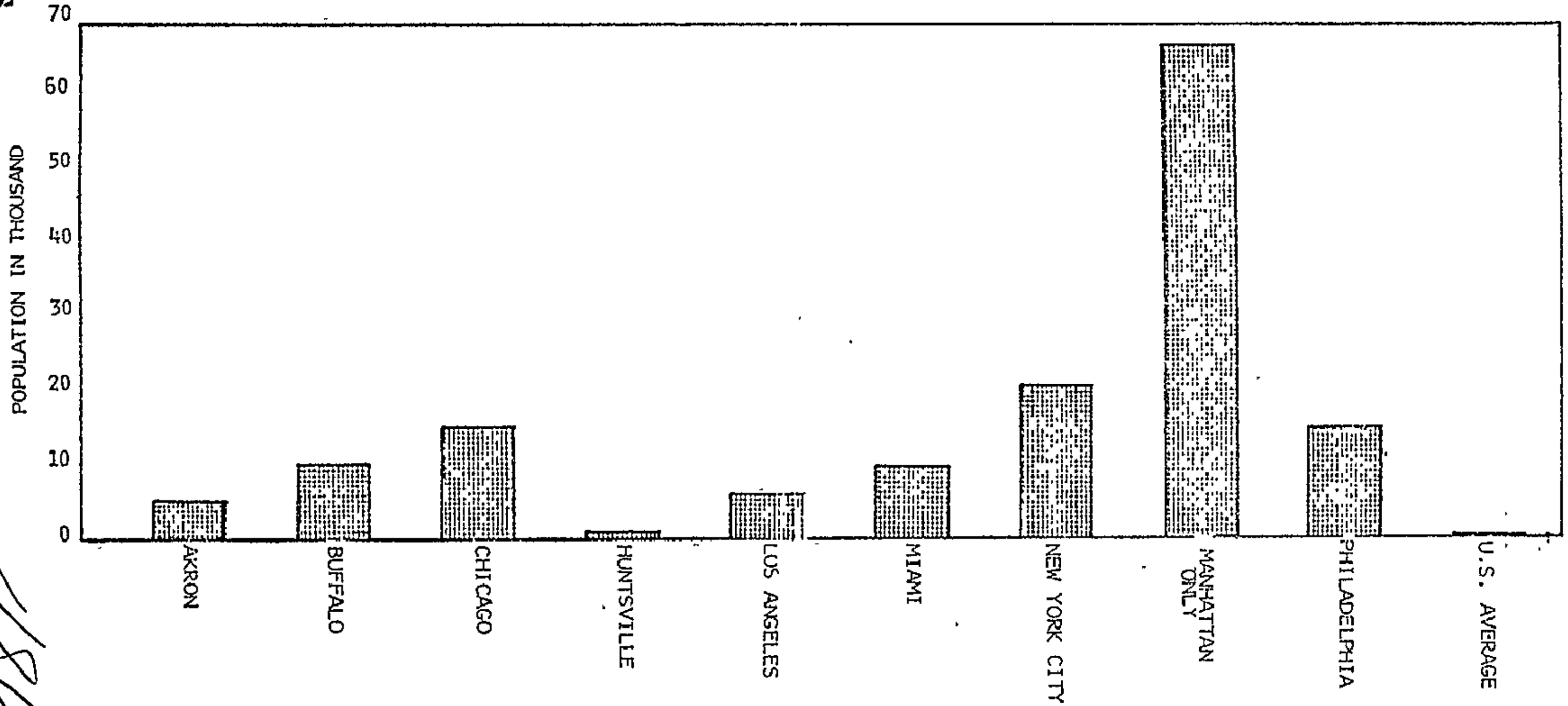
[3] U.S. Bureau of the Census, Statistical Abstract of the United States: 1974, (Washington, D.C., 1974) (hereafter: Statistical Abstract, 1974).

[4] Environmental Facts, op.cit., p.1-2.

FIGURE 3

POPULATION DENSITY - 1970

(Population per square mile in thousands)



SOURCE: U.S. BUREAU OF THE CENSUS, STATISTICAL ABSTRACT OF THE UNITED STATES: 1974 (WASHINGTON, D.C.., 1974).

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The urbanization process shows no signs of abatement and the pressures on urban land are increasing. From 1960 to 1970, the population in the total metropolitan areas of the United States increased 17%, at the same time, the population in suburbs increased 28%,while the population in the central city only increased 5%.[5]

As a result of this increase, 35 million acres of land are now in urbanized areas; and from 1960-1970 over 2000 acres a day shifted from rural to urban use. Much of this development has taken place in an uncoordinated and scattered fashion aggravating the "hop, skip and jump" or urban sprawl problem in the country.[6] While the problem of increased urbanization is discussed in detail elsewhere, let us review some of the land abuse problems associated with it.

A recent study supported by the Council on Environmental Quality entitled The Cost of Urban Sprawl investigated the comparative cost of low, medium, and high density communities. They concluded that low density urban sprawl communities traditionally made up of single family homes on quarter acre lots that "leap frog" the suburban area consumed more than twice as much land as the high density land communities. Low density communities also contribute to land abuse by increasing the proportion of land allocated to vacant-improved and semi-improved uses -- at best, an inefficient use of land, at worst, a waste of land. Because this land is scattered between housing units, housing development and community developments, it is essentially

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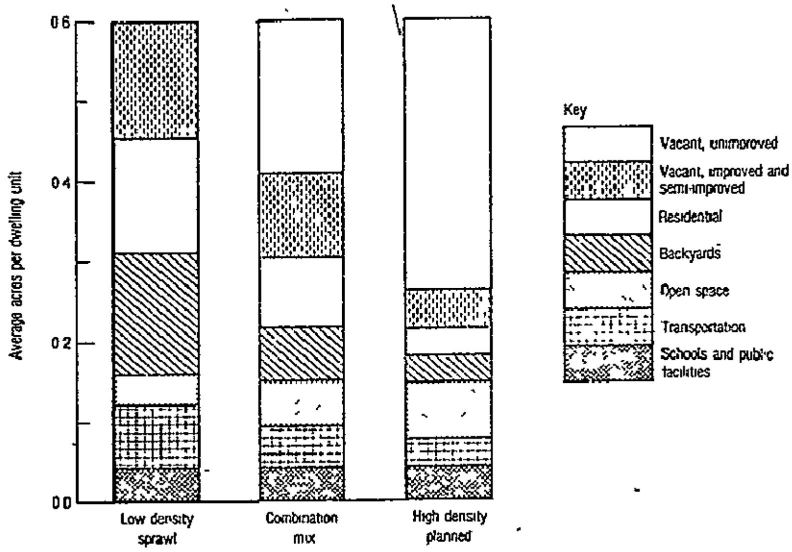
[5] U.S. Bureau of Census, Census and Population: 1970 - General Demographic Trends for Metropolitan Areas, 1960-1970 (Washington, D.C.: U.S. Government Printing Office) 1971

[6] U.S. Dept. of Agriculture, Economic Research Service, Major Uses of Land in in the United States, Summary for 1969, AER 247 (Washington, D.C.: USGPO) 1973

unusable. The inefficiency of this land use pattern is shown in Figure 4.[7]

FIGURE 4

Community Land Use



Source Real Estate Research Corporation, *The Costs of Sprawl Executive Summary* (Washington, D C U S Government Printing Office, 1974), p 3 Referred to by title in subsequent figures.

The concern with urbanization, however, is not merely the amount of land that is allocated to urban purposes that could be used for other purposes; but the unique stress that high concentrations of population can place upon the environment. The pattern of residential development known as urban sprawl actually increases air pollution because of the increasing requirements for automobiles and residential heating. The Costs of Urban Sprawl determined that high density planned communities generated about 45% *less* air pollution than the low density sprawl community (assuming the same population), as shown in Figure 5. The simple shift of housing density alone could result in reduction of air pollution from automobiles from 20 to 30 percent.[8]

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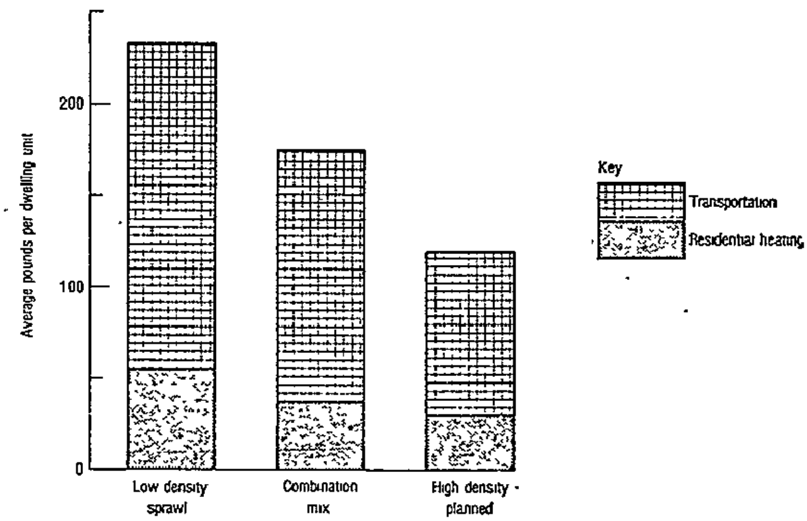
[7] Real Estate Research Corporation, The Costs of Sprawl: Executive Summary (Washington, D.C.: U.S. Government Printing Office, 1974)

[8] Ibid., p. 8

FIGURE 5

Community Cost Analysis
Annual Air Pollution Emissions

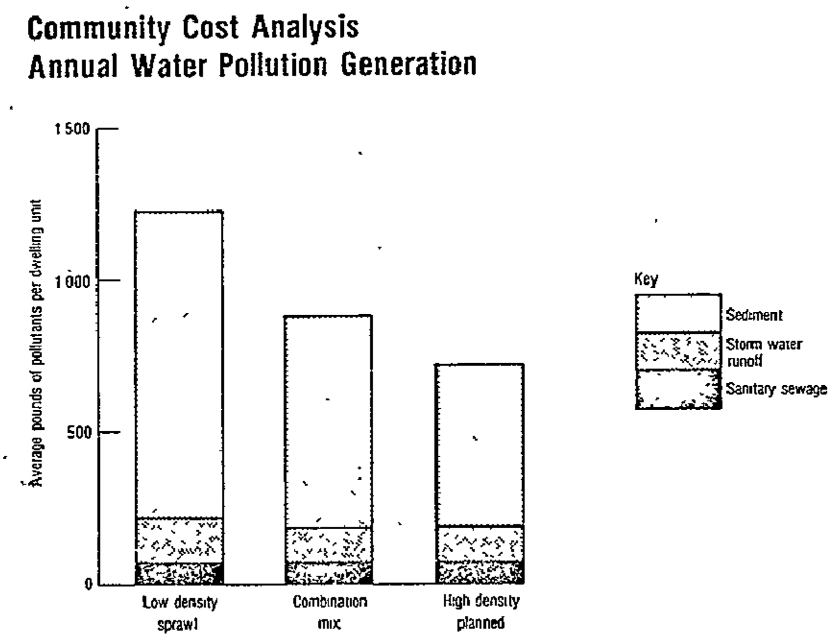


Source *The Costs of Sprawl" Executive Summary*,p.4.

The kind of urban architecture and urban form can also affect the way pollutants are dispersed as well as the environmental chemistry of a region. As is discussed elsewhere,the mean temperature of an urban area is 2-3^{o}C higher than its surrounding areas due to the high concentration of asphalt and concrete which absorb heat more efficiently than vegetation. This increased temperature in turn affects the local wind patterns which affect the ability of an urban area to disperse high concentrations of air pollution. Hence, the level of open spaces, trees, parks and recreational areas within an urban area has a functional role other than mere aesthetics in its contribution to the region's ability to cleanse itself of air pollutants.

Water pollution problems also vary with the kind of urban development that is permitted. The Costs of Urban Sprawl analyzed the types of water pollution problems that are generated by alternative housing and density communities. Figure 6 indicates that low density areas actually contribute higher levels of water pollution than high density areas (again, assuming the same population levels). This somewhat counterintuitive result is largely the result of increased sediment pollution which occurs when large amounts of land are disturbed.

FIGURE 6



Source *The Costs of Sprawl: Executive Summary*, p 5

Population densities *per se* can contribute untold environmental pressures upon an area. Consider, for example, the impact of winter road deicing programs in the United States. One-tenth of the world's salt production is spread on U.S. roads each year, an amount equal to 12-15 million tons annually and an amount that has been doubling every five years. While the impact of this high concentration of salt is not clearly known, it is known that in those areas with shallow soils and a dense network of highways, the chlorine level in drinking water is increasing rapidly and increasing at the same rate as the increase in salt usage. Chlorine levels rose tenfold in some towns during the 1960's and are approaching the Public Health Service maximum acceptable level, 250 milligrams per liter. At least one town has had to close its wells and buy water from another source.[9] The danger of this increased use of salt is pollution of ground waters and public drinking water supplies.

Another study indicates that storm run-off in urban areas may be a substantial source of pollution of urban watersheds through the concentration of heavy metals and heavy pollutants. Comparing storm water run-off with waste process by means of municipal sewage treatment plants, run-off becomes the major source of pollution in most cities as soon as secondary treatment (defined as 85% removal of BOD) of municipal wastes is achieved. It will also be the major source of settleable solids, pathogens and bacteria, and a major contributor of such toxic pollutants as lead and mercury.[10] The study also found that raw storm water contained five times the level of pollution as treated sewage.[11]

<u>Siting Requirements:</u> The second category of land use which may lead to land abuse is the siting of electrical, nuclear and industrial parks. It has been estimated in another section of this report that energy demands are expected to increase at about the rate of 3.6% per year from 1970-1980.[12] It has further been estimated that electricity generation will account for approximately 50% of the basic national energy utilization for the year 2000.[13]

The implications of this kind of energy growth on land use is quite substantial. It has been estimated by the Environmental Protection Agency that additional sites for 492 new power stations will be needed by 1990, some

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[9] Ian C.T. Nisbet, "Salt on the Earth," <u>Technology Review</u>, (May 1974) p. 6

[10] <u>Environmental Quality - 1974</u>, <u>Op. Cit</u>., p. 13

[11] "Pollution from the Streets," <u>Technology Review</u>, (October/November 1974) p. 74

[12] See "Energy and Materials"

[13] <u>Fusion Power and Assessment of Ultimate Potential</u>, Report AEC-WAHC 1239 (Washington, D.C. U.S. Atomic Energy Commission) February 1973

of which will require cooling ponds of 2,000 acres or more. At the same time transmission line rights of way will require another two million acres during the same period.[14] In 1970, the Federal Power Commission estimated that 395 new power plant sites would be required by 1990, as shown in Figure 7 below.

FIGURE 7

NEW POWER SITES

Type	1971-80	Number 1981-90	Total
Conventional hydro (100 MW and above)	15	25	40
Pumped storage hydro (300 MW and above)	20	35	55
Fossil Steam (50 MW and above)	80	60	140
Nuclear (500 MW and above)	70	90	160
Total	185	210	395

Source: Federal Power Commission, 1970 National Power Survey

The siting of power plants is complicated by a host of land use controversies. The siting must consider access, slope, drainage, weather protection, possibilities of floods and earthquakes. While economic considerations require "close in" locations to minimize transportation, transmission and water supply costs, environmental considerations force them further away.

As future plants will be several times larger than present ones, they will require more land. The Office of Science and Technology estimated the land required for a 3,000 MW power station of the future will range between 100 and 1,200 acres, according to type. Coal-fueled plants require land for ash disposal and coal storage. Sizable open areas around nuclear

[14] Environment Facts, op.cit.

plants are advised for public safety. Gas and oil fired plants require the smallest sites -- 100 to 350 acres.[15]

Because of continuing environmental fears concerning the location of nuclear power plants, it is quite likely that nuclear power plants will have to be located much further away from population centers and will require additional acreage as a buffer zone. This will create further land demand both in terms of the acreage required for the individual nuclear power plant and because of the additional acreage that will be required for transmission and rights of way.

Another siting requirement which is likely to cause substantial controversy is the siting of petroleum refineries and their pipelines. The recent efforts of the Onassis empire to locate a refinery in the heating oil scarce New England region is an example of the vehemence of public opposition.

<u>Strip Mining</u>: A third and substantial stress on the land is degradation of the land through strip surface mining for different minerals. As a result of mining for clay, coal, stone, sand and gravel, coal, phosphate rock, iron ore and other minerals, it has been estimated that over 3.1 million acres of land have been disturbed as shown in Figure 8.[16] The major source of this disturbed land is coal mining. In 1965, an estimated 1.3 million acres of land in the U.S. had been disturbed by strip mining. A sharp jump in new acreage disturbed by strip mining occurred between 1969 and 1970. This increase (amounting to 25,000 acres) equalled the increase in the previous four years. Assuming the accessibility of the mineral, economics have always dictated strip mining.

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[15] <u>Material Needs and the Environment Today and Tomorrow</u>, Final Report of the National Commission on Materials Policy, June 1973, p. 7-20.

[16] <u>Environmental Quality</u>, Appendix 8.

FIGURE 8

LAND DISTRIBUTED BY STRIP AND SURFACE MINING IN THE UNITED STATES AS OF JAN. 1, 1965, BY COMMODITY AND STATE (ACRES)

State	Clay	Coal (bituminous, lignite and anthracite)	Stone	Sand and gravel	Gold	Phosphate rock	Iron ore	All other	Total
Alabama [1]	4,000	50,600	3,[illegible]	21,200	100	....	52,600	1,500	133,900
Alaska [2]	....	500	....	2,000	8,600	....	....	....	11,100
Arizona [1]	2,700	....	1,[illegible]	7,200	1,200	....	....	20,300	32,400
Arkansas [2]	600	10,100	[illegible]	2,600	....	....	100	8,100	22,400
California [2]	2,700	20	[illegible]8,[illegible]	19,900	134,000	....	900	8,500	174,020
Colorado [1]	2,000	2,800	6,[illegible]	15,500	17,100	....	25	11,400	55,025
Connecticut [1]	....	....	[illegible]	16,100	....	....	....	100	16,300
Delaware [2]	200	....	[illegible]	5,200	....	....	100	10	5,710
Florida [1]	13,[illegible]	....	25,[illegible]	3 900	....	143,600	....	2,800	128,800
Georgia [1]	[1] 1,300	[3] 300	[3] 6,[illegible]	[3] 1,200	....	....	[3] 100	[4] 12,000	[1] 21,700
Hawaii [2]	....	....	....	....	....	....	....	10	10
Idaho [2]	500	....	[illegible]	11,200	21,200	3,100	35	4,200	40,935
Illinois [2]	1,400	127,000	5,[illegible]	9,000	....	....	....	....	143,100
Indiana [2]	1,500	95,200	10,[illegible]	18,000	....	....	....	400	125,300
Iowa [1]	1,300	11,000	12,[illegible]	17,600	....	....	6	2,300	44,406
Kansas	[1] 1,100	[3] 45,600	[1] 7,[illegible]	[1] 5,100	....	....	....	[3] 200	59,500
Kentucky	[1,2] 2,400	[1,2] 119,200	[1] 3,[illegible]	[1] 1,700	....	....	....	[1] 500	127,700
Louisiana [1]	900	....	[illegible]	29,700	....	....	50	....	30,750
Maine [1]	400	....	4,[illegible]	28,200	12	....	100	1,700	34,8[illegible]2
Maryland	[1,2] 1,200	[3] 2,200	[3] 2,2[illegible]	[1] 18,800	....	....	[1] 20	[1] 800	25,2[illegible]0
Massachusetts [1]	700	....	1,[illegible]	36,400	....	....	1,100	900	40,300
Michigan [2]	600	....	7,[illegible]	25,200	....	....	2,200	1,200	36,900
Minnesota [1]	600	....	3,[illegible]	41,600	3	....	67,700	1,600	115,403
Mississippi [2]	2,700	....	[illegible]	26,500	....	....	30	....	29,630
Missouri [2]	6,600	31,800	8,[illegible]	3,200	....	....	200	8,300	59,100
Montana [2]	....	1,500	10	[3] 13,500	5,600	100	10	6,200	26,920
Nebraska [2]	900	....	4,300	23 700	....	....	....	....	28,900
Nevada [1]	100	....	1,600	5,500	5,600	....	600	19,500	32,900
New Hampshire [2]	....	....	100	8 000	....	....	....	200	8 300
New Jersey [2]	1,400	....	2,000	27 600	....	....	1,000	1,800	33 800
New Mexico [2]	13	1,200	100	400	40	....	100	4,600	6,453
New York [1]	1,700	....	12,500	42 200	5	....	700	600	57,705
North Carolina [1]	5,800	10	6,000	18 400	2,200	300	100	4,000	36,810
North Dakota	[1] 800	[3] 7,700	[3] 300	[1] 26 100	....	....	....	[1] 2,000	36,900
Ohio	[1] 10,200	[2] 212,800	[1] 21,000	[1] 28,100	....	....	[1] 4,000	[1] 600	276,700
Oklahoma [2]	....	23,500	....	2,500	....	....	....	1,400	27,400
Oregon [2]	100	....	300	1,300	6,500	....	10	1,400	9,410
Pennsylvania	[1] 10,400	[2] 302,400	[1] 24,400	[1] 23 800	[1] 2	....	[1] 8,800	[1] 400	370,202
Rhode Island [1]	....	....	20	3 600	....	....	....	....	3,620
South Carolina [1]	10,900	....	1,400	10,400	200	8,100	100	1,600	32,700
South Dakota	[3] 2,000	[1] 900	....	[1] 28 000	....	....	....	[2] 3,300	34,200
Tennessee [1]	2,700	29,300	4,400	18 400	....	27,000	5,300	13,800	100,900
Texas [1]	6,800	2,900	21,900	132,300	....	....	9,600	2,800	166,300
Utah [2]	600	....	200	2,200	....	10	500	2,000	5,510
Vermont	....	....	[1] 2,300	4 000	....	....	....	[1] 400	6,700
Virginia	[1,2] 1,100	[2] 29,800	[1] 4,300	[1] 3,100	[1] 600	[1] 100	[1,2] 7,700	[1,2] 4,100	60,800
Washington [2]	500	100	1,300	5,700	400	....	20	800	8,820
West Virginia [2]	300	192,000	2,800	300	....	....	100	....	195,500
Wisconsin [2]	100	....	9,000	26 400	5	....	49	....	35,554
Wyoming	[1,2] 3,500	[1] 1,000	[1,2] 300	[1,2] 200	....	[3] 800	[1,2] 300	[3] 4,300	10,400
Total	108.513	1,301,430	241,430	8[illegible]3 300	203,167	183,110	164,255	162,620	3,187,825

[1] Data obtained from Soil Conservation Service, U.S. Department of Agriculture

[2] Data compiled from reports submitted by the States on U.S. Department of the Interior form 6-1385X.

[3] Estimate

Source: "Surface Mining and Our Environment: A Special Report to the Nation", U.S. Department of the Interior.

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ORIGINAL PAGE IS OF POOR QUALITY

As a rule, deep mining required three times as many workers to produce the same tonnage as strip mines do, and underground mining productivity has actually fallen in recent years.[17] One of the reasons for the economic advantages of strip mining is that a larger proportion of the coal deposit can be removed from the land by that method. In underground mining about 50% of the coal that is *in situ* can be extracted, while in surface mining this is generally increased to 80-85%.[18]

Although the strip mined acreages represent a small proportion of the national acreage, the effects that they have upon the immediate and adjacent areas of the mine itself are often quite dramatic and substantial. The dominance of surface mining as an extractive technique is strong and is gaining in importance in the United States. About 50% of the coal and more than 90% of all other minerals produced in the United States, with the exception of petroleum and natural gas, are extracted by surface mining methods.[19]

If, in fact, coal becomes the energy source of the future as many suggest, the impact upon land degradation could be substantial. It has been estimated up to 92,000 additional acres of land could be destroyed by coal strip mining by the year 2000.[20] This same study identified a substantial source of strippable coal reserves in the western states. In fact, the estimated strippable reserves in the western states amount to over

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[17] Edmund Faltermayer, "Its Back to the Pits for Coal's New Future," Fortune (June 1974) p. 137

[18] National Academy of Sciences, Mineral Resources and the Environment (National Academy of Sciences: Washington, D.C.) 1975, p. 193

[19] Material Needs in the Environment Today and Tomorrow, Op. Cit., p. 76

[20] National Academy of Sciences and National Academy of Engineering, Rehabilitation Potential of Western Coal Lands: A Report to the Energy Policy Project of the Ford Foundation, Ballinger, 1974

26 billion short tons.[21] The cost of a reclamation of this land is astronomical: 925-2750 dollars per acre plus potential road rehabilitation costs of $500-2000 per mile.[22]

Of the four million acres surface mined in this country, about 45% require no further treatment to prevent substantial environmental damage; however, the remaining 55% require shaping, planting or drainage control. Surface mining can result in serious erosion because of the lack of vegetation material to hold the soil during rain and wind. Strip mining coal is a common source of sulfuric acid, and the pollution can adversely affect stream life miles away.[23]

The controversy and arguments of strip mining are not close to resolution - witness the current federal legislative battle. Like other environmental protection controls the efforts to protect the land against the ravages of strip mining are likely to run into increasing obstacles because of the energy and material shortages that the country is experiencing. Costs of rehabilitation and reclamation will be a further impediment to effective action.

While coal mining bears the brunt of the attack against strip mining, it must be remembered that coal mining accounts for but 40% of the total land that is disturbed by strip mining. Hence, there are many other minerals extraction processes which equally disturb the land.

Waste Disposal: Another major source of degradation of the land is the disposal of waste materials including sewage sludge, radioactive wastes and

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[21] Ibid., p. 27.

[22] Ibid.

[23] Ibid.

industrial and consumer solid wastes. As has been mentioned previously, there are essentially only three methods of waste disposal available: discharging it directly into the nearest body of water, burning the waste, or burying it in the nearest body of land. It is the disposal of such wastes on land that is our concern here. In the case of solid waste, there is another technically feasible option: resource recovery.

Disposal of solid wastes is a significant environmental management problem. Each year in the United States it is necessary to dispose of 55 billion cans, 26 billion bottles, 65 billion metal and plastic bottle caps and more than 1/2 billion dollars worth of packaging materials. The amount of urban solid wastes collected annually is approximately two hundred million tons, and the per capita level of solid wastes in the United States is nearly one ton annually.[24] In addition, in 1971 industrial activities generated over 140 million tons of solid waste: scrap metal, slag, ash, plastics, paper and rags.[25] Figure 9 on the following page shows the solid waste levels generated by selected industry.

Currently, the disposal of solid wastes is largely dictated by economics. Costs of incineration of solid wastes range from $10 to $20 per ton. Costs of sanitary land fill range between $3 and $13 per ton but can be much higher in particular locations, especially where land values are high or lack of suitable land fill sites necessitates substantial transportation costs. Because these costs are continually rising, the economics of resource recovery are becoming more attractive. Because of increasingly severe material shortages, the value of recoverable waste materials is

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[24] Paul Ehrlich and Anne Ehrlich, People Resources, Environment (San Francisco, California: W.H. Freeman and Co.) p. 159

[25] Material Needs, Op. Cit., p. 4E-4

FIGURE 9

SOLID WASTE GENERATED BY INDUSTRIAL ACTIVITY

Industry	Tons (Millions) 1965[1]	1975[2]
Food	5.3	7.0
Meat	.8	1.2
Textile mill products	.9	1.1
Apparel and related products	.3	.5
Wooden containers	1.2	1.1
Sawmills	32.8	11.5
Millwork	.3	.4
Wooden furniture	1.5	2.6
Paper	5.0	7.3
Printing and publishing	1.2	1.6
Chemicals	1.3	2.4
Paints	.2	.2
Asphalt roofing	.6	.8
Rubber	1.5	1.9
Tanning	.3	.3
Glass	1.3	2.0
Metal cans	.1	.1
Fabricated metal products and machinery except electrical	3.0	4.4
Electrical machinery	1.4	2.5
Auto and aircraft	1.5	1.8
Cotton ginning	.8	.8
Demolition	19.1	22.1
Stockyards (including auction)	.4	.4
Supermarkets	10.2	13.2
Total	91.0	87.2

Source: National Bureau of Standards Report 10595, April 1971
[1]Estimated [2]Projected

rising significantly. As a result, a number of resource recovery techniques, especially those combining recycling of the heavy components of the wastes with combustion of the light components to recover energy, become economically competitive with traditional land fill and incineration techniques.[26]

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[26]Environmental Quality - 1974, p. 131-132

The major emphasis of current resource recovery techniques is to recover the energy value of the material. Figure 10 shows the planned implementation of energy recovery schemes.

Disposal of sewage sludge presents another land use problem. Most sewage sludge is disposed of through land fill projects. This disposal problem is likely to increase in the future for several reasons. One, as higher levels of waste treatment are required under increasing stringent pollution and control laws, the pollution of sewage sludge will increase as well.

Secondly, obviously as population grows, so will sewage sludge. Thirdly, irrespective of aggregate population, density in a region may aggravate the sewage sludge problem. The ability of a waterway or water body to effectively cleanse itself of the biological oxygen demand (the pollution problem generated by sewage sludge) declines with population growth; that is, the carrying capacity of a given water body is soon reached. This requires that sewage be subjected to higher and higher levels of treatment before the waste is discharged. One of the unusual aspects of sewage control is the diseconomies of scale that result from population growth. As the population increases the waste degrading ability of the watershed decreases and an increase in the degree of the sewage and water treatment is required. In summary, the greater the population in a given watershed, the higher the per capita cost of water pollution and control and abatement are likely to be.[27]

With the exception of New York City, the bulk of the sewage sludge in the country is either incinerated or used for land fill. While

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[27] Paul Ehrlich and Anne Ehrlich, Population, Resources, Environment (W. H. Freeman and Co.) 1972.

FIGURE 10

PROJECTED IMPLEMENTATIONS OF ENERGY RECOVERY SYSTEMS BY 1980

Location	Tons per day	Description
California		
San Diego County	200	Pyrolysis; EPA is sponsoring project to demonstrate the Garrett Research and Development system; oil produced will be accepted by San Diego Gas and Electric; project in engineering design phase.
Connecticut		
Bridgeport	1,200	Solid waste as fuel; state-wide resource recovery authority is reviewing proposals, Northeast Utilities will accept the fuel.
District of Columbia	1,000	Solid waste as fuel; D.C., Fairfax County, Arlington County, the City of Alexandria, and the Metropolitan Washington Council of Governments are studying the feasibility of a supplemental fuel system on a region-wide basis. Virginia Electric Power Company and Potomac Electric Power Company are cooperating in the studies.
Illinois		
Chicago	2,000	Solid waste as fuel; construction started in early March, Commonwealth Edison will accept the fuel.
Chicago area excluding the City	1,000	Solid waste as fuel; several suburbs have approached Commonwealth Edison to determine the feasibility of implementing supplemental fuel systems
Iowa		
Ames	200	Solid waste as fuel; construction to begin by June 1974; municipal electric utility will accept the fuel.
Maryland		
Baltimore	1,000	Pyrolysis; EPA is sponsoring project to demonstrate the Monsanto system; pyrolysis gas will be combusted on-site to generate steam for sale to Baltimore Gas and Electric; plant will be operational in early 1975.
Montgomery County	1,200	Solid waste as fuel; County is planning project with Potomac Electric Power Company cooperation; feasibility study has been completed; County Council and County Executive have approved the plan.
Massachusetts		
Braintree	240	Water wall incineration; plant has been operating since 1972; contract signed early 1974 for sale of steam to Weymouth Art Leather Co.
East Bridgewater	1,200	Solid waste as fuel; privately financed processing facility; Weyerhauser is accepting the fuel for its industrial steam boilers.
Saugus (near Boston)	1,200	Water wall incineration; plant under construction; steam product will be sold to General Electric Co. for process steam.
Lawrence	1,000	Solid waste as fuel; Lawrence will be the first implementation under the statewide solid waste master plan approved in early 1974; master plan calls for supplemental fuel production for steam and steam electric boilers, and materials recovery.
Missouri		
St. Louis	8,000	Solid waste as fuel; Union Electric Company plans to implement, by mid-1977, a system to handle the residential, commercial and selected industrial waste from the entire metropolitan area; Union Electric will process raw waste, recover magnetic metal, aluminum, and glass as well as fuel.
New Jersey		
Essex County	1,000	Solid waste as fuel; request for proposals being prepared; supplemental fuel to be accepted by Public Service Gas and Electric or other industrial steam boilers.
Hackensack-Meadowlands	2,000	Solid waste as fuel; detailed proposals are currently being reviewed; it is anticipated that the fuel will be accepted by Public Service Gas and Electric or industrial steam boilers.
Union County-Middlesex County	1,000	Solid waste as fuel; feasibility of producing a supplemental fuel for Public Service Gas and Electric is being assessed.
New York		
Albany area	500	Solid waste as fuel; feasibility of producing supplemental fuel for industrial steam boilers, state owned heating plant and municipal electric utility is being assessed.
Hempstead	1,000	Detailed proposals have been received for design and construction of energy and materials recovery systems.
Monroe County	500	Solid waste as fuel; feasibility study to produce a supplemental fuel for Rochester Gas and Electric completed, request for proposals being prepared.
New York City	2,000	Solid waste as fuel; City has completed feasibility study of using waste as supplemental fuel in Consolidated Edison's boilers; City writing request for proposals to design and construct supplemental fuel facility; City and Consolidated Edison plan contract to determine feasibility of designing new steam-electric boiler to burn 50 percent solid waste
Westchester County	1,500	Feasibility study completed; County most interested in energy recovery for County-owned industrial park
Ohio		
Akron	1,000	Water wall incineration; detailed engineering study is underway; steam product will be used for downtown heat and air conditioning and for B.F. Goodrich process steam.
Cleveland	500	City has received bids for a steam generation system; the super-heated steam will be used for electric generation by the municipal utility.

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improvements in incineration technologies hold promise for an effective long run solution to the problem, in the short run incineration of sewage sludge contributes substantially to air pollution. The use of sewage sludge for land fill on the other hand offers an opportunity for reclamation of strip mined lands as well as a potential for nutrient rich fertilizer. The metropolitan area of Chicago has investigated the costs and benefits of using nutrient rich sewage sludge for fertilizer. Their research has concluded that it is indeed cost effective to use it as a nitrate/phosphate concentrate. The potential hazard of using sewage sludge lies in the possible persistence of heavy metals, carcinogenic, mutagenic or toxic materials which may be in the sewage sludge. As industrial polluters are precluded through the Water Pollution Control Act from discharging toxic materials into water bodies, they often discharge them instead into municipal sewage and water systems. Therefore, instead of dealing with the problem of persistent and toxic materials in a fresh running water system, the toxic materials instead turn up in sewage sludge.

Agricultural Requirements: A fifth major issue with respect to land use is the requirements for agricultural purposes. Apparently, less than one-quarter of the total land in the United States is used for crop land. Approximately a third of the land is used for pasture, and range land. These numbers are only expected to increase a small amount between now and the year 2020,[28] as shown in Figure 11 on the next page.

Contrary to the publicity, there is not much latitude in the allocation of the United States land for agricultural purposes. Figure 12 on the next page shows the current crop land potential of the nation's arable land.

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28 Water Resources Council, The Nation's Water Resources, (Washington, D.C.: 1968).

FIGURE 11

PROJECTED USES OF U.S. LAND

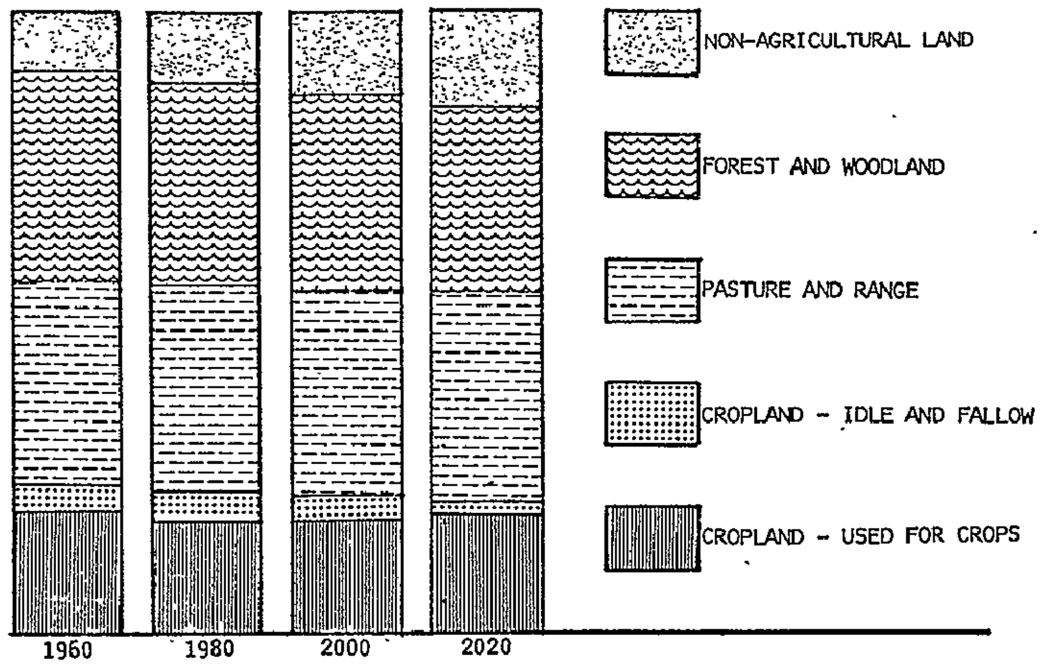
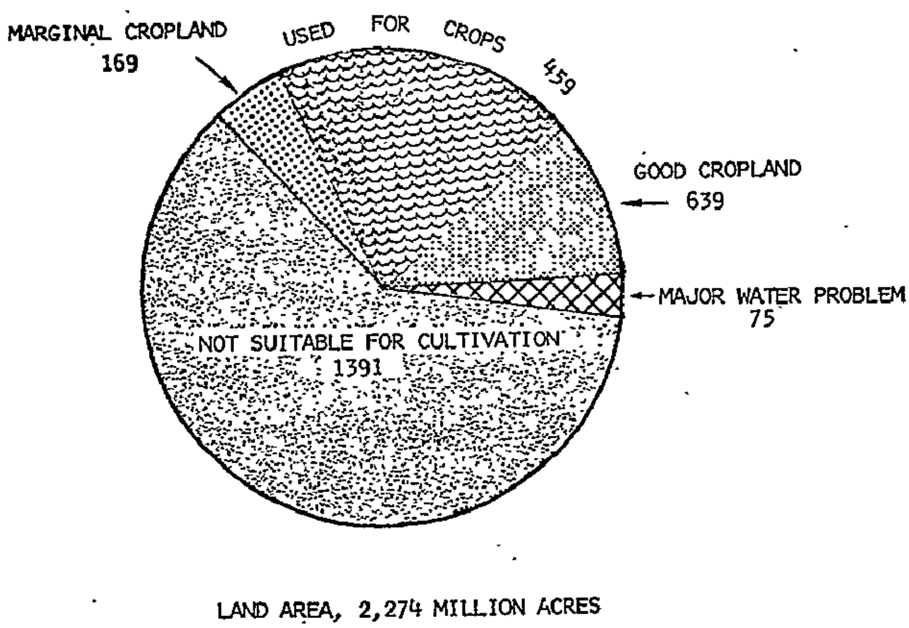


FIGURE 12

CROPLAND POTENTIAL



Source: Water Resources Council, The Nation's Water Resources, (Washington, D.C.: 1968).

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Over 61% of the U.S. land (or 1391 million acres of land) is unsuitable for cultivation. In addition, another 75 million acres have a major water problem, either insufficient water or excess water. This land could be cultivated for agricultural purposes with major reclamation efforts. While less than 50% of the lands which are suited for crop lands are currently so used, the remaining suitable crop land is used for pasture, range, forests—or woodlands.[29] Much of this land goes for support of animal crops, as well as for supplying an increasingly high demand for wood products and urban purposes. It is the conclusion of the Water Resources Council that these activities will severely limit the amount of potential crop land which can actually be made available for cultivation.

The ability of the nation to turn non-crop land to crop land purposes as the demand arises is likely to meet with severe obstacles. It is not at all clear that the United States will have sufficient land to serve as "the world's bread basket." The world food shortages -- not likely to be a short lived phenomenon -- will undoubtedly generate further pressures for the United States to serve in this capacity because of its high level of agricultural productivity. These kinds of pressures will of course necessitate that more land be allocated to crop land. However, recent research indicates that increases in U.S. agricultural productivity through further uses of fertilizers, pesticides and herbicides may not, in fact, be possible.[30]

In fact because of the problems associated with pesticide persistence and water pollution from agricultural run-off, it may even be necessary

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[29] Ibid., p. 1-7

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[30] National Academy of Sciences, Productive Agriculture and a Quality Environment, (Washington, D.C.: National Academy of Sciences) 1974

to reduce the present reliance upon fertilizer and pesticides given the current state-of-the-art. This would, of course, increase further the amount of land required for the same level of production. Even without these additional pressures, Resources For The Future has estimated that as many as 416 million acres will be required for crop land by the year 2000 versus 384 million acres presently so employed.[31]

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[31] Resources for the Future, Resources in America's Future, John's Hopkins Press, p. 979-980.

ACCUMULATION OF POTENTIALLY HARMFUL SUBSTANCES IN THE FOOD CHAIN LEADING TO DISEASE AND GENETIC DEFECTS IN THE POPULATION

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ISSUE: ACCUMULATION OF POTENTIALLY HARMFUL SUBSTANCES IN THE FOOD CHAIN LEADING TO DISEASE AND GENETIC DEFECTS IN THE POPULATION

The Issue:

There is growing evidence that the American public is consuming, both directly and indirectly, substances which may, over a period of time and in differing concentrations, be toxic, carcinogenic or mutagenic. [1] These substances can enter the food chain in several ways: [2]

1. They can be present in food as a consequence of a natural event, such as mold or chemicals naturally occurring in plant tissues.

2. They can result from materials used in agricultural production that have not been removed and remain in the final product.

3. They can result from excessive use of additives during food processing, perhaps accumulating through different stages of the food preparation process.

4. They can result from containers and packages, and from accidents or negligence in various processes directly or indirectly related to food production, processing, and handling.

Toxics[3] refer to any harmful material that may enter the food chain. The most obvious, and hence, prevalent, points of entry, are in the agricultural process (i.e. pesticides, herbicides, biological agents, growth agents, antibiotics and vaccines) and the industrial process (heavy metals such as lead, mercury, cadmium, arsenic and nickel). Increasingly, there is

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[1] The focus of this issue is on substances ingested with normal intake of food. The subject of general environmental pollution and its effect upon society is discussed in another section.

[2] Emil T. Chanlet, Environmental Protection (New York: McGraw-Hill, 1973, p.370.

[3] While the term "toxic" actually refers only to "poisons," the term will be used here to refer to a general class of harmful substances whether poisonous to the host who originally ingests the substance or not. For instance, some substances may not be poisonous to the consumer, but may, in fact, be mutagenic and poisonous to later generations (such is the postulated effect of DDT)

evidence that substances added to foods to enhance flavor, retard spoilage, improve color, consistency and other aesthetic qualities of the food, may actually be harmful. Especially suspect are artificial sweeteners, nitrate preservatives, fluorides, monosodium glutamate, and artificial dyes. Even known beneficial substances, such as essential minerals and vitamins, may be hazardous when ingested in high concentrations. Likewise some drugs such as the hormone stilbestrol ("the morning after pill") and other therapeutic hormones are known to cause cancer in humans.

Consumption of these materials has increased substantially in recent years because of the industrialization of American agriculture, the increasing industrialization of the preparation of foodstuffs, the reliance upon mass produced convenience foods, and the tremendous number of new chemicals that have been introduced since World War II. For example, a list of organic pesticides commonly found in the diet of Americans is shown in Figure 1. Clearly, each item may not prove to be harmful, especially since effects from the dosage, the period of exposure, and even the diet, race, age, and other characteristics vary with the individual involved. [4]

However, the growing reliance on these materials suggests that close monitoring and further research is required. According to Robert L. Rudd of the University of California, in 1945 DDT, benezene, hexachloride, and lead arsenic were the only insecticides used in any significant amount. DDT production increased enormously after the World War II (in the United States and around the world). Growing concern about its use ultimately resulted in its curtailment. Yet overall use of pesticides in the Unites States more than doubled between 1960 and 1970, reaching a level of about one billion pounds in 1970. [5] In fact, there currently are more than 32,000 pesticide

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[4]Paul R. Erhlich and Anne H. Erhlich, Population, Resources, Environment (San Francisco, Calif.: W. H. Freeman & Co., 1972), p. 163.

[5]Ibid, p.213.

	Incidence %	Daily intake range (mg)
DDT	37.3-55.6	0.015-0.041
DDE	31.1-50.6	0.010-0.028
TDE	19.4-32.8	0.004-0.018
Dieldrin	15.3-31.3	0.004-0.007
Lindane	10.6-15.8	0.001-0.005
Heptachlor epoxide	8.9-13.4	0.001-0.003
BHC	6.0-13.1	0.001-0.003
Malathion	1.9-11.1	0.003-0.013
Carbaryl	N.D.-7.4	N.D.-0.15
Aldrin	0.8- 5.6	T-0.002
2,4-D	0.3- 4.2	T-0.005
Diazinon	0.3- 5.8	T-0.001
Dicofol	0.5- 5.6	0.003-0.010
PCP	N.D.- 3.3	N.D.-0.006
Endrin	1.1- 3.3	T-0.001
Methoxychlor	N.D.- 1.9	N.D.-0.001
Heptachlor	N.D.- 1.9	N.D.-T
Camphechlor	N.D.- 3.6	N.D.-0.002
'Perthane®'	N.D.- 1.3	N.D.-0.004
Parathion	0.6- 5.0	T-0.001
Endosulfan	0.3- 5.3	T-0.001
Ethion	0.3- 4.4	T-0.004

N.D. = not detected. T = <0.0005

SOURCE: R. E. and M. B. Duggan, "Pesticide Residues in Food," in C. A. Edwards (ed.), Environmental Pollution by Pesticides (New York: Plenum Publishing Corp., 1973), p. 341.

Figure 1 Organic residues commonly found in total diet in the United States, 1965-1970.

products containing almost 1000 chemicals which are registered for use in the United States.[6] New plant hybrids require greater and higher concentrations of pesticides and fertilizers per acre to achieve their advertised high yields.[7]

One of the most widely used flavor enhancers, MSG (monosodium glutamate), has been shown to cause central nervous damage to fetal and infant primates. Therefore, it has been banned from commerical baby foods yet is still readily available on the spice shelves of the grocery store.

Mercury is one of the most hazardous materials. For example, a chemical plant in Minamata City, Japan, substantially increased production and the release of mercury in 1953. Soon thereafter, more than 100 people died or experienced serious nervous system damage from eating seafood obtained from Minamata Bay. Also, a New York woman, in the mid-1960's, suffered dizziness, memory loss, hand tremors, tongue quivers, hypersensitivity to light, difficulty in vision focusing, and loss of physical coordination due to mercury poisoning as the result of the daily consumption of 10 ounces of swordfish. This was the first known case of mercury illness attributed to eating mass-marketed food in the United States and resulted in the banning of swordfish.[8]

However, a frequent example of toxic ingestion is the consumption of shellfish that have been tainted by other industrial and sewage waste. It has been estimated that over 20% of the nation's shellfish beds are closed due to contamination and that the economic loss from shellfish pollution is $63 million.[9] Even where contaminant levels do not prevent safe consumption,

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[6] Environmental Quality, The Council on Environmental Quality (Washington, D.C.: U.S. Government Printing Office, Spetember 1973), p.183.

[7] Population, Resources, Environment, op.cit., p.213.

[8] Population, Resources, Environment, op.cit., p.169.

[9] Ocean Dumping: A National Policy, A Report to the President Prepared by the Council on Environmental Quality (Washington, D.C.: Government Printing Office) October 1970, p.17.

the food may be discolored or tainted. Even in small amounts oil can taint the flesh of fish. In addition, polycyclic aromatic hydrocarbons (present in oil) are known carcinogens. While there has not been an identified case of hydrocarbon-caused human cancer, such cancers have been found in fish.

These and many other instances attest the need for concern about the effects of toxic materials in the food chain. Of particular worry is the increasing concentration of some substances through the food chain as food is ingested by higher organisms. For instance, filter feeders such as oysters, will have higher concentrations of toxic substances in their tissues than will be found in the surrounding environment. As a result of their shallow coastal water habitat where pollution may be heavy and the constant filtering of the pollutant laden water, oysters can contain much higher concentrations of radioactive substances and lethal chemicals than is found in the surrounding water. Concentration levels of up to 70,000 times the normal concentration of chlorinated hydrocarbon insecticides found in the environment have been found in oyster tissues.[10]

But the effects of many toxic substances are not immediately apparent. Blindness, deafness, loss of coordination, madness, or even death, while readily apparent may not be easily related to years of ingesting a particular -- and possibly unknown -- chemical. Further, many effects may not be readily apparent and may not show up even in the same generation. Often the effect may be so insidious and gradual (such as mental retardation from lead poisoning and central nervous system effects) as to not even be readily apparent for years and then to be seemingly without direct cause.

[10] Population, Resources, Enviornment, op.cit., p.198.

Many of the commonly used chemicals such as chloro-methyl methyl ether (CMME), bischloromethyl ether (BCME), and polyvinyl chloride were not identified as carcinogenic until 20 to 30 years after widespread use. Unlike most illnesses, it typically takes 15 to 30 years for cancer to develop in the body. One researcher in the area, Dr. Irving J. Kelikoff of the Mt. Sinai School of Medicine, noted that "to prevent cancer in the year 2000, we have to identify the problem chemicals in 1975."[11]

Increasingly, as the foundation of heredity is better understood, the chemical basis for many congenital defects and illnesses is being discovered. Occupational exposure to chemicals (i.e. vinyl chloride, arsenic, asbestos) is increasingly being recognized as a pathway for toxic substances that is at least as hazardous as direct consumption, as evidenced by the recent conference on Occupational Carcinogenesis sponsored by the National Academy of Sciences. Researchers found not only increased incidence (i.e.even orders of magnitude higher than the normal expected incidence) of cancer and cancer-caused deaths in workers that came in contact with potentially carcinogenic materials, but also higher rates in their families and in people who lived near the factories.[12]

In sum, the effects of these substances are highly dependent on:

1. The mode of exposure (inhalation, ingestion, or contact).
2. The amount taken.

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[11] Stuart Auerbach, "Cancer: A Work Hazard Industry is Forced to Face," The Washington Post (March 30, 1975) p.A-3.

[12] Stuart Auerbach, "Job Caused Cancers are Found Spreading to Workers' Families," The Washington Post (March 25, 1975) p.1.

3. The time span of intake, including intervals between intakes (which largely affect excretion and therefore recovery by the body).

4. Physiological and psychological status of the individual, including the sum of his assets and deficits which determines his ability to cope with the toxicant.

5. Synergistic or amplifying effects of other substances taken in at the same time. [13]

Unfortunately, the lack of an immediate and well understood crisis may retard effective policy on this issue, especially since long-term effects are likely to be irreversible but are not likely to be perceived or understood until the damage has been done.

Dimensions of the Problem:

Agricultural Chemicals: Prior to World War II, only a small number of lethal inorganic compounds and relatively non-toxic products were used in agriculture. The location of residues from these materials in the food supply was predictable and examination of foods for such residues was relatively simple. But there are now many sources of pesticide residues in food and the list of such residues is long (see Figure 2). Pesticide residues have even been found in foods whose production did not entail the use of pesticides. For instance, pesticide residues have been found in milk because pesticides were used during the growth of cattle feed. Pesticides can enter the food chain in other ways as well. [14] Materials used to protect forests and fiber crops, to control weeds on roads and other right-of-ways, and to control insects in homes and gardens are transported by air, soil, and water movements. Even disposal of used pesticide containers provides another source of residues in food.

[13] Environmental Protection, op.cit., p.374.

[14] Population, Resources, Environment, op.cit., p.160.

Domestic: Number samples examined	Domestic: Number samples (>2.0 ppm)	Domestic: Pesticide chemical	Domestic: Number samples	Domestic: Range of levels (ppm)	Imported: Number samples examined	Imported: Number samples (>2.0 ppm)	Imported: Pesticide chemical	Imported: Number samples	Imported: Range of levels (ppm)
				July 1, 1967–June 30, 1968					
Large fruits									
1,551	10	Ethion	1	5.6	162	0			
		Carbaryl	3	3.0-8.0					
		Dicloran	2	4.3-8.0					
		Zineb	1	3.6					
		Trithion	1	3.5					
		SOPP*	1	13.5					
		DDT	2	2.8-3.5					
Small fruits									
419	5	Dicloran	1	8.0	58	0			
		Dicofol	2	2.1-2.5					
		Ethion	1	3.8					
		DDT	1	3.2					
Leaf and stem vegetables									
2,461	97	Camphechlor	59	2.1-84.0	122	0			
		DDT	28	2.2-34.0					
		TDE	4	3.6-21.1					
		Zineb	12	2.4-6.2					
		Parathion	3	2.3-3.0					
		BHC	1	9.6					
		Malathion	1	4.6					
		'Pethane®	1	3.4					
		Maneb	1	2.1					
		Carbaryl	1	4.0					
		Nicotine	1	5.3					
		Sodium arsenite	1	5.4					
		Lead arsenate	1	4.2					
Root vegetables									
1,954	6	Parathion	2	2.1-3.3	67	0			
		DDT	2	3.5-3.9					
		Dicloran	1	3.0					
		Lindane	1	2.1					
Vine and ear vegetables									
1,091	3	DDT	1	2.3	300	0			
		Toxaphene	2	2.3-4.0					
Grains (human)									
934	25	Malathion	20	2.1-15.1	8	0			
		Methoxychlor	2	3.0-4.0					
		Camphechlor	1	2.3					
		Methyl bromide	1	31.4					
		Mercury	1	4.2					
Grains (animal)									
371	1	Malathion	1	28.0	10	0			
Dairy products									
1,141	5	DDE	4	2.0-2.1	177	3	Heptachlor epoxide	1	2.3
		DDT	1	2.8			Lindane	2	3.5-7.6
Fluid milk									
1,552	10	DDE	10	2.0-3.9	0				

* Sodium-o-Phenylphenate; Orthophenylphenol

SOURCE: R. E. and M. B. Duggan, "Pesticide Residues in Food," in C. A. Edwards (ed.), Environmental Pollution by Pesticides (New York: Plenum Publishing Corp., 1973), pp. 344-347.

Figure: 2 U.S. Food Samples Containing Pesticide Residues Exceeding 2 ppm.

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Figure 2 (cont'd)

Domestic					Imported				
Number samples examined	Number samples (>2.0 ppm)	Pesticide chemical	Number samples	Range of levels (ppm)	Number samples examined	Number samples (>2.0 ppm)	Pesticide chemical	Number samples	Range of levels (ppm)
July 1, 1968–June 30,1969									
Large fruits									
863	7	DDT	1	2.4	94	0			
		Methoxychlor	1	2.7					
		PCNB	1	4.1					
		Diphenyl	1	2.7					
		SOPP*	3	2.2-6.2					
Small fruits									
410	9	Methoxychlor	1	2.3	144	2	Dicofol	2	2.1-3.1
		Ethion	4	2.3-3.2					
		Dicofol	2	2.2-3.9					
		Captan	2	5.1-5.9					
Beans									
85	1	DDT	1	5.0	24				
Leaf and stem vegetables									
1,920	139	Camphechlor	85	2.1-40.0	19	4	Camphechlor	2	2.9-183.0
		DDT	30	2.1-23.0			DDT	2	2.7-68.0
		TDE	1	2.5			Thiodan	1	4.7
		DDE	1	6.1					
		Zineb	6	2.1-20.1					
		Endosulfan	2	2.1-2.3					
		Malathion	1	2.9					
		Tedion	1	2.9					
		BHC	1	2.8					
		Ethion	4	2.6-8.4					
		'Perthane®'	4	2.8-4.0					
		Carbaryl	1	8.4					
		Chlordane	3	2.8-7.1					
		Diazinon	7	2.4-6.4					
		Parathion	6	2.2-13.2					
		Methyl parathion	1	2.1					
Root vegetables									
1,213	4	DDT	2	2.2-3.0	90	0			
		Chlordane	1	3.8					
		Camphechlor	1	2.3					
Vine and ear vegetables									
856	2	DDT	2	2.0-7.5	280	0			
Grains (human)									
590	14	Malathion	11	2.7-28.0	4	0			
		Methyl parathion	1	5.5					
		Camphechlor	1	2.9					
Grains (animal)									
119	7	Malathion	3	2.1-3.8					
		Parathion	3	2.8-8.8					
		Calcium arsenite	1	3.7					
Dairy products									
691	2	Heptachlor epoxide	1	4.1	620	11	BHC	7	2.1-6.1
		BHC	1	6.0			Lindane	2	3.7-7.2
							DDT	1	24.1
							DDE	2	2.0-2.3
							Tetradifon	1	7.9
Shell eggs									
640	1	Chlordane	1	14.8	0				
Fluid milk									
857	4	DDE	2	2.3-2.6	0				
		TDE	1	4.1					
		Methoxychlor	1	4.1					

Adapted from: W. R. Poage, Chrm. 1971. Fed. Pesticide Control Act of 1971. Hearings U.S. Gov't Printing Office, #92.A.

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The lack of understanding of the movement of these substances through the food chain and, more importantly, the inadequate understanding of the short and long term health effects of these materials aggrevate the problem. Not surprisingly, there is no consensus among international experts regarding the maximum tolerances for these substances (see Figure 3). In fact, a single measure of toxicity, it is argued, may not be sufficient to measure the risk of various pesticide residues in food.[15]

Even though the biological importance of pesticide residues in food is currently of considerable interest, reliable evidence does not exist that even *suggests* that current levels of pesticide exposure are harmful. However, this may be more a judgment about the quality of the evidence than the safety of pesticides. The National Academy of Sciences concluded: "On the one hand, data presently available do not indicate that man is being harmed by small quantities of pesticides in his tissues; on the other hand there are even fewer data to justify complacency."[16] It is argued that data on large population groups with either high or low exposure are required for epidemiological studies to determine whether pesticides have any influence on the incidence of disease, apart from the known consequences of obviously excessive exposure.[17]

Another important source of hazardous compounds is the increasing use of growth hormones in livestock. In January of 1973, diethylstilbestrol (DES) was determined to be carcinogenic and was banned from further use.[18]

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[15] Environmental Protection, op.cit., pp.376 and 378.

[16] Productive Agriculture and A Quality Environment (National Academy of Sciences: Washington, D. C.), 1974, p.27.

[17] "Insecticide Residues in the Human Diet," Archives of Environmental Health, Vol. 10, No. 831 (1965).

[18] Chemical Marketing Reporter, Vol. 206, No. 13 (September 23, 1974), pp.3 and 13.

Figure 3

REPRESENTATIVE TOLERANCES FOR INSECTICIDE RESIDUES

Insecticide chemical (common name)	Maximum tolerance, mg/kg Switzerland	The Netherlands	U.S.	U.S.S.R.
Aldrin	0.1	0.1	0.25	0.0
Arsenic-containing	1.0	0.7	2.3	0.0
DDT	4.0	5.0	7	1.0
Diazinon	0.75	1	0.75	
Methyl parathion	0.75	0.5	1	
Parathion	0.75	0.5	1	5.0*

* The purified compound only; the "impure" compound is restricted to 0.0 ppm.

SOURCE: Emil T. Chanlett, Environmental Protection, McGraw-Hill Series in Water Resources and Environmental Engineering (New York: McGraw-Hill Book Co., 1973), p. 378.

According to Dr. W. Clarke Wescoe, a top drug company executive, the decision to ban DES "was a triumph of superior, sophisticated analytical techniques that permitted the measurement of 120 parts per trillion of DES." He indicated that with the development of better, more sophisticated techniques, more and more substances can be identified in more minute quantities. This conflict between promulgation of standards and technological capabilities of monitoring, is similar to many of the difficulties in the establishment of the air and water quality standards.

Despite the evidence, the ban on DES was overturned by a federal court due to a procedural error -- the FDA did not conduct public hearings previous to the ban, thereby depriving producers of their chance to comment. At this writing, DES is still being used as a growth stimulant for cattle.

While both the FDA and EPA monitor toxic and potentially toxic substances, the rate of introduction of new products has been high. The management of agricultural chemicals ultimately rests with the farmer and the agricultural chemical supplier. Unfortunately, many chemicals have proliferated widely without understanding of their long run impact, and the consequences of their widespread presence only becomes apparent at a much later time.

It appears that most human effects associated with pesticide residues in food are related more to accidents than ingestion through the food production process. But this is no reason to become complacent, as there have been many epidemics of poisoning by pesticides (see Figure 4). In the cases shown here, spillage from transportation or storage caused 11 incidents, eating formulated chemicals caused five others, and irresponsible applications were the cause of four. Fatalities occurred in 12 of these epidemics.

Industrial Processes: In one way or another, all of the toxic metal materials are used in industrial processes in the United States, including lead, mercury, cadmium, arsenic, and nickel.

Contrasted to the uncertainty about the effects of agricultural chemicals, the harmful effects of consuming heavy metals is well-known and documented. The dangers of lead poisoning have been recognized for centuries. A popular theory ascribes the decline of both Greek and Roman civilizations to an over-exposure to lead, as it was used by them to line bronze cooking, eating, and storage utensils.[19] As lead is a cumulative poison, it is difficult to diagnose early, especially when its effects are still at a low level. The largest single use of lead in the United States

[19] Population, Resources, Environment, op.cit., p.166.

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Kind of accident	Pesticide	Material contaminated	Number of cases	Number of deaths	Location
Spillage during transportation or storage	Endrin	Flour	159	0	Wales
	Endrin	Flour	3	0	Egypt
	Endrin	Flour	691	24	Qatar
	Endrin	Flour	183	2	S. Arabia
	Dieldrin	Food	21	0	Shipboard
	Diazinon	Doughnut mix	20	0	U.S.A.
	Parathion	Wheat	360	102	India
	Parathion	Barley	38	9	Malaya
	Parathion	Flour	200	8	Egypt
	Parathion	Flour	600	88	Colombia
	Parathion	Sugar	300	17	Mexico
Consumption of treated soil	Hexachlorobenzene	Seed grain	>3,000	3-11%	Turkey
	Organic mercury	Seed grain	34	4	W. Pakistan
	Organic mercury	Seed grain	321	35	Iraq
	Organic mercury	Seed grain	45	20	Guatemala
Improper application	Toxaphene	Collards	4	0	U.S.A.
	Toxaphene	Chard	3	0	U.S.A.
Miscellaneous	Parathion	Crops	>400	0	U.S.A.

E. M. Mrak (Chairman), Report of the Secretary's Commission on Pesticides and their Relationship to Environmental Health, Part II, 311, U.S. Department of Health, Education, and Welfare (1969).

SOURCE: R. E. and M. B. Duggan, "Pesticide Residues in Food," in C. A. Edwards (ed.), Environmental Pollution by Pesticides (New York: Plenum Publishing Corp., 1973), p. 356.

Figure 4 Epidemics of poisoning by pesticides reported in literature between 1952-1969.

today is in leaded gasoline for automobiles. Exhaust dust, settling on crops and water supplies, has been a major source of consumed lead. Recognition of this problem is long standing and attempts are being made to remove it (witness automobile engines designed to meet new pollution requirements cannot use leaded gasoline).

Mercury, another well-known poison, enters the environment from many sources: industrial processes, processing of pulp and paper, agricultural fungicides, and even through the combustion of fossil fuels. It has been estimated that in 1971 over 23 million pounds of mercury were released into the environment.[20]

Mercury appears not to be a problem in marine waters currently, but the addition of mercury to fresh waters is substantial due to the disposal of industrial wastes. Metallic or elemental mercury is essentially non-toxic to humans, but certain micro-organisms convert it to more toxic organic forms, including methyl mercury and other alkyl-mercury compounds which become increasingly concentrated in the food chain, especially in fish (concentrations in fish tissue are thousands of times higher than the surrounding water). Mercury has been found in significant quantities in tuna, swordfish, and other animals that exist near the top of the marine food chain. Recently, the FDA discovered that most of the samples of swordfish it tested exceeded maximum allowable concentrations and that 8% of the samples exceeded such levels by a factor of 3. Sensitivity to mercury varies with individuals and involves blindness, deafness, coordination loss, madness, and even death in high concentrations. Populations consuming large amounts of seafood are likely to have high exposures to mercury, as discussed earlier.

[20] Population, Resources, Environment, op.cit., p.168.

Cadmium is now being detected in lobsters and other food, but the implication of these concentrations is uncertain. Fatal cases of cadmium poisoning have been reported in Japan, and cadmium has now been found in concentrations above U.S. Public Health Service limits, in the water supplies (prior to treatment) of 20 cities. High levels of cadmium and chromium have been found in Long Island, where the contamination was traced to waste deposited during World War II.

A study by MIT on critical environmental problems listed lead, mercury, cadmium, chromium, arsenic, and nickel as the most toxic, persistent and abundant elements in the environment. It is agreed, however, that considerably more information on short-and-long-term human exposure is needed before proper courses of action can be formulated.[21]

In addition to the metallic poisons, it is becoming clear that asbestos is profoundly carcinogenic. Autopsy findings indicate that it is found in the lung tissue of 100% of the urban population who died of cancer and lived or worked near construction sites.[22] In Duluth, Minnesota, asbestos tailings in Lake Superior have become a test of the strength of the environmentalists.

Another material which is causing increased concern is polychlorinated biphenyls (PCBs). These chemicals are used in the preparation of paint, as a plasticizer for vinyl plastics and as an ingredient in certain waxes. They have already been found in hazardous levels in fresh poultry. Another group of chemicals, the chlorylethers, are being considered as possible water pollutants and drinking water contaminants. It has been reported that bis-chlorylethel ether and bis-chloroisoprophyl ether have been found

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21 <u>Population, Resources, Environment,</u> pp. 169-170.

22 Stuart Auerbach, "Job Caused Cancers," <u>op.cit.</u>

in some water supplies, including treated drinking water. Both of these compounds are closely related chemically to bis-chlorol ethylmether which is known to produce cancer in mice.[23]

There are other chemicals which are used for health purposes and have become part of the food chain, and may, under some circumstances, present health hazards. Fluoridated water is the classic example and a source of continuous debate. Fluorides are also discharged into the air from steel, aluminum, phosphate, glass, pottery, and brickworks. These effluents can add to the fluoride intake of individuals who drink fluoridated water. It has been noted that the difference between safe and unsafe levels of fluorides is small and that people in fluoridated communities and elsewhere are now ingesting more than the official safe level.[24]

There are two fundamental difficulties in establishing standards and protecting the population from further exposure to hazardous substances. One is the huge number of new chemical and biological substances that are introduced annually. A second problem is the state of understanding of the biological and chemical impact of these substances. Quite often a product will pass the tests established by the FDA and will, in full conscience, be introduced by their manufacturers. It is only after prolonged exposure, perhaps under conditions that cannot be duplicated in the laboratory and perhaps in synergistic combination with other materials, that the negative implication becomes clear. As previously mentioned, the latency period for development of human cancers may be 20 years or so. Often, the mutagenic

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[23] Environmental Quality, op.cit., p.189

[24] Population, Resources, Environment, op.cit., pp.170-171.

consequences cannot be observed for several generations. A contributing problem has been the inability to monitor and and trace known hazardous compounds in the food chain.

But the fundamental difficulty has been and will continue to be the inadequate understanding of cellular mechanisms. Biochemical study of the cellular processes is in its infancy and it is through this research that the best hopes for understanding the carcinogenic and mutagenic effects lie. While to date much of the biological evidence has been inferential, further understanding of these cellular mechanisms will make it possible to better identify cause and effect relationships.

Potential Actions:

Several distinct and different courses of action are possible as means of minimizing or preventing hazards associated with ingestion of toxic substances from the food chain.

However, additional capabilities are required to develop effective policies. These involve:

1. Determining acceptable limits of various materials.

2. Developing and implementing monitoring systems which can measure the level of various trace constituents.

3. Improving understanding of the movement of substances through the food chain, and developing and implementing means of removing toxic elements.

4. Seeking ways to negate, counteract, ameliorate the effects of toxics.

5. Increasing research into basic cellular biochemistry.

These are goals of an extensive and expensive research program that would contribute substantially to improving all areas of public health management.

The use of materials can be regulated or prohibited by law, and many statutes exist which already govern the use of various materials. The ban on DDT would presumably open the markets for other pesticides, but producers are having difficulty meeting Environmental Protection Agency standards. According to the National Agricultural Chemicals Association in 1970 it took $5.5 million, 6.6 years and the testing of 7630 chemical compounds to get a pesticide on the market -- as opposed to the former $3.4 million, 5 years and 5481 tests in 1967.[25]

While there is recognition of the problem and cognizance of the need for policy response, an inadequate understanding of the biology and chemistry of the problem is hampering efforts to respond effectively. The most efficacious action would be the continuation of the fundamental research, environmental monitoring and data gathering necessary for informed policy formation and decision making.

[25] "New Pesticides," Wall Street Journal, August 23, 1973, p.1.

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DETERIORATION AND MODIFICATION OF THE BIOSPHERE LEADING TO IRREVERSIBLE CLIMATIC CHANGE OF THE GLOBAL ECOSYSTEM

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ISSUE: DETERIORATION AND MODIFICATION OF THE BIOSPHERE LEADING TO IRREVERSIBLE CLIMATIC CHANGE OF THE GLOBAL ECOSYSTEM

The Issue:

Previous sections of this report have explored the level, intensity, nature and impact of a variety of man's activities upon the environment. These discussions were largely concerned with the relatively short run problem of human health impacts. This, of course, must be the primary concern of environmental regulators. However, of equal importance in terms of the long run stability -- even viability -- of the planet is the question of whether current activities, decisions, and actions of man are having irreversible impacts upon the weather and climate that could fundamentally change the level and kind of life that could be supported. This issue, then, explores the possibility of such changes, their likely impact, and tries to identify actions that man could take to reverse these trends. Part of the question of modification of the biosphere includes not only climatic modifications but also modifications of the delicate balances of the ecosystem that may result in extinction of some species, overpopulation of others, and the like.

It is important to clearly differentiate between short run perturbations and long run change. For instance, research and experimentation in weather modification has identified certain ways of increasing the naturally occurring precipitation. This precipitation, then, can be modified by the inadvertant application of the same materials -- say, through industrial pollution. However, this kind of change is clearly different from change in the temperature of the planet itself which undoubtedly will have substantially more profound effects and will be substantially more difficult to perturb on a global scale.

The problem of biosphere change and climate modification is extremely difficult even to assess because of the difficulty in observing and monitoring trends. Climatic change involves consideration of time series data that are centuries long, most of which, obviously, must be inferred. Unlike ambient air quality standards, we cannot run out and monitor the state of the climate at any given point of time -- it is only through long run relative measurements that climatologists can discern the dynamics that are occurring. The issue is further complicated by the fact that the negative effect of a given set of actions may not be observed until the action has been carried on for some time or even until the action has ceased. Even then, the problem of ascribing cause and effect is never adequately surmounted.

A final cautionary note must be mentioned with respect to climate change. The climate is changing, it always has been changing, and it is the evolutionary nature of the planet that it always will be changing. Hence, what we are concerned with here is those climate modifications which are the direct result of particular actions of mankind and which alter or perturb the "natural" evolution of the planet. While this may be exceedingly difficult, it is important to at least conceptually differentiate between change which would have occurred without man and change which could not have occurred without man.

The discussion below, then, will center on some major issues with respect to the present and future condition of the biosphere: temperature changes of the planet, precipitation changes of the planet, urban/rural weather imbalances, and disruptions of the ecological system of balances.

<u>Dimensions of the Problem:</u> 526

That the earth's climate has been changing should not be surprising to any reader. Careful reading of the Farmer's Almanac combined with possibly apocryphal stories of past blizzards attest to the observed changes in local weather patterns. These observers are not incorrect; within the last several decades there have been substantial changes in the weather. Moreover, worldwide changes in weather and climate have accelerated in the last century; and there is some evidence that this acceleration is directly attributable to activities of man, in particular, the Industrial Revolution.

However great the anecdotal evidence, the situation calls for more rigorous analysis. Yet a fundamental problem remains, the infancy of the science of climates. Assuming that the problems of monitoring and measuring changes of the global climate could be overcome, there is no model of climatic change. It is not merely a problem of modelling, there is not an adequate theoretical base that describes the interrelationships of the many variables that are known to affect climate. A very generalized model of what is known about climatic change is pictured in Figure 1. The important thing about this model is the feedback, i.e. dynamic nature of the relationships. The *ceteris paribus* assumptions of economists have absolutely no role in this model. The range of interactions among these variables is immense and the likelihood that only a variable could be acting singularly is highly unlikely. Experts, however, do not think that the complexity of the issue will preclude them from developing an adequate theoretical understanding of climatic change, and from this theory a simulation can be developed.[1]

The present state-of-the-art in theoretical climate dynamics has identified five external variants which can substantially alter the climate.

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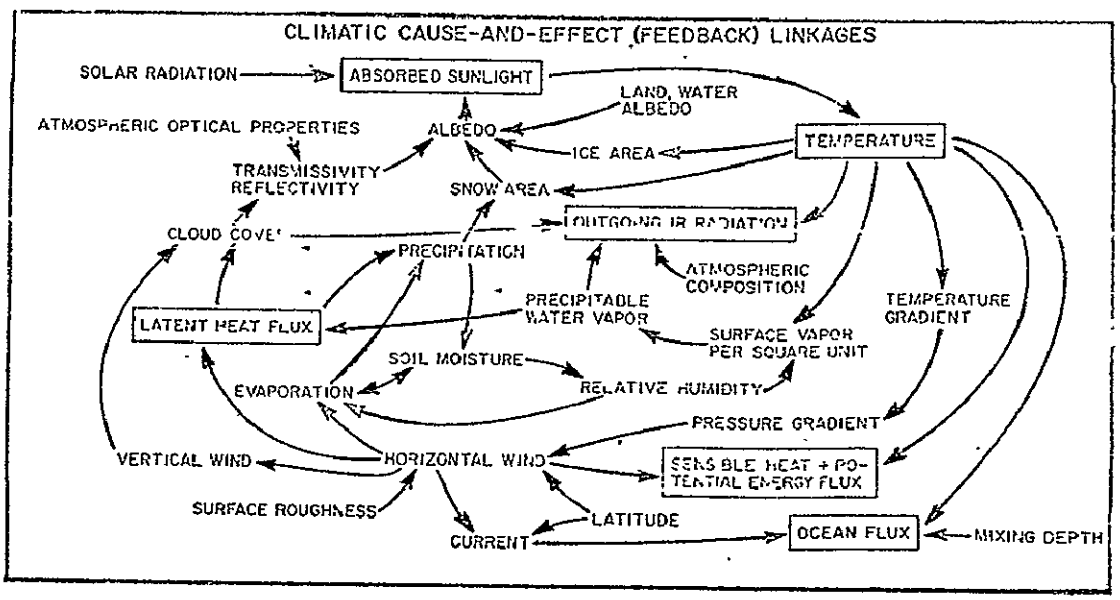
[1] W.W. Kellogg and S.H. Schneider, "Climate Stabilization: For Better or For Worse?" Science (December 27, 1974) p. 1163

These include:

1. Fluctuations in solar emissions
2. Variations in the earth's orbit and axis of rotation
3. Changes in the atmospheric carbon dioxide content
4. Changes in atmospheric dust content, and
5. Changes in the character of the land surfaces.[2]

As the first two are unlikely to be altered by man's actions -- at least in the short run -- we will concern ourself largely with the kinds of activities that have affected the CO_2 levels, dust content and land surface changes.

FIGURE 1



SOURCE: W.W. Kellogg and S.H. Schneider, "Climate Stabilization: For Better or For Worse?" Science (December 27, 1974) p. 1163

Let us briefly examine the state of the global climate over the past century or so and then explore the likely role that man's activities may have had in these changes. The first part of this century, through 1940, saw abnormally warm weather climate in all parts of the globe as shown in Figure 2. During this warming trend, the global human population

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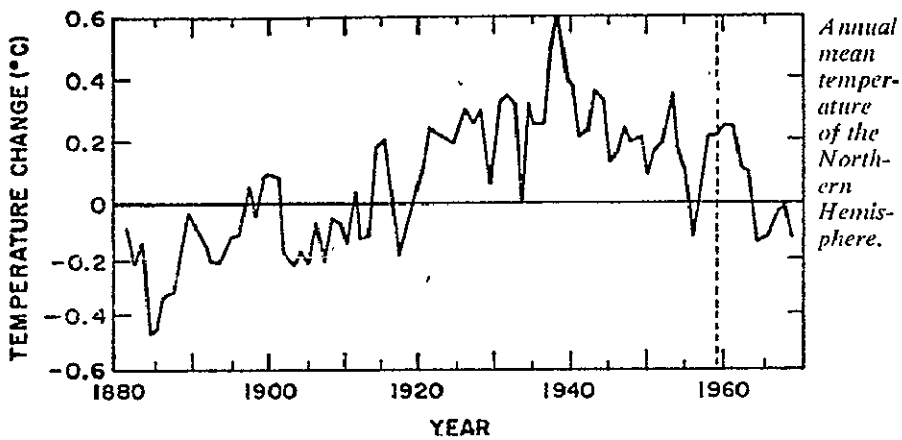
[2]Kellogg and Schneider, Op.cit., p.1165.

more than doubled. The warming conditions of this period were also extremely conducive to satisfactory agriculture as it lengthened the growing times and encouraged increasingly high crop yields. Beginning around 1940, a cooling trend suddenly began. After the temperature had risen about 1.1°C between 1885 and 1940, it has already dropped 0.6°C.[3] This may seem relatively insignificant until one realizes that a mere global change of 2 or 3 degrees would be sufficient to trigger another major ice age. Measured another way, the dimunition of the sunlight by as little as 1% could be sufficient to trigger a major glaciation.

FIGURE 2



Source: John H. Douglas, "Climate Change: Chilling Possibilities," Science News, Vol. 107 (March 1, 1975) p.138

It now appears that the period beginning in the early 15th century and lasting through the mid-18th century was among some of the worst weather in over 2000 years and has become known as the "Little Ice Age."[4] It is likely that the warming trend between 1885 and 1940 was the anomalous condition, not the colder period that has been occurring since then. Furthermore, the

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[3] John H. Douglas, "Climate Change: Chilling Possibilities," Science News, Vol. 107 (March 1, 1975) p. 138

[4] Tom Alexander, "Ominous Changes in the World's Weather," Fortune, (Feb., 1974)

precipitous drop in global temperatures since 1945, relative to the historical mean, represents the longest period of sustained temperature decrease that has been noted in several countries.[5] Recent conclusions derived from drilling of the ocean floor suggest that for at least the past 700,000 years, global mean temperatures have not been as high as they were in 1885-1940 period except for about 5% of the time.[6]

What has caused the temperature changes in the planet? Generally the cooling of the earth's surface is accomplished by the planet's albedo, the planet's capacity to reflect solar radiation. About 35% of the incident radiation is reflected back into space. This reflection is largely accomplished by the clouds, dust particles in the atmosphere, or from reflection from the surface of the earth. Any change in the albedo, obviously, could have significant temperature impact.

It appears that change in the earth's albedo powers is exactly what has happened, causing both the previous warming trend as well as the current cooling trend. Historically, these kinds of changes have been associated with the level of volcanic activity on the earth. Volcanism introduces substantial levels of dust and particulates in the air which in turn reflect solar radiation back into space. During the warming period of the early century there was a cessation of volcanic activity; and since 1955 (during the cooling period), there has been a period of extremely active volcanoes. A recent study of long term trends concluded that greatly increased volcanism during the last 2 million years coincides with major and rapidly oscillating climatic conditions related to glacial-interglacial cycles in the Southern Hemisphere.[7]

[5] Alexander, op.cit., p.90.

[6] Douglas, op.cit.

[7] James P. Kennett and R. C. Thunell, "Global Increase in Quaternary Explosive Volcanism," Science, Vol.187, No. 4176 (February 14, 1975) p.50.

However, climatologist Dr. Reid Bryson of the University of Wisconsin, has concluded that the level of volcanic activity or inactivity has not been sufficient to explain the temperature changes of the past century and that the primary responsibility rests with man.[8] The two man-induced forces at work include the increase in atmospheric CO_2, contributing to the greenhouse effect (a warming trend), and the vast increase in particulate pollution, increasing the albedo of the earth (a cooling trend).

The "greenhouse effect" refers to the role that CO_2 plays in trapping heat on the earth. It is so named because the CO_2 behaves in a fashion analogous to the glass of a greenhouse. Carbon dioxide is quite transparent to light of short wave lengths, the bulk of the solar radiation received from the sun. After penetrating the earth's atmosphere, the light is converted to heat and reradiated at the longer, infrared wave length. As CO_2 is not transparent to this wave length, the heat is "trapped" on the earth by the atmospheric CO_2.

There is no question that the level of CO_2 has increased substantially over the past 100 years, largely due to the Industrial Revolution and the burning of fossil fuels. Atmospheric CO_2 has been increasing steadily as measured for three decades at Mauna Loa, Hawaii. The increased levels of CO_2 are largely related to the increasing reliance upon coal as an energy source. According to the National Academy of Sciences, atmospheric CO_2 has been rising by 4% a year since 1910 because of industrialization.[9]

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[8] Alexander, op.cit. [Note: in the interests of objectivity, it is important to point out that Dr. Bryson is the leading spokesman of the "doomsday" school of thought regarding climatic change.]

[9] Kellogg and Schneider, op.cit.

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Because CO_2 is quite stable it persists in the atmosphere for sometime. In fact, it has been estimated that the atmospheric level of CO_2 has increased from the pre-Industrial Revolution level of under 290 parts per million by volume to 320 parts per million. By the year 2000 the CO_2 level could reach 380-400 parts per million, which would *increase* the global temperature by 0.5° by the year 2000,[10] assuming a continuing reliance upon coal rather than oil or natural gas.

During this warming trend, the impact was quite visible. For instance, the growing season in England increased by two-three weeks.[11] Some argue that the advances in agricultural technology (especially in yields per acre) were not due to technology or plant strains, but to favorable weather, all of which has ended.[12]

If rising CO_2 concentrations mean warming of the planet and phenomenal agricultural successes, then why are crops failing worldwide and the planet cooling? Since 1940-45 the mean annual temperature of the Northern Hemisphere has been declining. In this period of time the average temperature has declined about 0.6°C -- the average temperature showing a consistent decline. Meteorologists have isolated atmospheric dust as the cause of this cooling. The atmospheric dust content, by increasing the reflective capacity of the atmosphere, decreases the intensity of the sunlight that reaches the earth's surface. Without the impact of the "greenhouse effect," this cooling would have begun earlier and many of the agricultural and natural disaster problems facing the world this decade would have occurred a decade earlier. As

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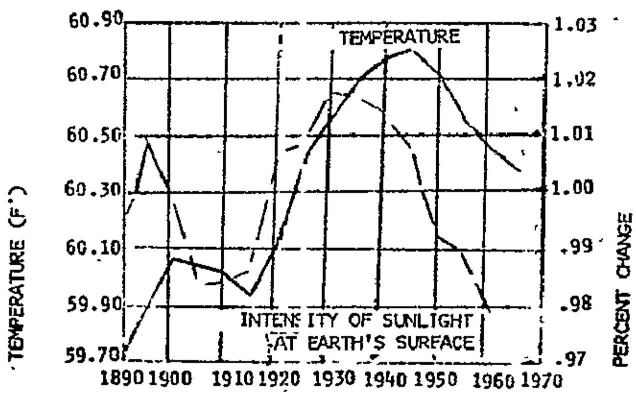
[10] Douglas, op.cit.

[11] "NAS Warning on Climate Changes," Science News (January 25, 1975) p.52-53.

[12] James McQuigg, a government climatologust at the University of Missouri, in Alexander, op.cit.

Figure 3 shows, the intensity of sunlight reaching the earth's surface first began to decline in 1930, but CO_2 levels were sufficient to prevent substantial cooling until the early 40's. Here is a paradoxical situation where one pollutant (CO_2) softened the impact of the second (atmospheric dust).

Figure 3



SOURCE: Alexander, Tom, "Ominous Changes in the World's Weather," Fortune, (February, 1974) pp. 94.

Atmospheric dust has shown tremendous increases in the past several decades. Dust is generated by natural phenomena (volcanism, wind erosion, forest fires, salt particles from evaporated sea water, etc.) and man-induced activities. While the present day particulate loading is estimated to exceed the average stratospheric loading by volcanic dust during the past 120 years, it is thought to equal only by perhaps one-fifth the stratospheric loading that followed the 1883 eruption of the volcano Krakatoa.[13] Despite this, the human contribution is the only one over which we have any control and the only one that we can project with some certainty.

Man-induced atmospheric dust -- called particulate emissions or "Total Suspended Particulates" by the environmentalists -- is generated largely through industrial processes, fuel combustion, wind erosion of abused land, and "slash and burn" techniques of primitive agriculture. In this country, the primary contributors are industrial processes and steam electric fuel combustion. The Environmental Protection Agency estimates that nationwide emissions of particulates have increased approximately 15% over the past three decades, although they indicate that some of this increase could be attributable to refinements in monitoring capabilities.[14] Particulate pollution is more severe with combustion of coal than with oil or gas -- witness the plague of coal miners: black lung or "Coal Worker's Pneumoconiosis." We can expect that in the short run -- the next several decades -- it is likely that petroleum shortages will encourage a further reliance upon coal, at least in this country, further contributing to particulate loading of the atmosphere.

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[13] National Academy of Sciences, Understanding Climatic Changes: A Program for Action (Washington, D.C.: National Academy of Sciences, 1975) p.44.

[14] Environmental Quality 1974, op.cit.

Misuse and abuse of the land contributes to substantial atmospheric dust. Any activity which removes the vegetation cover and exposes the surface soils contributes to the atmospheric dust problem. Strip mining is an immediate example; currently 3.1 million acres of land in this country have been stripped, of which 1.3 million can be attributed to coal mining. By the year 2000 another 209,000 acres in the coal rich Western states could be abused.[15] Abuses of the land have increased the proportion of land termed."wasteland or desert." In 1882 land so designated amounted to 9.4% of the total land on earth; by 1952 it had risen to 23.3% (recognizing that these numbers could reflect better monitoring as well as changing definitions).[16] The Sahara Desert, moving southward at the rate of several miles per year, is partially man created: the results of mismanaged deforestation as well as inadequate naturally occurring climatic changes. Finally, erosion of the topsoil contributes to atmospheric dust. In India, fully one-third of the farmland is faced with topsoil loss due to erosion.[17] Likewise, erosion is the most widespread land management problem in this country, threatening 51% of the non-Federal rural land.[18] Worldwide, the greatest contributor to atmospheric dust may well be agriculture. Windblown dust from mechanized agriculture, overgrazed arid land and smoke from "slash and burn" primitive agricultural techniques generate substantial amounts of atmospheric contaminants.

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[15] National Academy of Sciences and the National Academy of Engineering, Rehabilitation Potential of Western Coal Lands: A Report to the Energy Project of the Ford Foundation (Ballinger: 1974).

[16] Paul R. Ehrlich and Anne H. Ehrlich, Population/Resources/Environment (W.H. Freeman and Co.: 1972) p.202.

[17] Ibid.

[18] United States Water Resources Council, The Nation's Water Resources Washington, D.C.: 1968) p.5-5-1,2.

In sum, it appears likely that worldwide atmospheric dust will continue to increase, perhaps at increasing rates. The global spread of industrialization, the worldwide search for resources, the need to expand agricultural productivity and the reliance upon fossil fuels is likely to ensure a continuance of the atmospheric dust problem. Assuming continuation of these trends, the planet is also likely to continue its cooling process, at least through the end of the century.

What has been the effect of these weather changes and what is the prognosis? First, much of the disruption of world agriculture can be attributed to these weather changes. Temperature changes fundamentally affect location, frequency and intensity of precipitation. The general consensus of the experts is that a cooling trend increases the variability of the weather causing alternating periods of high and low temperatures, droughts contrasted with floods.[19]

This increased variability can be readily seen in the global weather disturbances of the last several years. The progression of the Sahara desert has been discussed previously. In addition, the Sahel section of Africa south of the Sahara has experienced a consistent drought for five years, resulting from the shift of its normal rains to over the Atlantic.[20] This drought is one of the fundamental causes of the current sub-Saharan food problem.

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[19] Douglas, op.cit.

[20] Stuart Auerbach, "The Future: New Ice Age or More of the Same," Washington Post, (Washington, D.C.: February 16, 1975).

The wind currents that bring warm and cool weather, heavy precipitation or none at all are largely determined by temperature changes on the planet. It is possible that these wind current changes and the concomitant changes in water temperatures resulted in the failure of the Peruvian anchovy harvest in 1972-73. Similarly, the farmland of the United States was plagued by heavier than usual rains in the planting season and hot dry weather during the prime growing season, reducing the feed grain harvest by 17% in 1974.[21]

It is conceivable that future schemes to increase energy self-sufficiency and decrease reliance upon fossil fuels may even have an impact of greater magnitude upon the climate than that which has come before. Perhaps one century from now, the per capita energy consumption of a world population of 20 billion will be quadrupled the present U.S. consumption rates; and the major sources would be thermonuclear, nuclear, solar and coal. This population would require 8×10^5 gigawatts, about 1% of the total solar power absorbed at the surface. This power, of course, would be concentrated on the continents, about one-fourth of the earth's area. Existing climate models indicate that a 1% increase in thermal power would raise the average global temperature by $1^{\circ}C$, and some regional temperature changes could raise this temperature by a factor of 1.3 to 3.0 (the effects differing as a result of latitude). Hence, the future physical impact of mankind could be extensive; and those technological interventions which have been heralded as the panaceas for the future may in fact greatly exacerbate global problems.[22]

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21 "Weather Creates a Peck of Troubles," Business Week (August 17, 1974) p.24.

22 Kellogg and Schneider, op.cit.

The list of current climate related calamities is already endless; for example, the cooling trend of the past three decades has reduced the growing season of England by up to three weeks[23] and the Russian wheat failure of 1972 was caused by a winter freeze followed by a summer heat wave and drought.[24]

What about the future? The National Oceanic and Atmospheric Administration has concluded that variability will be the keynote of the future. They also estimated that in any given three year period the probability of a drought seriously disrupting the American Midwest Wheat crop is 29%.[25] Any increased variability will have a negative impact on food yield. As the United States food surplus is used to equilibrate the world food supply, any disruption in the U.S. food supply could have grave implications for global food security.

Despite the accumulating body of evidence -- or perhaps because of this growing body of data -- the role of man in the climatic changes and even the direction of that climatic change is hotly debated by the experts. The prognoses for the future fall into one of three categories:

- a new ice age is coming, in part due to man's interference with the atmosphere;
- the world's natural climate cycle is shifting and a period of adverse weather is beginning;

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[23] "NAS Warning on Climate Changes," Science News, Vol. 107 (January 23, 1975), p.52.

[24] Auerbach, op.cit.

[25] Douglas, op.cit.

- the observed climatic change is a normal shift in the weather pattern leading to an Ice Age at least 15,000 years from now and the atmosphere is sufficient to compensate for man's activities.

Regardless of the direction of these three schools of thought, they do agree on one aspect: weather patterns are changing and a continued period of adverse weather is likely.

The role that man plays in this global change is also highly debated. While there is no question that atmospheric dust causes cooling, normal precipitation goes far to cleanse the earth of this atmospheric dust. Whether the increased concentrations of atmospheric dust is the result of increased volcanic activity, industrialization, changes in patterns of precipitation or a combination of these, it is not known. It has been estimated that man's activities have only produced one-fifth of the atmospheric dust that the 1883 eruption of Krakatoa did. The relationship of climatic change to the food situation cannot be overestimated. Recently, archaeologists have been relating the fall of some past power civilizations to climatic changes. Repeated droughts and agricultural failure are thought to have contributed to the demise of the Indus, Hittite, Mycenaean and Mali empires.[26] The great civilizations of Rome, Egypt and China were developed during relatively warm, agriculturally supportive periods, while drought and famine drove the Greeks to the Hellenic Peninsula.[27]

Another massive debate is raging concerning activities of mankind that are alledgedly destroying the ozone layer, that layer of "superoxygen" which protects the planet from ultraviolet radiation. The two sources of ozone destruction that are at the center of the controversy are: SST's and chlorinated hydrocarbons used in the propellants of aerosol dispensed

[26] Auerbach, Op. Cit.

[27] Alexander, Op. Cit.

materials.

The basic concern is that nitrogen oxides emitted into the stratosphere by a fleet of SSTs -- as well as from nuclear explosions -- and chlorinated hydrocarbon will combine with ozone and convert it to normal but unprotective oxygen. The question then becomes (1) how important is ozone in solar radiation protection; and (2) just how much would be destroyed from these various activities. The lack of consensus over answers to both of these questions is at the heart of the controversy.

Sunburn from uv exposure is well documented, and the relationship between sunburn and potential skin cancer is fairly well known; hence, it becomes possible to give an estimate of the skin cancer relationship to ozone depletion.[28] Other studies at the University of Kentucky demonstrated that solar ultraviolet light killed large aquatic micro-organisms in a matter of minutes.[29] Another study team isolated some instances of changed rates of mutation in some plant species exposed to excessive ultraviolet light.[30] The evidence seems to suggest that while the ozone layer is important and necessary as a protective shield, the amount of ozone that can be safely destroyed without harmful consequences is not known.

The experts' assessment of the potential impact of the use of the SST seems to indicate that the ozone threat was somewhat overstated. After review of more than 1000 investigations from 16 separate agencies, the Department of Transportation's Climatic Impact Assessment Program recently concluded that SST operations involving between 1 and 30 planes flying a maximum of one hour per day would reduce the amount of ozone in the stratosphere by

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[28] Pythagoras Cutchis, "Stratospheric Ozone Depletion and Solar Ultraviolet Radiation on Earth," Science, Vol. 184, No. 4132 (April 8, 1974) p. 13

[29] "Clime Study: SST O.K. with Controls," Technology Review (July,August 1974) p. 56

[30] Ibid.

no more than 0.01% annually and that over ten years the ozone depletion would amount to about 0.5%. Subsonic fleets, it was estimated, now deplete the stratospheric ozone at an annual rate of about 0.1%[31] Supersonic fleets have been perceived as being more dangerous because they fly at greater heights with higher concentrations of ozone depletion. Other studies have come up with higher levels of ozone depletion but have based their calculations on the fuel inefficient American model and have estimated huge fleets, 500-1000, flying 8 hours per day.[32,33] These assumptions are not consistent with current political realities.

Based on the data available at this point in time, it is likely that supersonics, as well as subsonics, do result in some appreciable depletion of the stratospheric ozone layer. However, evidence to indicate that this rate of depletion is hazardous does not exist. Despite this, caution dictates that supersonic transport be undertaken with adequate controls.

Researchers working on the SST controversy may be reaching a consensus, but the furor over flurocarbon aerosol propellants is just getting underway. A recent mass media magazine said aerosol cans " . . . have a disastrous delayed effect capable of destroying all life on this planet by the year 2000."[34] While this doomsday approach seems to be a bit of an overstatement of the problem, it does indicate the level of emotion and public uproar that is accompanying the issue. The issue is recognized as sufficiently threatening to warrant an investigation by the National Academy of Sciences.[35]

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[31] "SST and Ozone: Less Danger Than Thought?" Industrial Research (March 1975) p. 34

[32] H.S. Johnston, Report LBL-2217 (Berkeley, California: Lawrence Berkeley Laboratory) 1973

[33] Performed by the MIT Department of Meteorology and reported in "SST: Doubts Confirmed," Technology Review (October/November 1974) p. 74

[34] Michael Drosnia, "Not With a Bang But with a Psssst!" New Times (March 7, 1975) p. 27

[35] "NAS Launches Study on Flurocarbons," Science News (November 30,1974)p.314

The concern about chlorinated hydrocarbons (chlorine-containing fluorocarbons) is that they are disassociated by uv energy and release reactive chlorine atoms which in turn react with ozone (0_3) to create oxygen (0_2). It is this chemical reaction that has been the basis for the modeling and simulation efforts to date. The most pessimistic conclusions have come from F.S. Rowland at Irvine and M.B. McElroy at Harvard. Rowland's observations lead him to conclude that the amount of fluorocarbons in the lower atmosphere is about equal to that manufactured, meaning that these chemicals do not dissipate through normal degradation processes or through rainfall.[36]

The Harvard computer analysis is hardly more reassuring. Their results are shown in Figure 4 and show that if growth continues at the 1960-72 rate of 22% and production is not halted for 10 years, then 10% of the earth's ozone layer could be destroyed. This could translate into several thousand cases of skin cancer per year. Similarly, decreases of 16% ozone could result in 500,000 to 1.5 million additional cases of skin cancer and 20,000 to 60,000 deaths annually.[37]

Despite the hysteria surrounding the issue, it appears that the causal agent may not be properly identified. It is not freons per se that are dangerous but rather the atomic chlorine produced when they are irradiated by uv light. The emphasis upon freons (the chlorinated hydrocarbon propellant of aerosol cans) seems misplaced as they are a relatively unimportant source of atmospheric chlorine. In addition, there is an effective mechanism for removing chlorine from the atmosphere. A much larger proportion of chlorinated hydrocarbons are produced in ordinary solvents, paint thinners, dry cleaning

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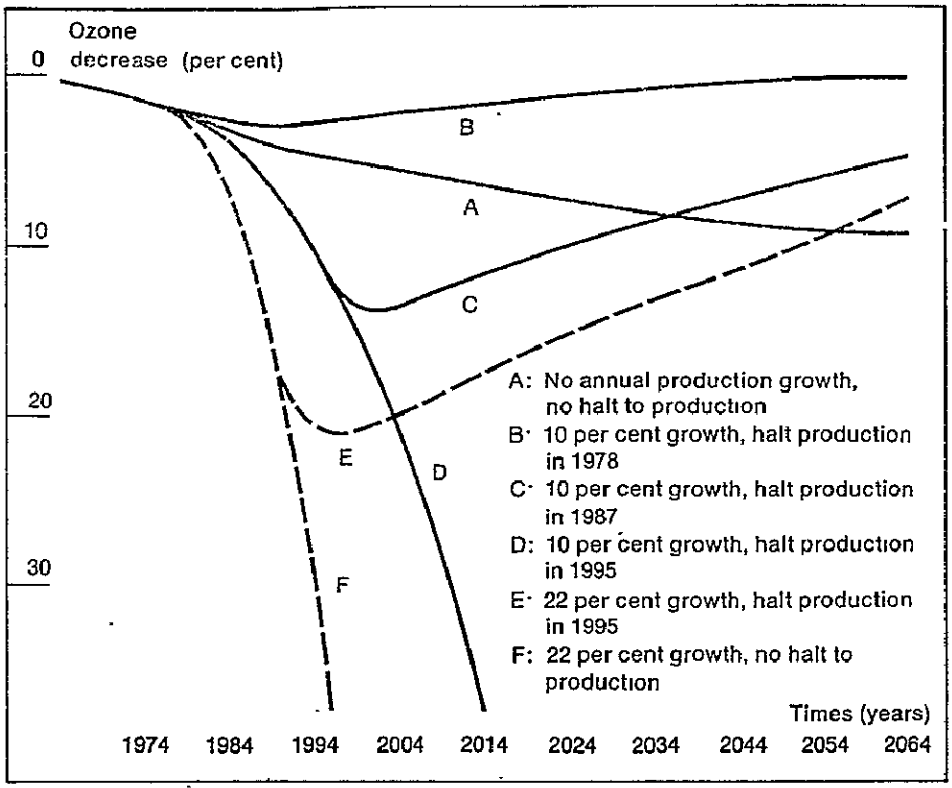
[36] "From Upper Arms to Upper Atmosphere," Technology Review (December 1974) p. 61

[37] "Environmentalists Seek Fluorocarbon Ban," Chemistry and Engineering News (December 2, 1974) p. 14

fluids (carbon tetrachloride, for instance) and the like. Combustion of fossil fuels similarly produces nitrogen oxides. The fact that the ozone layer has not been seriously depleted by all of these other potentially "threatening" materials gives some insight into just how resilient the ozone is.

FIGURE 4

PROJECTED DEPLETION OF OZONE LAYER



SOURCE: "From Upper Arms to Upper Atmosphere," Technology Review (December 1974) p. 61

It is possible, of course, that we are approaching a limit in the capacity of chlorine removing mechanisms and that only a small incremental loading of freons could cause disaster. However, until more is known about the chemistry of the atmosphere, it is impossible to estimate the reality of this possibility. Regardless of the particular school of thought that one adheres to on this issue, it is clear that the major stumbling block to resolution is scientific understanding of the atmospheric dynamics.

While we have discussed at some length the potential long term effects of man's activities, there is an immediate example of the impact of man's activities. The weather in a downtown area is usually different from the surrounding areas. Temperatures in cities are commonly 2^{o}-3^{o}C and even as much as 10^{o}C higher than those in neighboring rural areas. This urban "heat island" is due to the large areas of concrete and asphalt which absorb and store heat better than vegetation and soil. Simultaneously, large amounts of heat are injected into the air of cities from combustion processes and air conditioners.[38]

At the same time, because of these surface temperature differences and the "roughness" of the topography, there is a difference in the winds of a city. The downtown urban area usually has 40% less wind overall, and up to 10% less "light wind." These decreases in the level of wind activity may have substantial impact upon the concentration of pollutants in a region and the ability of the region to "cleanse" itself -- witness the difficulties of the Los Angeles basin.

<u>Some Potential Actions</u>:

The recognition of these problems is only of recent vintage. The question of what could be done about them is even less well understood. The strategies reduce themselves to three categories of actions:

(1) Research into understanding global climatic interactions

(2) Actions (government incentive/regulation, technological) to prevent negative consequences identified as contributing to climatic change of their occurrence

(3) Actions to ameliorate negative climatic modification, and

(4) Actions to modify or influence the weather and climate.

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[38] P.V. Hobbs, H. Harrison, E. Robinson, "Atmospheric Effects of Pollutants," Science, Vol. 183, No. 4128 (March 8, 1974) p. 909+

(1) Research Needs: Clearly the need for research is fundamental and further insights must be forthcoming before any programs of climate modification should be undertaken. Research should be geared to understanding the long run climatic cycles and the consequences of man's perturbations of these cycles. Hopefully this research would produce some simulations of the global climate so that it would be possible to gain insight not only into the consequences of current activities but also any consequences of explicit actions to modify the climate.

The National Academy of Sciences has noted the inadequacy of current knowledge about climates. What we *cannot* identify at the present time is how the climatic system operates, which are its most critical, sensitive parts, which processes are responsible for its changes, and what are the most likely future climates. In short, while we know something about climate itself, we know very little about climatic change.[39]

(2) Preventative Actions: Even without an adequate understanding of the consequences of man's intervention in the globe, the information that does exist concerning the impact of various environmental contaminants is sufficient to warrant control over their ejection into the atmosphere. It is unlikely that much public support will be gained for pollution control and abatement on the grounds that particulate emissions may contribute to global cooling of 0.5°C over the next three decades. However, a great deal of support can be mustered on the grounds that particulate emissions are a substantial health hazard , cause respiratory disease and may even be carcinogens.

The current efforts underway to rehabilitate and protect the environment on the basis of public health concerns and public welfare costs will

[39] Understanding Climatic Change, Op. Cit., p. 65

also, of course, help to protect the global ecosystem balance. Hence, if the air, water, solid waste, radioactive, noise, etc., regulations are met, they will protect the globe from further degradation.

However, this discussion refers to the United States only. Obviously, the U.S. is only part of the problem and as mentioned previously the global spread of industrialization and the global search for resources will contribute substantially to worldwide biosphere degradation. As the dynamics of climate are better understood, it is likely that international conflict could stem from disputes over environmental degradation and weather pattern interruption. Hence, any preventative action, to be effective, must be global in nature. Gradually, the need for global cooperation is becoming apparent, witness the Stockholm Conference and the Law of the Seas Conference, yet greater international cooperation is essential.

(3) Corrective Mechanisms: Another set of actions have to do with correcting or ameliorating the effects of man's industrialization in advance of substantive climatic change. Such actions would include ways of dissipating the concentration of atmospheric dust, protecting the ozone layer, and even increasing the level of CO_2 in the atmosphere to encourage the greenhouse effect thus counteracting the cooling trend. This does not seem to be a productive area of inquiry at this point in time because of the level of the state-of-the-art and the outlook for it.

(4) Climate Modification: The most radical kinds of actions are those associated with actually modifying the climate and weather. A number of schemes have been attempted already, such as hail suppression technologies, seeding of clouds and Snowpak enhancement. Experiences from cloud seeding experiments to date have yielded both positive and negative results. A

study by the National Academy of Sciences concluded that a review of the work done to date showed that artificial modification of precipitation exercises can sometimes lead to more precipitation, can sometimes lead to less, and can sometimes have no effect whatsoever. Dissipation of cold fogs over limited areas appears operationally practiciable, while there is no reliable procedure for dissipating warm fogs over airports. Little is known about the ability to modify severe storms, as data and opinions are contradictory.[40]

Research into such weather modification efforts is proceeding, recognizing the infancy of the art. Simultaneously, research is underway into another class of activities: massive climatic change (rather than regional weather modification.) Figure 5 shows many of the schemes currently contemplated. An often repeated suggestion is to eliminate the Arctic Ocean ice pack. The introduction of open ocean in this region would result in a much more moderate weather around the Arctic Basin with temperatures 10-15°C warmer. However, the possibility of more snowy winters might be sufficient to start another glaciation of northern Canada and Europe.[41] It would be relatively simple to do; spreading black particles such as soot would produce sufficient decreases in reflectivity in the area to cause a large area of the ice to disappear in a period of about three years.

Needless to say, the dangers both in a scientific sense as well as in terms of international conflict of widescale weather and climate modification are substantial. Even a seemingly humane activity as diverting a

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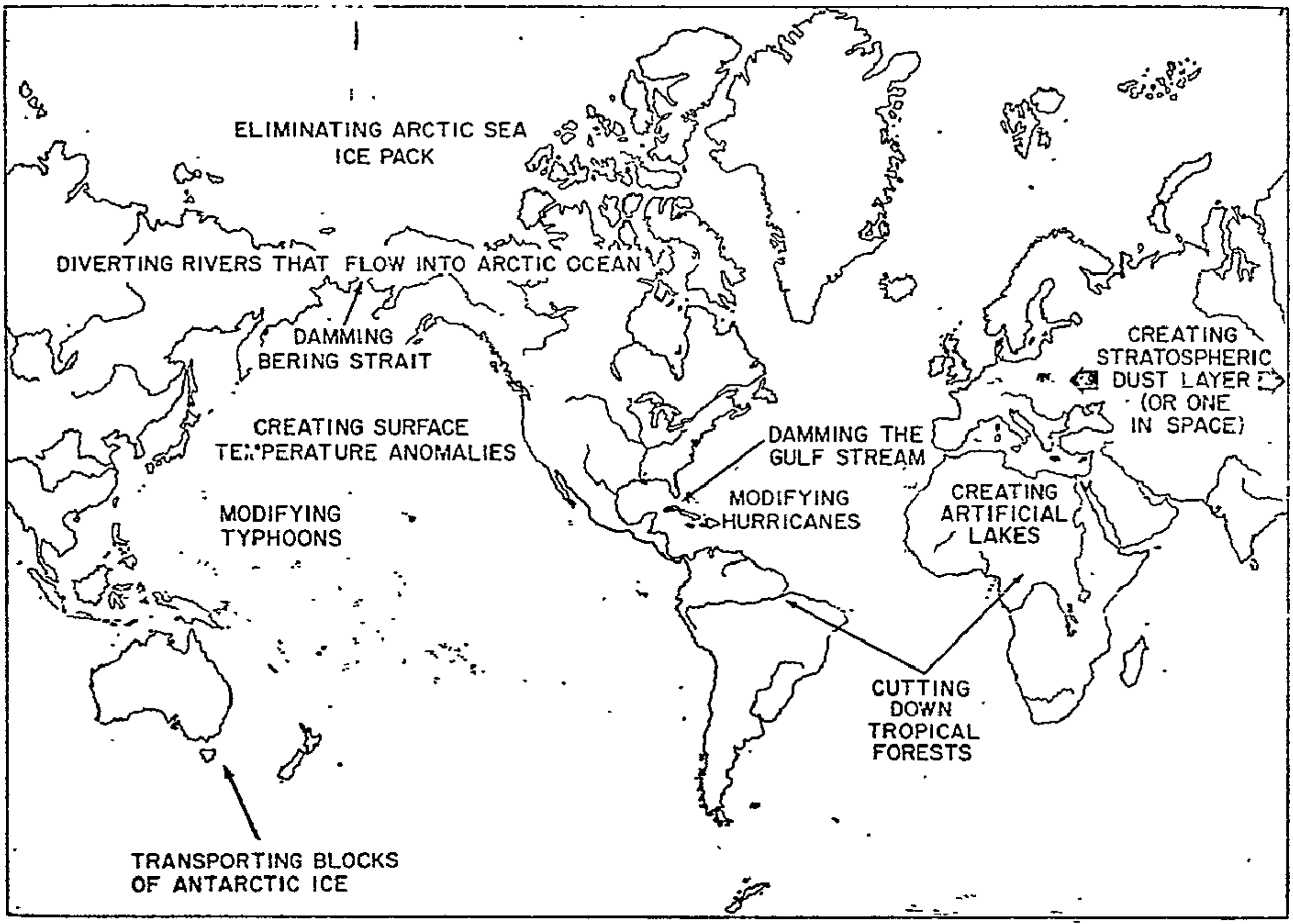
[40] National Academy of Sciences, Weather and Climate Modification: Problems and Progress (National Academy of Sciences: 1973) p. 4-12

[41] Kellogg and Schneider, Op. Cit.

hurricane from its path may have negative consequences because of the possibility of diverting needed rainfall from a potential drought ridden area.

Figure 5
SOME CLIMATE MODIFICATION SCHEMES



SOURCE: W.W. Kellogg and S.H. Schneider, op.cit.

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Kellogg and Schneider have concluded ". . . that it would be dangerous to pursue any large-scale operational climate control schemes until we can predict their long term effects on the weather patterns and the climate with some acceptable assurance. We cannot do so now, and it will be some time - if ever- before we can. To tamper with the system that determines the livelihood and life styles of people the world over, would be the height of irresponsibility if we could not adequately foresee the outcome."[42]

[42] Kellogg and Schneider, Op. Cit., p. 1170

WORLD CONCERN: ECONOMICS

No barrier strains the world's ability to meet the emerging crises and problems more than the potential collapse of the world and domestic economic system as we know it. Underlying any strategy for environmental protection, energy self sufficiency, resource assurance, world food adequacy is the requirement of a stable economic system generating income, employment and severely needed capital. There is no assurance whatsoever that these requriements will be met.

Inflation is a world-wide phenomena, many countries experiencing inflation rates of over 20%. Unfortunately, inflation will be a continuing factor in world economics, if for no reason other than the classical laws of supply and demand in the marketplace. This inflation will lead to the erosion of purchasing power of government as well as the individual, to reduced demand, and probably most important, to the constraint of capital investment.

The need for capital investment in many segments of the economy over the next decades is enormous, if the nations are to build the plant and facilities necessary to sustain even modest economic growth or, in the cases of the underdeveloped nations, to meet the rising expectations of their citizens for something like economic parity with the developed nations. The capital needed to meet the U.S. expanding energy needs over the next 10 years is estimated as almost $600 billion more than will be available.

In the aggregate, world-wide capital needs for the next decades could be staggering. The question is not can we sustain the economic growth levels of the past twenty-five years, but can economic growth continue at any level during the *next* twenty-five?

There are other economic issues with long term, future implications for the American society. The continuing income gap between whites and blacks based on discrimination in earnings, promotes social unrest and conflict, simply adding to the tensions within the society.

ECONOMICS: THE ISSUES

Continuing Inflation Leading to Erosion of Purchasing Power, Unemployment and Constraint of Capital Availability

National and International Capital Shortages Slowing, Perhaps Preventing, American Economic Growth and Leading to a Decline in the Domestic Standard of Living

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N76-18979

CONTINUING INFLATION LEADING TO EROSION OF PURCHASING POWER, UNEMPLOYMENT AND CONSTRAINT OF CAPITAL AVAILABILITY

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CONTINUING INFLATION LEADING TO EROSION OF PURCHASING POWER, UNEMPLOYMENT AND CONSTRAINT OF CAPITAL AVAILABILITY

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ISSUE: CONTINUING INFLATION LEADING TO EROSION OF PURCHASING POWER, UNEMPLOYMENT AND CONSTRAINT OF CAPITAL AVAILABILITY

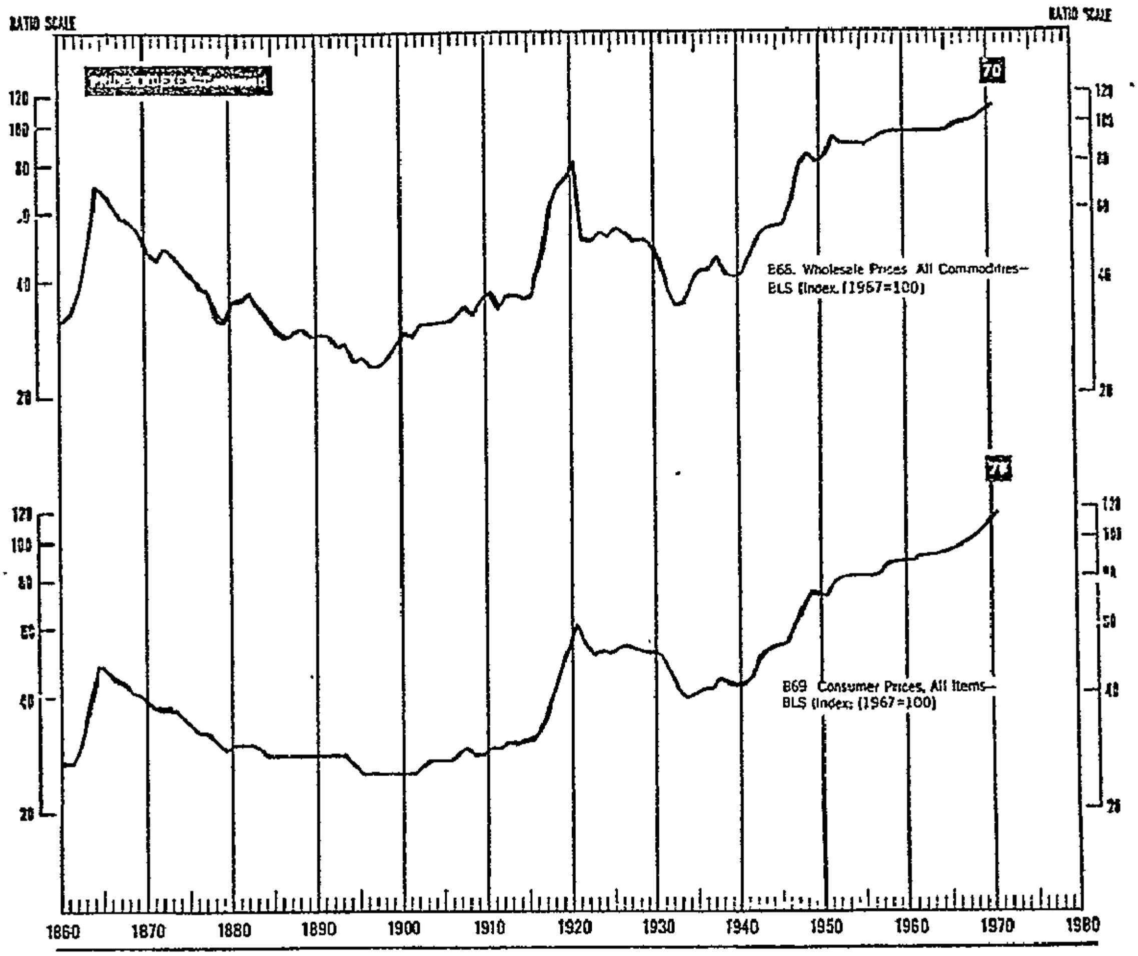
The Issue:

For the first time in American history consumer prices as well as wholesale prices have experienced sustained periods of rapid increase during peace time. In 1974, consumer prices increased 12.2%, the biggest annual increase since 1946 when prices increased 18.2% following the abolition of World War II price controls. There have been five major inflationary periods in the history of the United States: the Revolutionary War inflation, the War of 1812 inflation, the Civil War inflation, the World War II inflation, and the continuing Vietnam War inflation (See Figure 1). The first four of these inflationary periods were generally caused by the same short-lived original phenomenon; that is, government deficit spending to finance the war effort. Often the wars were financed merely by printing of currency. Contrary to the current experience, the previous four inflationary periods were brought to a close by an immediate return to a balanced budget, a substantial decrease in total government spending and explicit anti-inflationary actions. The post Vietnam inflation, contrary to the others, has persisted. Quite clearly, something new is happening.

An examination of historical trends again shows how atypical the current situation is. Figure 1 presents the wholesale and consumer price index for the past 100 years or so. It is only recently, beginning around the end of the 40's, that both the Wholesale Price Index and the Consumer Price Index have maintained a rather consistent upward trend.

FIGURE 1

HISTORICAL GROWTH OF INFLATION



SOURCE: DEPT OF COMMERCE, <u>LONG TERM ECONOMIC GROWTH 1860-1970</u>, (WASHINGTON, D.C.: GPO, 1973), P. 52.

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Why is this period so different? Inflation is remaining impervious to the traditional remedies (although one school of thought argues that the current dilemma exists because the traditional remedies have, in fact, not been implemented). High inflation has continued unabated for so long that significant unemployment is occurring because of the impact of the drastic reduction in disposable and discretionary income on demand.

The impact of this inflation has been devastating and has caused an erosion of personal income, unemployment, reduction in gross national product, cessation of economic growth, balance of payments deficits, and a host of other related problems. This section will speculate about the causes of this inflation, its implication, and possible policy responses to the problem.

Dimensions of the Problem:

The persistence of the current period of inflation and its apparent resistence to traditional fiscal and monetary policy have lead to profound economic controversy in the academic and political circles of the country. Current (i.e.. Keynesian/Friedman) economic thought argues that inflation is caused by too much money chasing too few goods -- this encourages escalating prices until such time as high prices result in a reduction in demand, and prices fall, or there is less money in the system doing the chasing. The corrective tools are somewhat different, depending on whether one relies upon fiscal policy (Keynesian) or monetary policy (Freidman). The appropriate fiscal policy would be to reduce aggregate demand by reducing government spending and increasing personal and corporate income taxes. Appropriate monetary policy would be to reduce the money supply by changing the discount rate and reserve requirements reducing the supply of money and increasing its cost. Friedman has advocated a fixed rate of money

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supply growth (4%), his estimate of the real growth that the economy can sustain (monetarists argue that if the money supply grows faster than the economy, that is, GNP, then inflation results). Keynesian policies were largely designed to respond to insufficient or excess demand. The supply side was largely ignored. This, of course, is a natural outgrowth of the Depression origins of the Keynesian economic doctrine. Hence, the bulk of the available theoretical and policy tools exist to correct excess or insufficient demand. It is becoming clear that these tools alone are inadequate, and perhaps, even inappropriate, for the current situation.

It is also becoming clear that the traditional view of inflation -- that is, *demand-pull* inflation, is, in fact, only a partial explanation of inflation. The second causal mechanism, *cost-push* inflation, is substantially different in origin and requires different policy remedies. The notion of cost-push inflation explains how prices can continue to rise after the economy begins to slow to reduce aggregate demand. Cost-push inflation usually occurs in response to previous periods of demand-pull inflation; beginning often with the demands by labor unions for substantial cost-of-living adjustments to compensate for the demand-pull inflation which has already occurred. Hence, the economy can begin to wind down (that is, a decline in demand), but because of cost-push accelerators, prices actually continue to rise.

Looking at the inflationary period from 1966-1974, one can determine that these different kinds of inflationary pressures were all operating during this time. A recent investigation by Business Week indicates the dimensions of the problem, (see Figure 3). From 1966-1969, the country experienced traditional demand-pull inflation caused by huge government deficit spending to finance the Southeast Asian war. At the beginning of this period the economy was already experiencing an industrial boom and was at full capacity; hence, there was no short term way to increase supply to respond to the demands that wartime deficit spending generated in the economy. Demand-pull inflation resulted. This was followed by a two year (1969-1971) period of cost-push inflation during which labor unions began demanding and receiving substantial cost-of-living allowances to protect their members against further erosion of their real income. The period 1971-1972 again saw demand-pull inflation, again caused by deficit spending. As 1972 wage controls were imposed, cost-push inflation began to come under control. However, in 1973, as controls were lifted, an immediate burst of cost-push inflation began again. This was then followed by a substantial increase in food prices, fueled by demand-pull inflation. In 1974 the skyrocketing cost of energy prices resulting from the OPEC actions began an inflationary spiral (again cost-push inflation) which may finally be exhibiting some signs of abating today.[1]

This view of inflation is considerably more complex than the traditional demand-pull concept. It is a more pessimistic view in that it implies a circular behavior that becomes increasingly impervious to ameliorative action. The following section describes the events that have triggered this spiralling process of inflation. These events which have never acted in tandem before in history, include:

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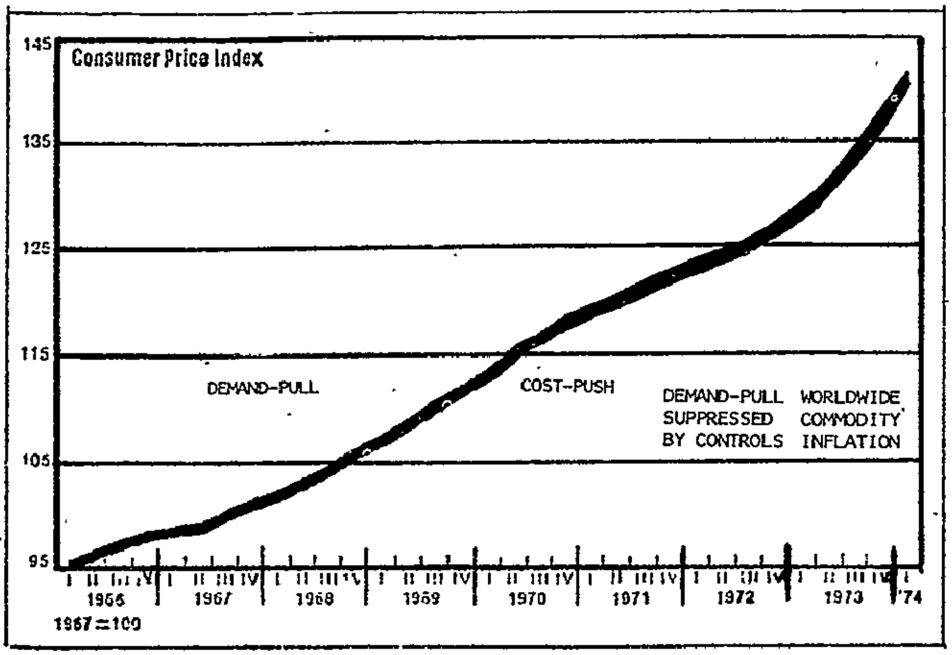
[1] "Why Inflation is So Hard to Cure." Business Week, June 1974.

FIGURE 2

HISTORY OF COST-PUSH/DEMAND-PULL INFLATION



SOURCE: "WHY INFLATION IS SO HARD TO CURE," BUSINESS WEEK, (JUNE 1, 1974), P. 80.

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1. A concurrent industrial boom among the industrialized countries.
2. Price and production policy of the oil exporting countries.
3. Devaluation and subsequent float of the dollar.
4. World-wide reductions in the supply of agricultural products.
5. International shortages of natural resources and raw materials.
6. Continued and increasing Federal government spending.
7. The administered price concept.
8. Rise of multinational firms and merchant banking.
9. Difficulties in improving productivity.

1. International Industrial Boom: Within the past five or six years there has been a simultaneous industrial boom among the major industrial powers of the world which has lead to significant international and domestic material shortages because of the international demand for materials, labor, technology and skilled manpower. This international industrial boom occurred at a time of insufficient international production capacity. The year 1973 saw a simultaneous economic upturn in the major industrial powers, including Japan, Italy, West Germany, France, U. S., and Great Britain, as shown in Figure 3. This was the first time since the early 1950's that practically all the advanced economies of the world have shown vigorous expansion at the same time. Total international trade increased about 13% in real terms stimulated by strong demand for food, manufactured goods, and basic materials.[2]

The occurrence of such an international industrial boom can in part be explained by the increase in international affluence, contributing to substantial increases in the worldwide demand for consumer durables, luxury goods, food products and the plant and equipment necessary to produce them.

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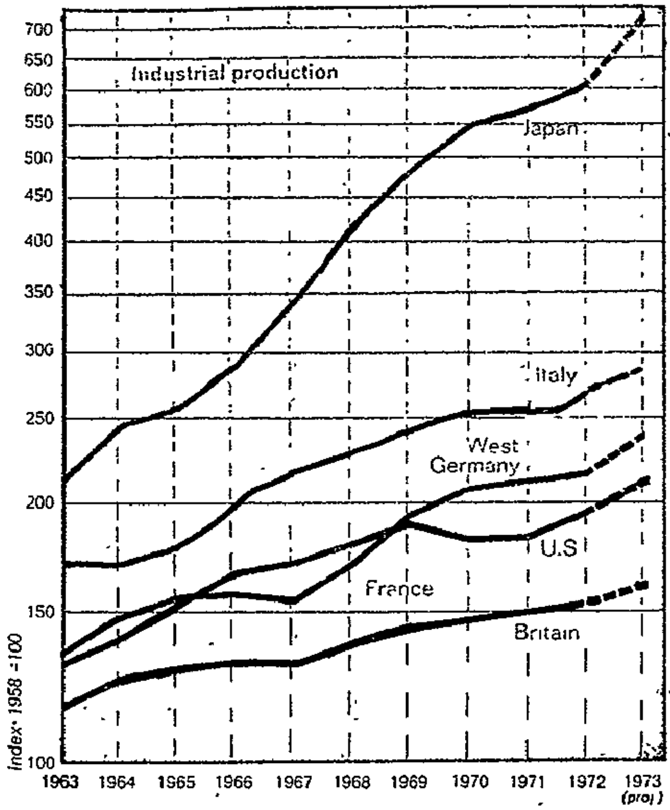
2 Lawrence A. Mayer, "The World Economy: High Prosperity is Here, but What's Around the Corner?" Fortune, Spetember 1973, page 165

FIGURE 3

INTERNATIONAL INDUSTRIAL BOOM



SOURCE: LAWRENCE A. MAYER, "HIGH PROSPERITY IS HERE, BUT WHAT'S AROUND THE CORNER?" FORTUNE, (SEPTEMBER, 1973), P.167.

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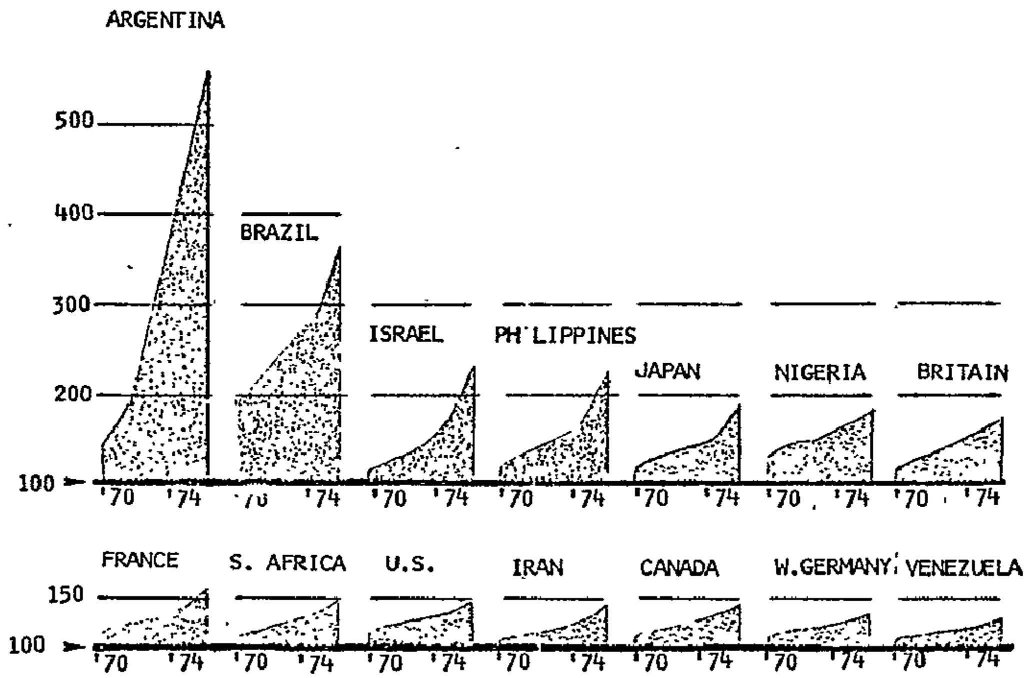
One of the consequences of affluence which profoundly affects U.S. prices is the substitution of animal for vegetable protein. This substitution process is seen currently in Europe and Japan. This worldwide increase in demand for meat has contributed to increases in U.S. food prices.

The international industrial boom and rising affluence have generated inflation worldwide -- the U.S. is not alone in suffering from inflation. In fact, as Figure 4 shows, the U.S. rates of inflation are considerably lower than experienced in other industrialized countries. A major contribution to worldwide inflation is the evolution of a one-world economy, a situation in which the economic and business decisions made in one country can profoundly affect the economic and business conditions in another. The recognition of the interrelationship and interaction of international decisions has profound implications for regulators and policymakers. Decisions cannot be made without consideration of external events. Neither can one nation have effective control over its economic destiny. It was said in the 30's that when the United States sneezes, the whole world catches a cold. It is quite clear that this view of the uni-directional flow of economic viruses is no longer accurate. The Sixties view of "fine tuning" the domestic economy has proven to be unduly optimistic in light of today's events.

There is no reason to expect the international forces of economic affluence -- and interrelatedness -- to diminish. In fact, all the evidence suggests that the United States is losing its leadership and preeminence in the international economic system. The current OPEC domination of the petroleum

FIGURE 4

COMPARISON OF INTERNATIONAL RATES
OF INFLATION



1974 ESTIMATED
SOURCE: BUREAU OF LABOR STATISTICS

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situation is transferring and redistributing the petroleum-dependent nation's wealth, ensuring the rise of affluence. The United States no longer leads the world in per capita income. In fact, Switzerland and Sweden are ahead of the United States. Incomes are rising more quickly in European countries than they are in the United States, even discounting for inflation. In the period 1965-1973, the United States experienced an average real annual increase in hourly earnings of 1.3%. During this same period of time, almost every developed country of the world exceeded this rate of increase. Japan's average annual increase in hourly earnings was almost 10% for the same time period.[3] While it may be argued that foreign industrialized countries have had substantially lower salaries and these increases merely reflect "catching up", there can be no doubt that the industrialized nations are quickly gaining on the economic standard of living that the United States has enjoyed.

Similarly, during this same period of time the United States economic growth was far below that of the rest of the world (See Figure 5). During the period 1968 to 1973, the average annual percentage change in GNP in the United States was 3.5% (See Figure 6). During that same period of time the Organization for Economic Cooperation and Development (OECD) experienced a 4.9% average annual change and Japan experienced almost 10% annual growth.[4] Clearly, the United States is no longer the economic leader of the world. These forces of international industrial boom and increasing affluence are likely to continue. In fact, every indicator suggests that this movement toward a global economy is accelerating rather than decelerating.

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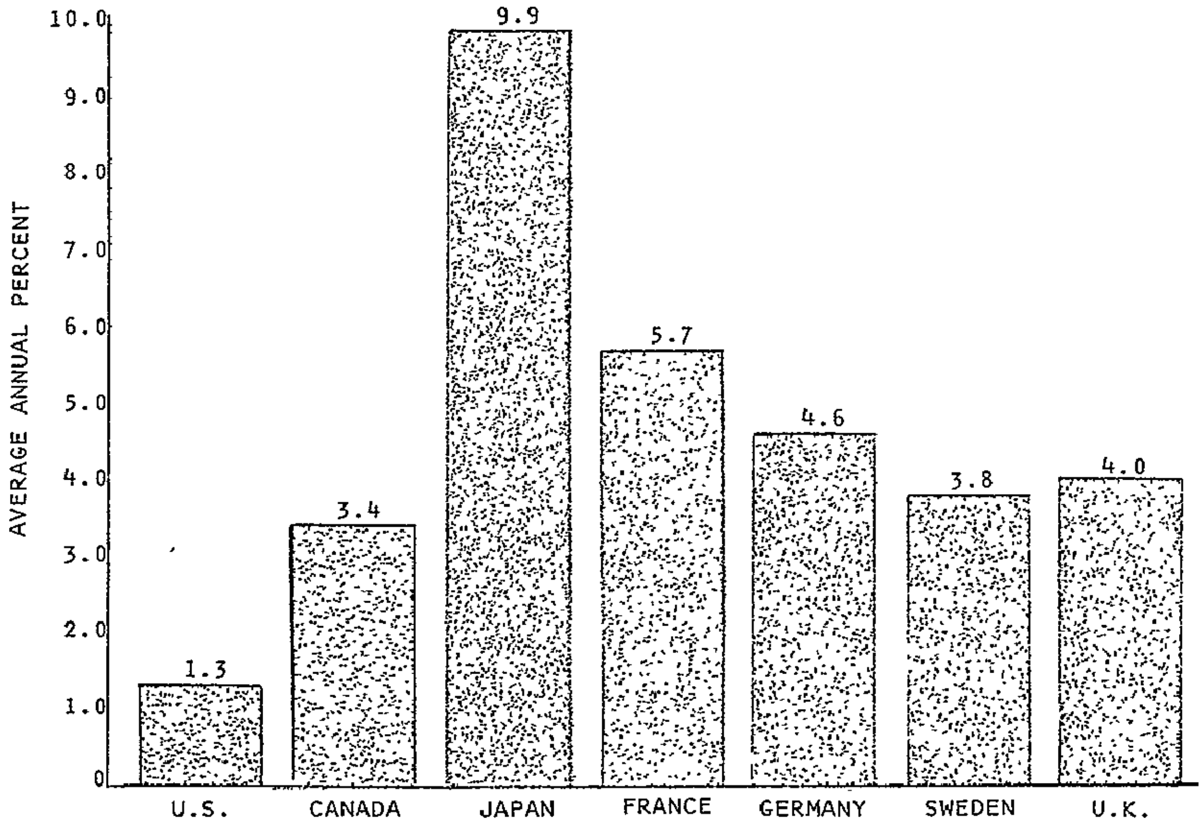
[3] U.S. Bureau of the Census, Statistical Abstract of the United States-1974, Washington, D.C., Government Printing Office, page 828.

[4] Ibid, page 824

FIGURE 5

COMPARATIVE ANNUAL RATES OF ECONOMIC GROWTH

1965 - 1973



SOURCE: U.S. BUREAU OF LABOR STATISTICS.

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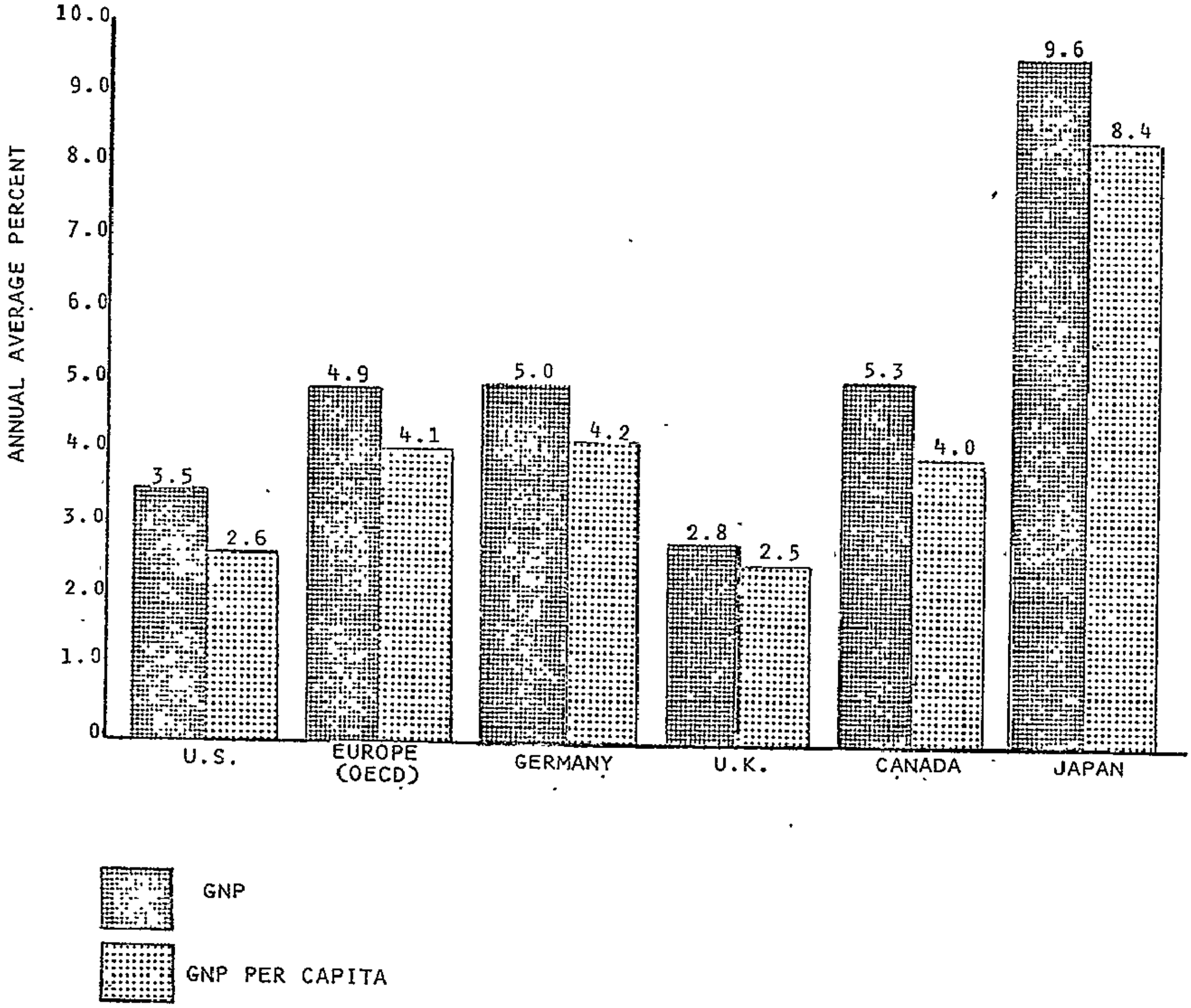
FIGURE 6

COMPARATIVE ANNUAL RATES OF GROWTH IN GNP AND GNP/CAPITA

1968 - 1973



SOURCE: U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

Hence, we can expect that the demand for scarce trained manpower, scarce technology, and scarce resources will continue to increase. This rapid acceleration of industrialization in some parts of the world means that more and more money will be chasing a finite (perhaps) number of goods, services, and materials.

2. Price and Production Policies of the Oil Exporting Countries:

The price and production policies of the oil exporting countries outside the United States (OPEC, the Organization of Petroleum Exporting Countries) wreaked havoc on the international economy. This began in late 1973, when the OPEC nations took direct action and formed a cartel to control and dominate the supply and price of world petroleum products. This aftermath of the Yom Kippur War of 1973 was quite unexpected by the developed petroleum consuming nations. In retrospect, it seems somewhat naive of the industrialized nations to be surprised by these activities. It is quite clear now that the OPEC countries had been selling their oil at unreasonably low prices, which further contributed to the vulnerability of the petroleum consumers.

While there is some evidence to suggest that the OPEC cartel is now close to disintegration, the impact of such economic warfare activities upon the petroleum consumers cannot be overestimated. Consider, for example, the impact that these oil prices had on the U.S. Balance of Payments. Immediately after the announcement of the OPEC decision in late 1973, the United States trade surplus took a downward turn. At the end of 1973, the U.S. Balance of Trade showed a surplus in excess of 1.5 billion dollars, but currently that balance is now a $7 billion deficit. Consider for example that the U.S. spent about $20 billion on foreign oil in 1974 versus $7.5 billion merely a year before. Between the Yom Kippur War in 1973 and the end of 1974, the OPEC nations had received more than $102 billion from the petroleum consumers.[5] The direct impact of OPEC actions can be immediately seen in the retail gasoline prices around the world as shown in Figure 7 comparing retail gasoline prices internationally. This clearly demonstrates the direct impact of the OPEC actions. Those nations which have substantial domestic oil deposits, such as the United States and Canada, experienced the smallest price increase while Japan, which is totally dependent on foreign sources for petroleum, experienced a doubling of its retail gasoline prices.

The implications of high energy costs are only recently becoming known and quantified as the energy dependency of the economy is becoming better understood. One of the reasons for the substantial increases in U.S. labor productivity and rates of real economic growth has been the substitution of energy intensive activities for labor intensive activities. This has resulted in the current energy dependency and vulnerability. The process of energy substitution is especially visible in the industrialization of U.S. agriculture which has become extremely energy intensive -- and, extremely productive. The reliance upon irrigation techniques, automated large scale machinery, fertilizers and pesticides, and hybrid plants has been increasing substantially in the last several decades resulting in substantial increases in agricultural productivity. As a result, it now requires more energy to produce a unit of food than it did thirty years ago; however, food output per acre

5 Saturday Review, January 25, 1975, page 13.

FIGURE 7

INTERNATIONAL RETAIL GASOLINE PRICES

(In U.S. cents for gallon of regular gas)

COUNTRY	July 31, 1974	July 31, 1974
United States (N.Y.C.)	59.9	41.9
Japan	136.1	83.2
Canada (Ottawa)	57.2	56.7
Britain	125.0	78.0
France	131.8	106.2
Germany	126.5	118.0
Brazil	60.6	29.2
Saudi Arabia	12.2	22.4

Source: N. Y. TIMES, January 26, 1975.

has increased substantially. While the energy intensity has increased -- (the kilocalorie return for a kilocalorie of input has declined from 3.7 in 1945 to 2.82 in 1972) the labor input has declined by a factor of 3.[6]

Similar kinds of substitutions of petro-chemical energy for human energy have occurred in other industries in the United States. Of course, it is not just the substitution of petroleum energy for human energy that renders the U.S. economy so vulnerable to the OPEC actions. It is also the reliance upon petroleum derivatives such as plastics, synthetic materials, and a host of other hydro-carbon derivatives. The substitution of synthetic materials (by and large petroleum derivatives) for natural materials is shown in Figure 8.

It has been argued that the abnormally low oil, electricity, and natural gas prices of the past two decades distorted the efficient allocation of these resources by encouraging waste and over-dependency. This dependency is probably far greater than that which would have occurred had energy prices been established solely by market forces.

While the OPEC nations clearly proved their ability to wreak international economic havoc, fears were expressed that members would collect petrochemical dollars indefinitely with the total approaching perhaps even a trillion dollars. It is likely that the imminent demise of OPEC was an inevitable result of its short run success. These increases, acting in concert with other international economic factors, triggered an international recession in the industrialized world. The recession, combined with oil conservation measures, has so reduced the international demand for oil that some experts predict a glut on the market. Oil turned out to be more price elastic than the U.S. had

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[6] David Pimentel, et al., "Food Production and the Energy Crisis," <u>Science</u>, November 2, 1973, pp. 443+.

FIGURE 8

SUBSTITUTION OF SYNTHETIC MATERIALS FOR NATURAL

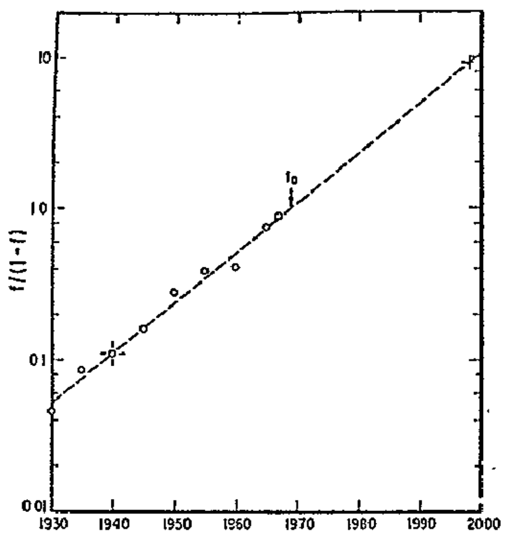
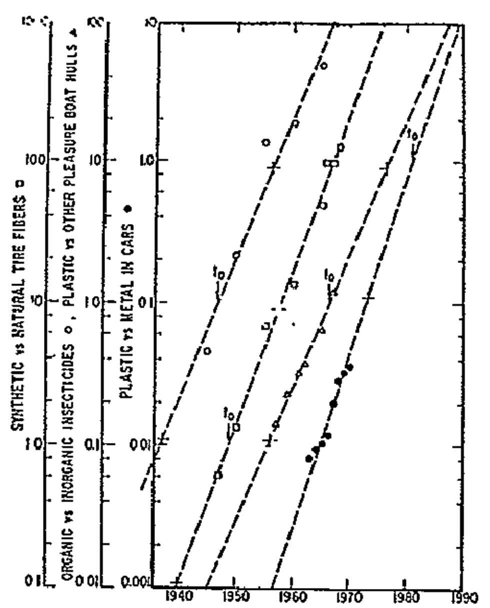


FIGURE 2

SYNTHETIC FOR NATURAL FIBER SUBSTITUTION VS YEARS--SUBSTITUTION MODEL FIT TO DATA



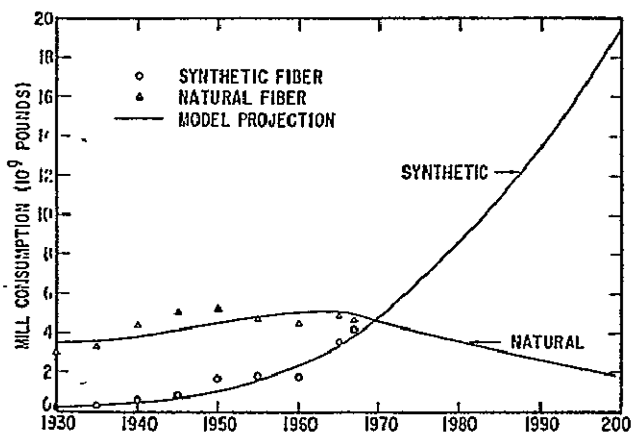


FIGURE 4

U. S. FIBER CONSUMPTION VS YEARS--DATA AND PROJECTION USING THE SUBSTITUTION MODEL

SOURCE: MARVIN J. CETRON AND CHRISTINE RALPH, INDUSTRIAL APPLICATIONS OF TECHNOLOGICAL FORECASTING, (NEW YORK, N.Y.: JOHN WILEY AND SONS, INC.,1970

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dared hope and far more than the OPEC nations had estimated. In addition two mild winters in a row substantially reduced the demand for petroleum as did energy conservation measures. Currently the OPEC nations, in fact, are reducing production in the face of excess capacity. The OPEC output is estimated to be 26 million barrels a day, 11 million barrels below capacity.[7]

Regardless of the possible decline in the price of oil, many of the inflationary pressures of the OPEC oil increases will remain within the economy for some time as cost-push inflation. While many of the petroleum derivative materials which were scarce are once again available, the experience has dramatically indicated the vulnerability of resource scarce countries to resource blackmail.

3. Worldwide Reduction in the Supply of Agricultural Products:

Rapid population growth and international weather catastrophies created substantial worldwide food shortages in the 1972-1974 period. The role of climate and weather change is discussed in detail elsewhere, but a quick review will be made here. Among the events contributing to the international food shortages were:

- The failure of the Peruvian anchovy crop, a basic feed for poultry.
- The failure of the Russian wheat crop due to weather.
- The seventh year of sub-Saharan drought.
- The catastrophic floods and/or drought in the major agricultural areas of the world.
- The inadequate American harvest due to excessive or insufficient rains.

[7] Robert Z. Alrber, "Impending Breakdown of OPEC Cartel", The Wall Street Journal, March 20, 1975.

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- Rising international affluence changing and increasing the demand for food stuffs, especially for protein inefficient foods (i.e., meat).
- Rapid population gorwth in those nations experiencing the most severe agricultural problems.
- Dramatic shortages and increasing prices of petrochemical derivative herbicides, pesticides, and fertilizers.
- Dramatic spot shortages and substantial price increases in energy in U. S. energy-intensive agriculture.

Finally, the energy intensity of U.S. agriculture provided another inflationary pressure on U. S. food prices. In fact, food prices have been the fastest growing component of the Consumer Price Index, growing faster than gasoline. The price of all commodities has increased over 57% since 1967, while the price of food has increased over 70% and gasoline over 60% for the same time period.

4. <u>International Natural Resource and Material Shortages:</u>

Until very recently, the United States and other industrialized nations viewed materials as infinitely available. It was always assumed that more capital investment would always be rewarded with discoveries of substantial new deposits. Should a resource become too expensive, new extractive technologies or technological substitutes could always be found (such as the substitution of synthetic rubber for natural rubber.)

Current economic difficulties suggest that this substitution process may not be as simple, as flexible or as optimistic as originally thought. While there is no doubt, for instance, that acceptable substitutes for fossil fuels will be developed in the long run, short run difficulties for the next several decades will currently be substantial with profound economic impact as there do not appear to be acceptable substitutes available. Scarce materials such as copper and platinum have no technological substitutes at this time. Clearly the infiniteness of resources can no longer be assumed, and it is also likely that infinite substitutions cannot be assumed, especially in the short run.

Among contributing causes to the current material shortages are the recent international political changes which have brought about profound changes in the ownership and management of key industrial resources. The end of the era of colonialism has created independent governments in some lesser developed countries which are well aware of not only the hugh reserves of scarce minerals that they control, but also the value of these materials to the industrialized world. Hence, this mixture of economics and politics result in continued cartelization of key materials and economic blackmail in the future. Other lesser developed countries will become quite conscious of the hundred billion dollars that the OPEC nations have received from the industrialized world and will review their own resource supplies to look for similar situations and are likely to apply the same approach.

In several key materials the United States is in an extremely vulnerable position, as a discussion elsewhere on U.S. material supplies indicates. By the year 2000 it is estimated by the U.S. Department of Interior and the National Commission on Materials Policy that the U.S. will be substantially (that is, more than 75%) dependent on foreign sources for such minerals as chromium, tin, titanium, platinum, beryllium, nickel, aluminum, asbestos, fluorine, and magnesium. The bulk of these resources are located in South Africa or Latin America, the transitional countries that are especially politically and economically vulnerable. A recent study has noted that many of these scarce minerals (chromium, platinum, tungstun, maganese, aluminum, titanium, and cobalt) are especially vulnerable to cartelization or embargo by their principal exploiters.[8] It may well be that the dependency of the United States upon foreign sources of materials will be a source of inflationary pressures, as well as political and military pressures over the next several decades. This undoubtedly will prompt conservation measures, development of technological substitutes, exploration of possible domestic sources, and further efforts to guarantee long term foreign sources.

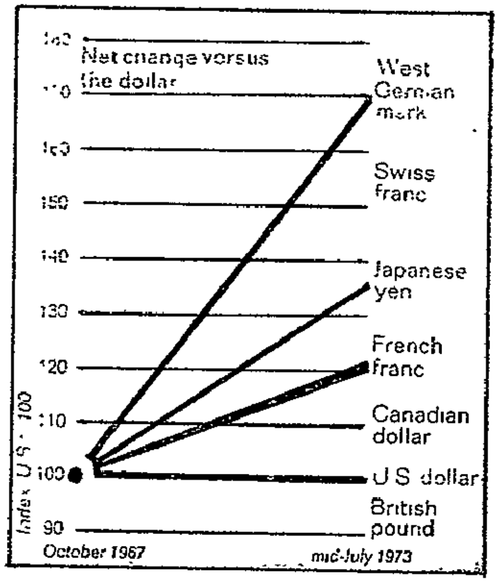
5. Devaluation of the Dollar:

The two devaluations of the dollar and its subsequent float resulted in the under-devaluation of the U.S. dollar which encouraged exports of materials which were already in short domestic supply. Figure 9 relates the value of the U.S. dollar to other major currencies of the world. The result of the devaluation of the dollar has been to reduce the value of the dollar relative to all major currencies except the British pound. Such under-valuation of the dollar makes the American goods and products (including scarce material resources) undervalued on the world market and, hence, more attractive export products. At the same time, it makes imports considerably more expensive and serves as an incentive to export, and a disincentive to import. This is normally a procedure used by policymakers to encourage exports and growth of international trend is to rectify Balance of Payments difficulties and promote economic growth. However, during periods of supply problems and capacity constraints such as those of the last several years, such undervaluation merely furthers the inflationary pressures upon American goods by increasing total demand for them.

[8] Alvin H. King and John R. Cameron, "Materials and the New Dimensions of Conflict," New Dynamics of National Security, New York, Crowell Publishers, 1975, p.95.

FIGURE 9

DEVALUATION OF THE DOLLAR



This chart begins in October, 1967, just prior to Britain's devaluation of the pound. The net result of currency shifts since then has been to reduce the value of the dollar relative to all major currencies except the pound.

SOURCE: FORTUNE, (SEPTEMBER, 1973), P. 168.

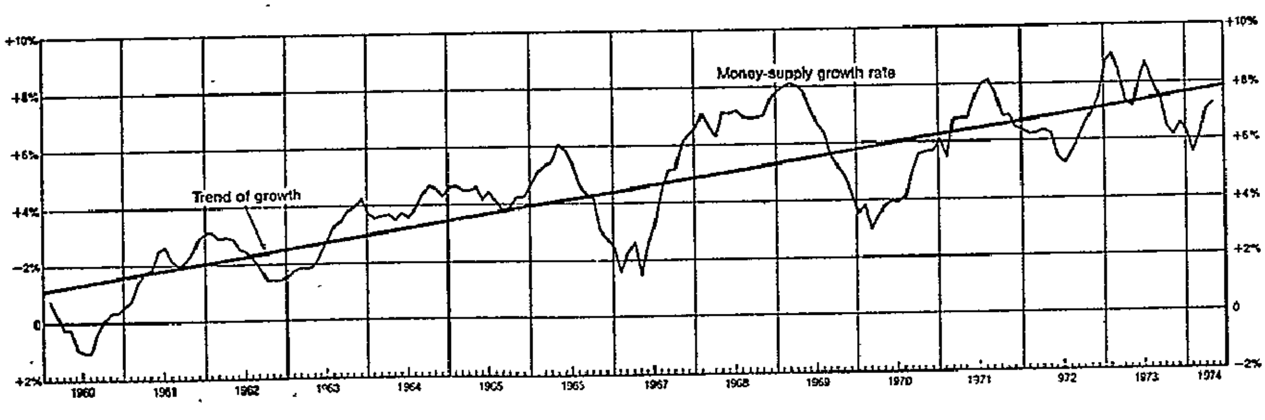
6. Big Government and the Supply of Money:

One argument suggests that the Federal Government is the cause of all inflation and that this inflation is attributable to massive government spending ("Big Government") and the concomitant increase in the supply of money that has occurred over the last decade. Monetary theory states that if money supply expands at a rate greater than the economy's capacity for real growth then inflation inevitably will result. As Figure 10 shows, the money supply has been growing at about an annual rate of 7% over the past three years. The spokesman for the monetary school, Milton Friedman, advocated that monetary growth be held to a constant rate of 4% annually to reduce uncertainty in the market. The percentage increase is based on his perception of what level of real growth that the conomy can sustain. In a recent Federal Reserve Publication, an economist stated the view of the monitarists quite simply: "The current inflation has *not* been largely determined by the supply behavior of non-industrial countries. The basic cause of the current inflation is the same as the cause of all previous inflations -- too much money chasing too few goods."[9]

In a desperate effort to check the growth in money supply the Federal Reserve system dramatically reduced the supply of money and caused the cost of money (interest rates) to rise substantially. It can be argued that interest rates are themselves viewed as components of cost and monetary policy may contribute to rising industrial costs. Therefore, as a result, the Federal Reserve efforts to reduce the supply of money are, in fact, substantial causes to cost-push inflation. Clearly, this can be seen in the impact of such policies upon the construction industry.

FIGURE 10

GROWTH OF THE MONEY SUPPLY



SOURCE: SANFORD ROSE, "THE AGONY OF THE FEDERAL RESERVE," FORTUNE, (JULY, 1974), P. 93.

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[9] Albert E. Bergur, "The Current Inflation: The United States Experience," Economic Review of the Federal Reserve Bank of St. Louis, September 1974. p.13.

7. The Administered Price Concept:

Increasingly, prices of goods are not being established by the traditional equilibrating devices of supply and demand. Inflation, interest rates and even profit are being viewed as legitimate costs of doing business which, like material and labor costs, must be recouped through the selling price. This is a primary source of cost-push inflation. Industry increasingly passes the costs of successive rounds of inflation to the consumer, regardless of the demand for the product. Hence, demand for the product could actually be decreasing, yet the price of the good may be increasing due to these successive rounds of inflation.

This vicious circle of inflation -- in the face of conditions that traditional economies indicate should result in price reduction -- becomes increasingly difficult to perturb. While restrictions of demand are likely to reduce the price pressures in the long run, the short run implications could be far more devastating than the price pressures. Consider, for example, the current situation of the automobile. Despite unprecedented declines in demand, inflationary pressures have continued to force the price of automobiles up. However, further attempts to reduce demand would have substantial negative impact upon the economy.

Clearly, the notion of freely fluctuating prices in the face of constantly changing demand would be managerially impossible, requiring a stock exchange mechanism for every wholesale and retail transaction. Hence, producers establish their prices ("administer" them) and maintain them until market circumstances force a change. Unless cost functions drop precipitously (witness the technologically induced cost reductions in computer componentry, calculating equipment, etc.) or a firm seeks to increase his share of the market through price reductions (price wars), there are few incentives to reduce price, but many forces to raise it.

Administered prices largely are not sensitive to changes in demand because of the moderate to high concentration of most industries where the concern is market share, and where any given product is likely to represent but a small percentage of the firm's sales and profits. Hence, faced with a declining share of the market and declining profits, a firm is likely to diversify and eliminate that product rather than continue to sustained long term losses that could be aggravated by price reductions.

Clearly, the existence of administered prices, the concentration of American industry and the notion of cost-push inflation make price increasingly impervious to changes in demand.

8. <u>The Emergence of the Multinational Firm:</u>

The last decade has seen the evolution of the multinational firm, a firm which truly views the world as its supplier as well as its market. Several writers have noted that the mark of evolution from an international firm (which predominantly views foreign soil as a new market only) to a truly integrated multinational firm is the abolition of the international division, which served usually as the foreign sales office. In multinational firms, organization is primarily product oriented and secondarily function oriented; hence, the view of the world as a market place is integrated into every activity of the firm.

The fundamental contribution that multinational firms make to domestic inflationary pressures is that they largely escape any government attempt to institute effective economic policy. Multinational manufacturing and service firms together with international banking can, for instance, create and participate in capital markets that are totally independent of central banking activities of any country. Hence capital becomes the mobil and transferable among organizations *irrespective* of political boundaries.

A recent book by Global Reach [10] contends that the multinational firm dominates any political or national entity and the nation state has little if any ability to regulate the multinational firm *without* causing domestic economic havoc.

Again, this is another instance of an institutional change which renders available economic policy obsolete because the policy tools were designed for an institutional structure than no longer exists.

9. <u>Difficulties of Improving Productivity</u>:

A final contribution to inflation is the difficulties in achieving productivity improvements in the domestic economy. One of the traditional forces, and a very strong one at that, against increasing costs is to improve the productivity of labor; that is, increase the output of goods or services per unit of resource input (whether that resource input be labor capital, technology, etc.). Massive technological innovation and the aforementioned

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[10] Global Reach, Richard J. Barnet and Ronald E. Muller, Simon & Schuster, 1974.

substitution of mechanical petroleum based energy for human energy has resulted in tremendous achievements in productivity in the manufacturing and agricultural sector. However, proportionally these are declining sectors of the national economy as measured by employment. Government and services accounted for 34% of total employment in 1960, and are projected to reach 45% by the year 1985.[11] The concept of the productivity of labor is extremely difficult to apply to these economic sectors and it becomes difficult to determine whether productivity is even improving or declining. How, for example, can the productivity of teaching be measured? Of civil servants? Of marriage counselors? And yet the costs of these services are rising, contributing to the general inflation and little is known about productivity in the dominant service sectors of the economy.

Implications of These Events:

These nine events never have occurred in tandem before; in fact, some of them have never occurred, even in isolation. The simultaneous occurrence of these events is the fundamental cause of the current economic predicament. Quite predictably, the lack of experience with these interacting forces renders the existing political and economic tools inadequate. The central fiscal and monetary policies available have evolved from 200 years of economic thought, most of which assumed the independent, even isolated, nation state. Most of the current economic policies are based on the work of John Maynard Keynes whose goal was to develop counter-depressionary policy tools for the 1930's. It is quite clear that the economic situation that we are faced with now is quite different from that which was occurring in the thirties in terms of both unemployment and inflation.

[11] Ronald E. Kutscher; "The United Economy in 1985: Projection of GNP, Income, Output, and Unemployment," Monthly Labor Review (December 1973) p. 39.

It can be argued that the fundamental economic difficulty of this country is the application of economic and policy interventions which are totally inappropriate for the current institutional, structural and cultural basis of the country. The entire institutional and value structure of the society is so significantly different from the depressionary period in American history when the current policy tools were originally invented, that the tools may, in fact, be totally inapplicable to the current situation. There is no doubt that the Keynesian formulas of the '30's substantively affected American life to the point of profoundly changing national goals, creating fundamental legislative change, increasing the role of the Federal government in the maintenance of the economy, and fundamentally influencing the way business and government was conducted in this country. The significance and impact of these changes was so basic that it cannot be understated. For instance, the notion of "full employment" as a goal and the concept of explicit action to achieve this goal was completely alien to American expectations and government policy in the pre-Keynesian period. Undoubtedly, one of the aspects of the inability to "fine tune" the economy is the reliance upon policy tools designed for an institutional structure that no longer exists.

Multinationalism and the tremendous concentration of productive capacity in a relatively small number of firms was not even foreseen in the thirties. Many of the social programs implemented in response to changing attitudes and values are inflationary, and reflect structural and institutional change. Daniel Bell has written recently of the "revolution of rising 'entitlements,'" that is, claims upon the government to provide an array of social programs and rights beyond anything heretofore demanded or expected. He notes that generations ago, the French observer Tocqueville identified the demand of equality of opportunity as the most dominant characteristic of American culture. Bell observes an aggressive shift: "Clearly, the demand of equality now goes far beyond equal *opportunity*, or protection against unfair hazards. Too many Americans who got that protection still came out losers. What is now being demanded is equality of result --- an equal *outcome* to all."[12]

Quite clearly, the institutions that have emerged from this set of values and demands are substantively different from those that developed a generation ago, the period of history that was the origin of the economic tools currently available. An equally preposterous and disastrous anology would be to require an electronic technician trained in the thirties to repair the IBM 370 computer. In both examples, the technological principles and the working mechanisms have changed fundamentally, but the tools have remained the same.

It is quite important to note that the economy has not failed: the population of the United States has never been so affluent. By 1973, the average citizen's disposable income was 2.4 times as large, in constant dollars, as it was in 1939. Increases in income have continually been in excess of price increases. The consumption of "luxuries" is clearly increasing as well as becoming more equitably distributed. A declining proportion of income is required to purchase "essentials" (food, housing and clothing), a smaller portion than in any foreign country. At the same time, many "quality of life" indicators have shown substantial improvement: life expectancy has increased, infant mortality has decreased, death rates from many diseases have declined, a larger percentage of the population is going to school for a longer period of time, leisure time is increasing.[13]

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12 Daniel Bell, "The Revolution in Rising Entitlements," Fortune (April 1975), p. 99.

13 Edmund Faltermayer, "Ever Increasing Affluences is Less of a Sure Thing," Fortune (April 1975), p. 92-97.

Hence, while we may not have the tools to regulate and fine tune the economy as optimistic economists had led us to believe, it is quite clear that the economy has generated a level of affluence for the United States not heretofore experienced in the world, and perhaps not likely to be duplicated.

Institutional Bias Towards Inflation:

One of the consequences of the Keynesian economic policies of the 1930's is that there is now an institutional bias in the legislative, regulatory and value structure of government, industry, and the public towards inflation -- full employment at (almost) any cost. Previous sections explored some of the external events which have contributed to the inflationary pressures upon the domestic economy. This section will discuss the factors which have become built-in, institutionalized and reflect the inflationary bias of the economic system.

First, full employment has become a national goal. The Employment Act of 1946, the foundation for current economic policy, declared that the goal of Federal Economic Policy should be "maximum production, unemployment and purchasing power." This has come to be interpreted as the basis for a full employment economy. As the economist Phillips originally pointed out, there is an implicit trade-off between the level of inflation and the level of employment in an equilibrium economy. That is, as unemployment has increased, inflation has decreased.. Therefore, any policy which encourages full employment is, by definition, inflationary. While the discussion of the Phillips analysis will be postponed for now, there is no question that the goal of full employment created built-in inflationary pressures.

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Most prevalent, and somewhat redundant, is the obvious change in social attitudes which encourages a tolerance for a moderate level of inflation in exchange for some assurance of full employment. Full employment policies are inflationary and include tax cuts for individual and corporate incomes, reductions in excise and sales tax, unemployment insurance (begun as a counter-recessionary incentive rather than as a "good deed"), federal deficit spending to increase demand, "easy" money policies, tax incentives (such as the current $2000 tax credit to encourage purchases of new homes to revitalize the housing industry), and increases in the level of and recipients of transfer payments (i.e. a guaranteed income or negative income tax). Even the more indirect efforts such as revaluation of the dollar or import controls often used to stimulate exports and the domestic economy are inflationary.

A second value change is the rising level of expectations. For instance the annual salary raise is viewed as automatic and earned. Hence, increasingly, the level of wages becomes separate from any judgment of or increases in productivity and output. The rising level of expectations also results in automatic cost-of-living escalators in union labor contracts as well as in material and service contracts. The rising level of expectations also generates ever increasing demand for "more," and this is viewed as a right that accompanies citizenship. Hence, a vicious circle is reinforced: the more prices increase, the more prices increase.

To some degree, rising levels of expectations contribute to another institutionalized pressure towards inflation: the unprecedented levels of consumer debt. The extremely easy consumer credit practices that exist undoubtedly contribute to substantial increases in demand. While firms are prohibited from charging usurious interest rates in most states, there is no regulation governing the number of credit relationships that a consumer may enter into nor any limit (other than common sense) to the magnitude of his deficit spending. Therefore, the consumer can enter into virtually unlimited debt. The level of consumer debt at the current time has never been higher (see Figure 11).

Consumer installment debt is currently $154.5 billion (August 1974), an increased of more than 50% since 1970 and an increase of 3,500% since 1946. This debt increase is not due merely to population growth. During this period of time the number of households in the United States increased by 8%, while the level of consumer debt increased 50%. This adds up to an increasingly large debt burden per individual household. Consumer debt now amounts to more than about 16% of disposable income. The Federal Reserve notes that deliquency rates on installment loans are at their highest level in more than 25 years.[14] The biggest credit users are households headed by those 25-34 years old with family incomes of $10-15,000, who account for 60-70% of all consumer debt. This age group is also particularly hard hit by the current recession, as they are often just beginning their careers and are in highly insecure positions vulnerable to lay-offs. Such lay-offs could encourage even more debt financing, and further fuel inflation.

Another inflationary bias is the personal income tax structure which is not nearly as progressive as Keynesian economics dictates that it should be to moderate consumer demand effectively. The underlying notion of a progressive income tax is to increase spending during periods of recession and decrease spending in periods of inflation. However, taxation at upper income levels is not sufficient to do this. Neither is there sufficient flexibility at the lower income levels to quickly (that is, automatically)

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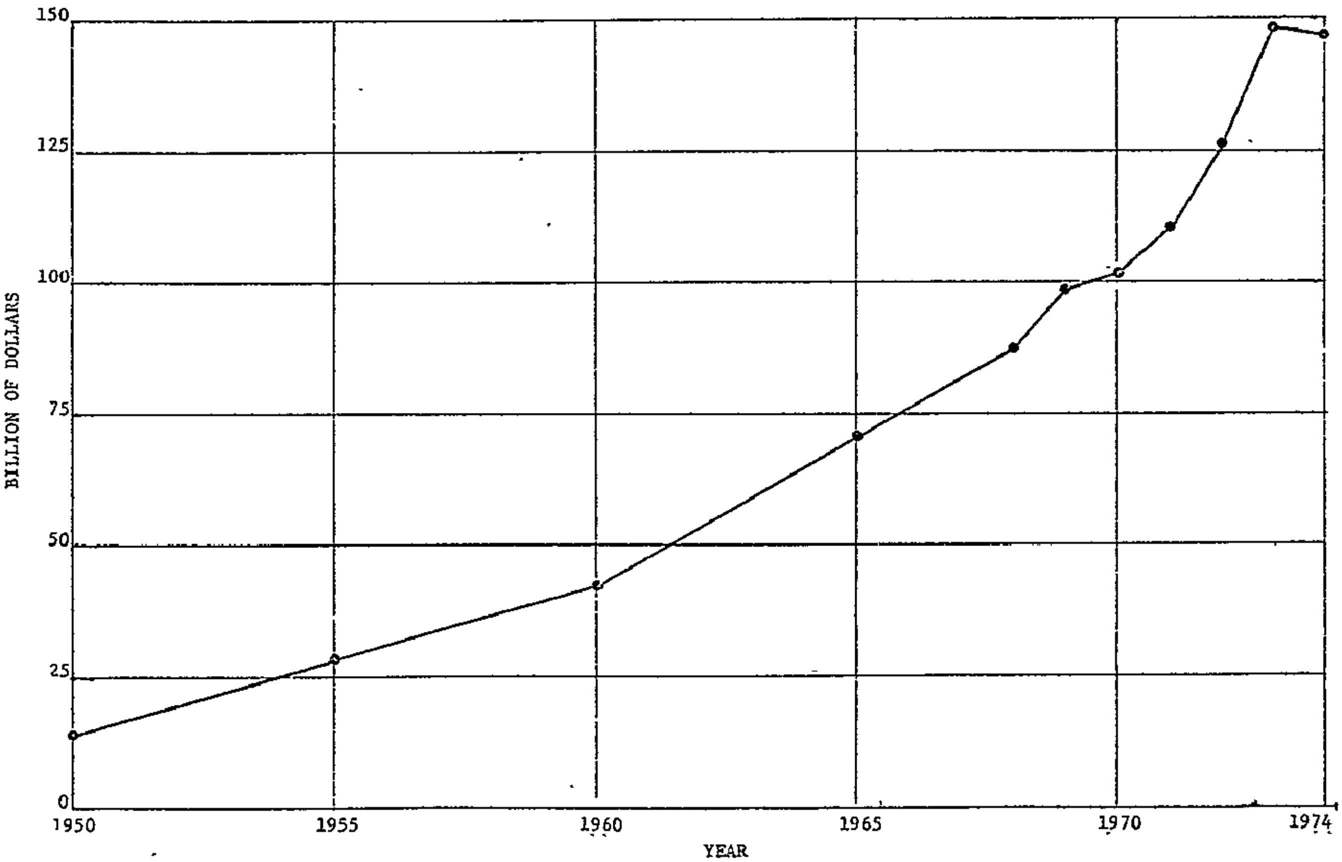
[14] "Will Consumers Stop Buying?" Business Week, October 12, 1974, p.94.

FIGURE 11

CONSUMER CREDIT
TOTAL INSTALLMENT DEBT



SOURCE: U.S. BUREAU OF THE CENSUS, STATISTICAL ABSTRACT OF THE UNITED STATES: 1974, (95th edition), Washington, D.C., 1974, P.461.

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increase the level of disposable income during recessionary periods. The unemployment insurance program is a similar approach to increase demand as unemployment increases, and decrease it as full employment is reached. However, political considerations ("unemployment benefits cause unemployment") often interfere with the optimum economic considerations.

Another institutional deficiency is the built-in time lag between recognition of a problem and the policy intervention. The reliance upon legislative solutions to structural economic problems results in today's policies for today's perception of yesterday's problems. This confusion over the state of the economy and the appropriate, that is, politically acceptable, solution can be readily seen in the current reversal of administration policy from advocating an *increase* in taxes to the recent *decrease* in taxes.

It is beginning to be recognized that present monetary policy may, in fact, be counter-productive and contribute to inflation. The Federal Reserve has taken a number of actions to reduce the supply of money (the appropriate policy of response of a monetarist to sustained periods of inflation), which have resulted in "tight" money; that is, exorbitantly high interest rates. The idea is that the increased cost of money will reduce the demand for it (through reducing debt financing), and hence, aggregate demand will fall and prices will soon drop.

To a degree this happens. But increasingly, interest (the price of money) is being viewed as an input cost. Industry continues to borrow at high rates and then passes these costs forward to the consumer. Hence, an argument can be made that high interest rates may, in some cases, contribute to inflation.

The impact of tight money on the housing market is well known. There is little question that the high interest rates significantly raise the cost of the existing house stock. There is a tremendous shortage of housing in this country, as indicated by the homeowner vacancy rates of about 1% and in urban areas the rental vacancy rate is about 2%. Hence, tight money reduces the ability to add to the housing stock (witness the collapse of the housing industry as measured by housing starts). This exerts extreme pressure on the existing housing supply and forces the prices of these housing units up dramatically. The lower the vacancy rate in the area (this is, of course, a regional phenomenon), the greater the impact of high interest rates upon housing prices. This is expressly the cause of the phenomenal appreciation in the cost of housing in the Washington, D.C. metropolitan area, the tightest housing market in the nation.

In sum, the institutional mechanisms encourage inflation through sustaining the cost-push forces. Current pricing policies are largely unresponsive to changes in demand because of the rising cost of input products.

Industry increasingly views both inflation and profit as legitimate costs of doing business. This coupled with the increased cost of input factors leads to higher prices. They, in turn, pass on the costs of these rounds of inflation to the consumer -- regardless of the demand. Hence, the demand for their product may be decreasing, and the law of supply and demand will tell us the price will fall. Yet because of these previous bouts of price increases for their inputs, the cost, in fact, must go higher.

Tradeoff Between Unemployment and Inflation:

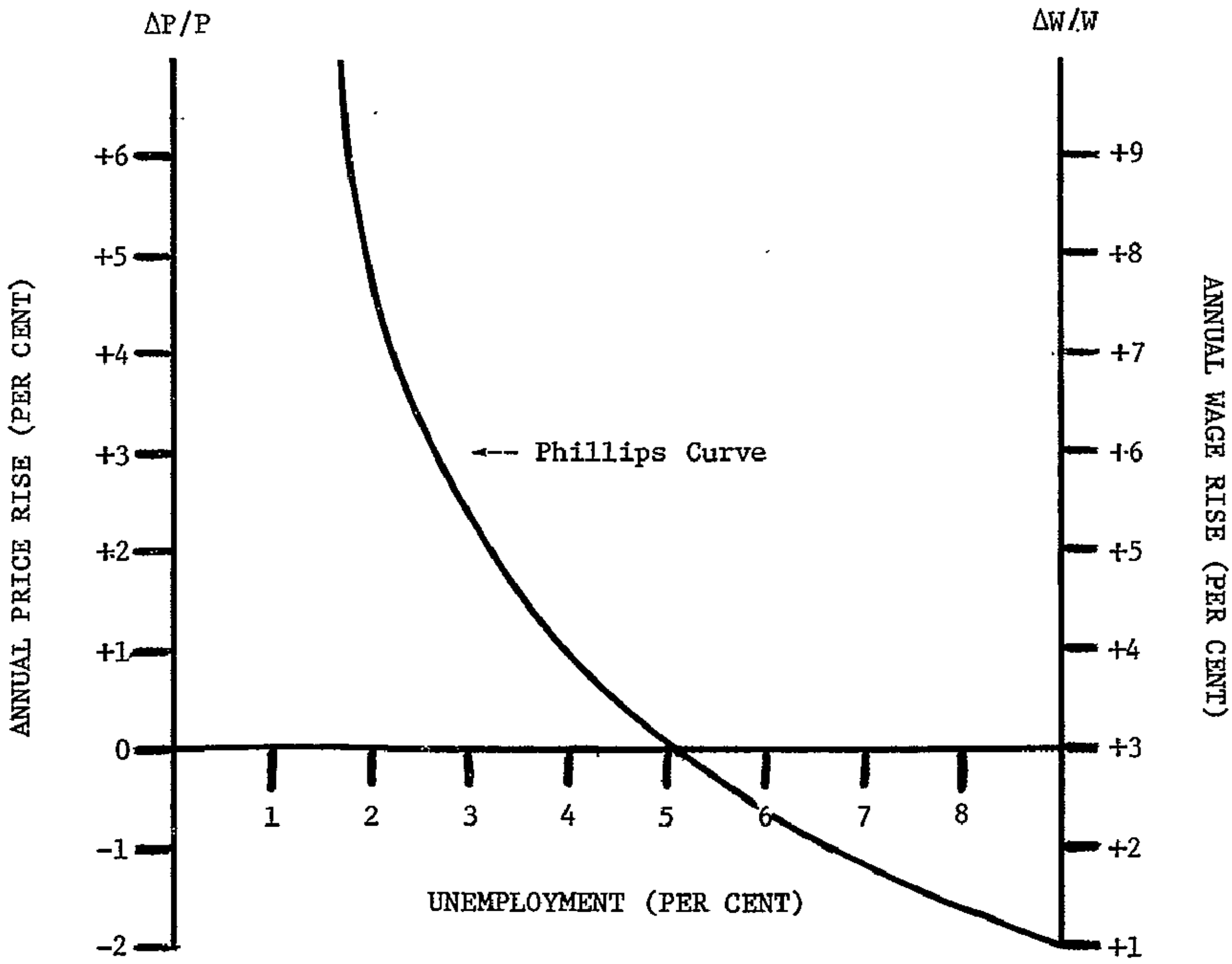
This section will discuss the relationship between unemployment and inflation. The confusion of this tradeoff is one of the issues which is at the center of current economic controversy and yields often contradictory economic policy recommendations. Most fundamentally the heart of the domestic economic difficulties may be the fact that the empirical relationship between unemployment and inflation is changing.

Historical evidence indicates that there is a quantifiable relationship between unemployment and inflation. Professor A. W. Phillips was the first to note the empirical relationship between the rate of wage-price changes and the rate of unemployment.[15] The original Phillips curve (shown in Figure 12) relates the set of inflation-unemployment tradeoffs or policy choices that are available to economic stabilization authorities. Essentially, the curve indicates that one can achieve a 2% unemployment rate at a cost of 3 to 4% inflation. The implication being that the only way to substantially reduce inflation further is at a cost of higher unemployment. This leads to some very hard decisions about the impact of policies

[15] A. W. Phillips, "The Relation Between Unemployment, and the Rate of Change of Money Wage Rates in the United Kingdom," Economica (November 1958).

FIGURE 13

TRADEOFF BETWEEN INFLATION AND FULL EMPLOYMENT



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that the government can pursue. One of the arguments is being conducted in economic circles is the degree to which the Phillips curve is shifting. The original Phillips curve essentially defined full employment at about 3 or 4%. That is, one could not go below that level of unemployment without substantial increases in inflation. There is agreement among economists that the Phillips curve has shifted substantially to the right, meaning that price stability is possible only at higher levels and only can be achieved at concomitant higher levels of unemployment.[16] This may contribute to the explanation of the present dilemma of concomitant "high" inflation and "high" unemployment ("high" being merely relative to the level of expectation and past experience) -- stagflation.

Why are higher levels of inflation and unemployment occurring? It is likely that the composition and causes of inflation in this country are changing. There are essentially three kinds of unemployment that we must consider. One is functional unemployment; that is, those people who are temporarily unemployed because they are shifting jobs, on vacation, leave of absence, etc. A second component is structural unemployment; that is, the "built-in" unemployment of the economy due to a long term mismatch of available skills and available employment opportunities. A large portion of this population is totally unskilled or possess technologically obsolescent skills (i.e., chimney sweeps). Note that this category of unemployment can co-exist with a boom economy; in fact, it is probably largely unaffected by industrial expansion. The third kind of unemployment is the kind which we traditionally define as demand unemployment; that is aggregate demand for goals and services is insufficient and workers are

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[16] Note that "high" rates of inflation and "high" rates of unemployment are politically defined. Professor Samuelson has noted that the modern electorate has become increasingly intolerant of levels of unemployment that would only have been labeled "moderate" in the 1950's.

laid off and denied employment opportunities. This kind of unemployment is amenable to such stimuli as tax cuts, federal deficit spending, "easy" money and the like, and is the kind with which the public is most familiar.

However, increased demand rarely has a substantial impact upon structural employment. In November 1974, it was estimated that only about 24% of the total unemployment was due to recession.[17] While clearly recession-induced employment has increased since this time, it has been suggested that the rise in structural unemployment is a fundamental weakness of the present day economy. Advocates of this argument indicate that the fastest growing segments of the labor force are those members with the greatest difficulty gaining employment because of lack of skills and experience (see Figure 13). This sector includes blacks, women and teenagers whose unemployment rates are highest in the nation.

The participation rate of women in the labor force has been increasing substantially over the past decade and has now reached 45% from a level of 37% in 1960. The unemployment rates of women are considerably higher than that for men as shown in Figure 13. One of the current difficulties is the job opportunities for women, teaching, sales and secretarial employment, are becoming saturated. The decline in the birth rate combined with the tremendous increase of college students majoring in education in the '60's has produced a glut of teachers in the market. Simultaneously, such significant productivity improvements are being made in sales and clerical jobs through the advent of computerized information systems that the demand for labor is slackening in these areas. While point-of-entry jobs (that is, first jobs in the job market) have always been difficult to obtain for low skilled women, blacks and teenagers, increasing difficulty is being experienced.

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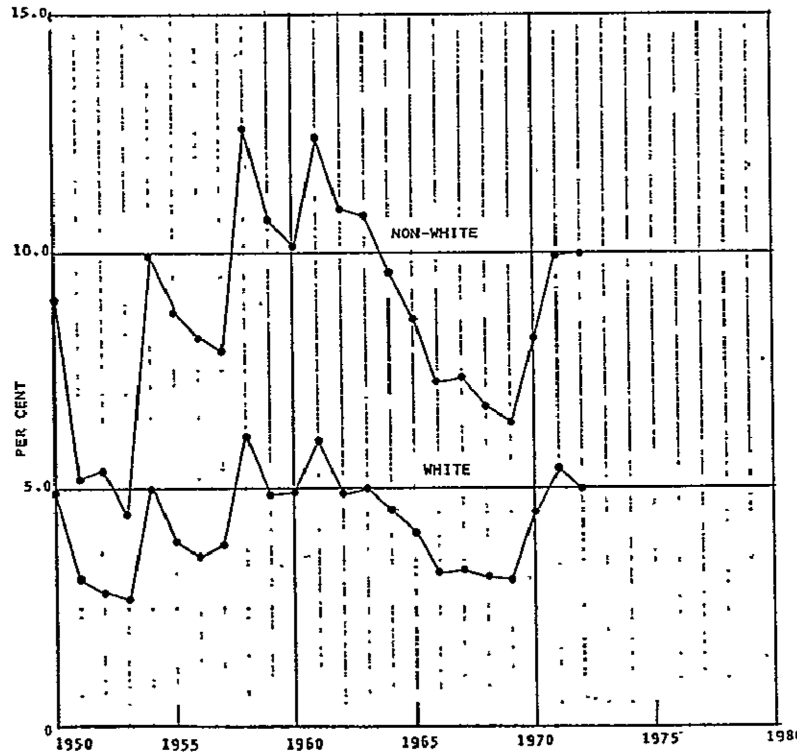
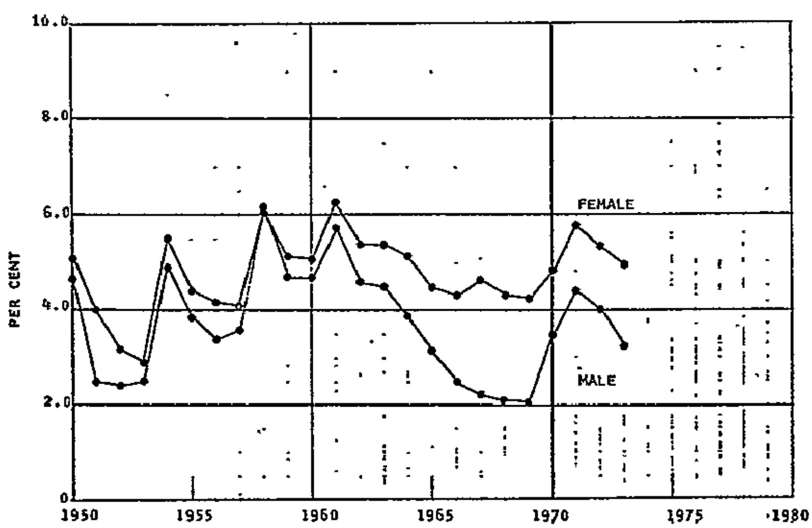
[17] "Unemployment Becomes An Explosive Issue," Business Week (November 9, 1974).

FIGURE 13

UNEMPLOYMENT BY RACE



UNEMPLOYMENT BY SEX



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SOURCE: U.S. DEPARTMENT OF LABOR, BUREAU OF LABOR STATISTICS, HANDBOOK OF LABOR STATISTICS.

Teenagers experienced the highest unemployment rate in the United States, approaching 18%. One concern expressed by some is that the cause of this is the minimum wage laws which discriminate against teenagers by pricing them out of the market. Given the choice between a teenager with no skills and no experience versus an older person with some skills and some experience, the teenager obviously loses. There is a growing movement to amend the minimum wage laws to exclude teenagers from its coverage to encourage their employment. Finally, black unemployment is significantly above average as well as shown in Figure 13.

It is argued that this population has skills and experience totally unsuited to the employment opportunities that do exist. Many of the current crises facing the nation have created demands for new job specialties such as energy technicians and scientists. As well, legislation in environmental, safety and health issues has created a tremendous demand for specialists in these fields. The U.S. Department of Labor has estimated that there are approximately 800,000 jobs that remain unfilled because they cannot find the workers with the right skills. While this is only slightly more than 10% of the total employment, it may well be vastly underestimated. It has been suggested that the most short-handed industry in the United States are oil drilling companies.[18] The energy companies in general are experiencing significant shortages of trained personnel. Representatives from the Department of Labor indicate that this is an underlying problem that is related neither toward recession nor prosperity but reflects the basic malfunctioning of the job market.

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[18]"A Million Jobs Go Vacant," Business Week, March 17, 1975.

One of the institutional difficulties contributing to unemployment is that unlike commodity markets, there is an insufficient monitoring of the labor supply and demand relationships resulting in both a lack of information, as well as a inadequate information transfer mechanism regarding the regional availability of both labor and jobs.

Consequences of Long Run Inflation:

This section explores some of the impacts of long run inflation upon the economy. Quite clearly, inflation serves as a tax upon the consumption of goods and services and without simultaneous increases in money wages, the immediate impact is to decrease the standard of living for that segment of the population that does not have access savings or deficit spending. In an effort to determine the real costs of alternative standards of living, the Bureau of Labor has established budgets for households estimating the amount of money required to sustain three different standards of living -- low, moderate and high. The budgets specify the amount of money that would have to be allocated to food, housing, transportation, medical care, social security, and income taxes to maintain these alternative standards of living. This is a device that the Bureau of Labor Statistics uses to determine regional differences and national changes in the cost of living and is an effective way of monitoring changes in the standard of living.

As Figure 14 indicates, the amount of income that will be required to sustain a family of four at the same standard of living in 1974 as in 1973 increased 14.6% in that one year. In 1973, a family of four could attain moderate standard of living on an income of $12,626. By 1974, the same standard of living would require $14,466. The recent inflation hit the poor

FIGURE 14

THE EFFECTS OF INFLATION
ON VARIOUS INCOME LEVELS

The figures below are estimates of what it would cost to maintain standards of living judged typical for a family of four at three income levels.

	FAMILY BUDGET DOLLARS		PERCENT OF FAMILY BUDGET*
FOOD	FALL 1973	FALL 1974	FALL 1974
Lower	$2,440	$2,730	29.3
Intermediate	$3,183	$3,562	24.6
Higher	$4,020	$4,498	21.5
HOUSING			
Lower	$1,627	$1,847	19.8
Intermediate	$2,908	$3,301	22.8
Higher	$4,386	$4,978	23.8
TRANSPORTATION			
Lower	$563	$644	6.9
Intermediate	$1,014	$1,159	8.0
Higher	$1,315	$1,503	7.2
CLOTHING & PERSONAL CARE			
Lower	$091	$988	10.6
Intermediate	$1,270	$1,393	9.6
Higher	$1,846	$2,024	9.7
MEDICAL CARE			
Lower	$660	$734	7.9
Intermediate	$664	$738	5.1
Higher	$692	$770	3.7
SOCIAL SECURITY			
Lower	$492	$560	6.0
Intermediate	$647	$787	5.4
Higher	$647	$787	3.8
PERSONAL INCOME TAXES			
Lower	$724	$950	10.2
Intermediate	$1,607	$2,033	14.1
Higher	$3,080	$3,842	18.4
TOTAL			
Lower	$7,407	$8,453	
Intermediate	$11,293	$12,973	
Higher	$15,986	$18,402	

*Budget items not accounted for are miscellaneous expenses.

Source: Bureau of Labor Statistics, Department of Labor, and Joint Economic Committee.

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the hardest, because the prices of foods consumed in greatest quantities by low income groups rose the fastest of all food commodities.

There are many readily apparent and immediate effects of inflation upon the consumption behavior of the moderate income families. For instance, consumption of luxury goods, consumer durables, recreation, and education decreases during periods of inflation -- witness the current state of the automobile, appliance, housing and tourist industries.

Because inflation changes both the *pattern* of demand as well as the *level* of demand for many luxury and durable goods (such as the appliances, automobiles, television and consumer electronics); unemployment inevitably will result in the long run. In the past, this reduction in demand has been sufficient to moderate inflationary pressures and this action combined with anti-inflationary actions restored price stability. As we have previously discussed, the new era of administed price, cost-push inflation, and structural unemployment interfere and a period of simultaneous unemployment and inflation result.

Some Potential Actions:

The available solutions and policy choices are at least as numerous as the advisors and economists that exist. One is reminded of Winston Churchill's comment that every time five economists walked into his office, he was offered six different ideas because Keynes was always arguing for two different positions. The diversity of opinion has not change significantly in the forty years since then. One of the current debates is the unemployment/inflation tradeoff suggested by Phillips and the apparent contradictory notion that they could occur simultaneously. The implication of this tradeoff is that inflation can be controlled only at the cost of increasing unemployment. As discussed earlier, this traditional analysis considers only the impact of demand-pull inflation and ignores the domestic institutional changes, the "one world economy," the impact of multinational firms, and the notion of administered price cost-push inflation and structural unemployment. It can be argued that the panoply of actions available are developed for an economic system that no longer exists. It has been said that an economic model describes how the world would work if only it worked that way. It is likely that it is not the policy interventions that are at fault, but rather the inappropriate and irrelevant economic model to which they are applied. The difficulty is not the failure of the theory, but the irrelevance of existing economic models to the current economic situation.

There are generally six categories of actions that are advocated today to improve the economic performance of the country. They include:

(1) monetary policy;

(2) fiscal policy;

(3) actions to affect supply and capacity;

(4) institutional mechanisms to realign the inflationary biases of the economy;

(5) actions and policies aimed at reducing structural unemployment;

(6) international mechanisms to account for the Eurodollar market, multinationalism and petrodollars.

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1. Monetary Policy: Advocates of monetary policy assume that equilibrium can be achieved merely by regulation of the supply of money. This policy intervention assumes that inflation is caused by rapid growth in the supply of money ("easy" money),and recession is caused by slow growth in the supply of money ("tight" money). While Keynesian economists clearly agree that the stock of money should be controlled, they do not agree that monetary policy instruments by themselves are sufficient for stabilization. One of the current arguments, then, is whether the monetary actions (in an effort to control inflation) may, in fact, be counterproductive because of their recessionary bias. For instance, the tight money policy no doubt contributed to the collapse of the housing market. It can also be argued that tight money contributes to inflation because interest if viewed as a cost and the high costs of money are passed on to the consumers with other increasing costs.

Figure 11 earlier shows the trend of consistent growth of the money supply in the U.S. over the past 14 years. Advocates of monetary policy argue that to prevent inflation the money supply can only grow at the same rate that the economy is capable of growing. Any growth beyond that contributes to inflation and any growth below that contributes to recession.

Most monetary policy advocates also recommend a reduction in the size of government because they also identify deficit spending and big government as one of the major causes of distortion of the equilibrating market mechanism that prevents monetary policy from achieving its goals. Through adequate manipulation of the monetary supply, the rest of the economy will equilibrate by itself.

Monetary policymakers recognize that the increasing interrelatedness of world economies tend to weaken the usefulness of monetary policy for stabilizing prices and unemployment. Any kind of activity that relates one country's economic activity with another country's, even international trade, renders monetary policy ineffective. Hence, the increasing connection of national economic systems is a strong force against the effectiveness of monetary policy. For instance, speculation in the $150 billion Euro-Dollar market further decreases domestic monetary policy effectiveness.[19] One can imagine that a continual outflow of dollars to the petroleum producing countries could have similar impact.

2. Fiscal Policy: Fiscal policy is the foundation of Keynesian economics which suggests that an equilibrium can be maintained through control of aggregate demand by government spending and tax policy manipulation. It was merely a question of timing and "fine tuning" of the economy, and equilibrium will be achieved. Currently, the government has chosen this route of activities (tax cuts) to stimulate demand. Increased deficit spending by the government is also underway to further stimulate the economy, recognizing the threats to price stability that are likely to accompany it.

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[19] Jane Sneddon Little, "The Impact of the Euro-Dollar Market on the Effectiveness of Monetary Policy in the United States and Abroad," New England Economic Review (March/April 1975).

There is no doubt that fiscal policy is an extremely powerful economic tool. However, the major difficulties, as previously mentioned, are the timing difficulties and the progressiveness of the income tax structures. For fiscal policy to be effective requires extremely quick recognition and implementation timing, both impossible because of the political process involved. Secondly, the tax structure is not as steeply progressive as it should be to provide the desired balancing mechanisms. Regardless, fiscal policy still remains a powerful tool.

3. Supply and Capacity Problems: Unlike other periods of inflation this period is aggravated by insufficient supply and productive capacity that is not readily corrected. Inadequate production capacity has plagued the economy in the past; this time, however, it is not merely production line capacity that is a barrier but also shortages of key resources and material inputs. A survey of the nation's largest 500 industrial firms by the Senate Permanent Subcommittee on Investigations indicated that the most severe problems were steel, petrochemicals, aluminum, copper and paper.[20] Many ideas have been offered to try to correct these imbalances including from a national stockpiling of key materials, based on the model of the critical materials stockpiling program for materials deemed necessary for national defense. These new stockpiles could then be used to insure adequacy of supply at reasonably stable prices. Another variation of this is to

[20] Material Shortages: Industry Perceptions of Shortages, Permanent Subcommittee on Investigations of the Committee on Government Operations, United States Senate, August 1974.

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establish an equitable rationing system for key energy and resource materials based on a system of economic priorities. A third idea which has been advocated a great deal has been the establishment of anti-cartel cartels. Essentially this is the effort that Dr. Kissinger has tried to use in trying to gain international support for joint action against the establishment of material based cartels. A fourth activity is aimed at the regulation of transportation, energy, and material industries, to more closely monitor their investment patterns, their capacity expansions, their price increases, and in general oversee the delivery of services to both consumer and industry. Many ideas revolve around incentives that would encourage technological innovation and the diffusion of innovations to encourage the development of new capacity, to develop technological substitutes for scarce materials; and finally to find, explore and develop new sources of materials and energy.

One of the current arguments is that government intervention in the marketplace through regulation of such things as energy prices has, in fact, stifled incentives to expand capacity by limiting the potential return on investment. While this may be an argument for increased prices now, there appears to be some merit to its historical effect on capacity.

4. Institutional Mechanisms: As has been mentioned previously, much of the current economic dilemma is based on the institutional biases and mechanisms which have been built into the economy over the last 20 or 30 years. Many of the economists, especially those who participated in the Conference on Inflation in September, recommend fundamental changes in economic institutional mechanisms to remove and alter some of the biases toward continued inflation.[21] There is consensus that institutional change must occur; however, the dimensions of this change are indeed

[21] Proceedings on the Conference on Inflation, held at the request of President Gerald L. Ford in the Congress of the United States, September 27-28, 1974, (Washington, D.C.: Government Printing Office).

controversial. Senator John Tower of Texas recommended fundamental changes that would basically restore things to the way they were in the 30's and 40's. He said: "It is clear to me that the roots of our current inflation may be traced to profound historical tilt in the social tolerances and value systems of our democratic system as reflected in our political decisions in the 1940's. Our political body subsequently superimposed massive social costs upon the normal workings of our free enterprise system. Such costs are only now coming home with the buyer and the consumer. Our greatest fault has been in not correctly assessing the total cost of our political actions and in educating the public as to what the true costs of programs are, both in terms of tax dollars spent and inflationary pressures unleashed."[22]

There can be no denial that these kinds of changes have occurred and that they may have rendered Keynesian economics inappropriate to the current situation. The past application of Keynesian economic policies have, as Senator Tower observed, changed the basic institutional mechanisms. However, it is not at all clear that a return to the institutions of the thirties and forties is even possible, regardless of the alleged desirability.

Economists, however, have suggested institutional change of another sort. There are many legislative and regulatory barriers within the panoply of industrial regulations that were originally created and suited for particular sets of circumstances which no longer exist. For instance, one of the regulations originally implemented to assist the failing U.S. maritime industry was the Jones Act which said that all goods travelling between American harbors must be transferred in U.S. ships. This law has

[22] Ibid., p.23.

caused a substantial increase in the price of goods because of the inability to use more efficient and cost-competitive foreign ships. It could also be argued that by protecting existing non-competitive U.S. shipping practices it has served as a disincentive for development of comparable ships by the U.S. industry. Another law which perhaps has created inflationary pressures in the cost of goods and services has been the Davis Bacon Act which requires government contractors to pay union wages. Some economists argued that this is unnecessary to gain the labor pool required, contributes unnecessary inflationary pressures, and puts the U.S. government in a non-competitive position with private industry in the ability to deliver goods and services. Recommendations also have been made with respect to the procurement policies of the U.S. Government, the anti-trust policies, bale-outs of existing industry, fundamental tax reform and revision of minimum wage laws. The economist, Dr. Hendrik Houthakker, of Harvard University recently recommended to the administration of Gerald Ford, that over 45 existing laws be abolished on the grounds that they contribute to inflation and encourage structure unemployment.

4. Structural Unemployment: There is a great deal of concern, as was discussed earlier, regarding the level of structural unemployment in this country and the likelihood that it will require massive job creation, job training, and job re-training programs in order to fundamentally lower the structural employment level. One argument is that minimum wage laws discriminate against the structurally unemployed that are without training or experience. It has been advocated that teenagers, for instance, be exempt from the law to encourage their employment. Other actions include matching jobs to people, not to matching people to jobs. This implies that factory design and layout would take into account the kinds of jobs,

skills, and the labor pool that was available rather than the optimal efficiency that the engineers can provide; a design often developed in the absence of any understanding of the local labor market characteristics.

Charles Holt of the Urban Institute argues that the nation requires a permanent public job program aimed at these groups that suffer the most. At the same time he argues that a second tier system which is counter-cyclical and would come into effect if the unemployment rate rise above a certain level is essential. This is a tacit admission that there is a group of people that would not be employed unless explicit action is taken by the Federal Government to employ them -- the notion of the Federal government as the employer of last resort.[23] Many economists believe that this race must be greatly increased through authorization provided by the Emergency Employment Act. Simultaneously, the comprehensive Employment and Training Act would allocate money to state and local governments for public service jobs as well as money for manpower training. However, traditional manpower training programs have failed consistently as was effectively demonstrated by the efforts of the 60's. Part of the problem is the lack of insight into job requirements of the future and the increasing obsolescence or unappropriateness of current job skills.

5. Direct Government Intervention: There are two basic components which are often recommended here. One is "let's live with it approach," such as indexation that is successfully used in Brazil. Indexing pegs all prices and wages to the current rate of inflation so that if the price of food increases 27%, then salaries increase 27%, and the cost of other goods increase 27% to prevent degradation in the standard of living.

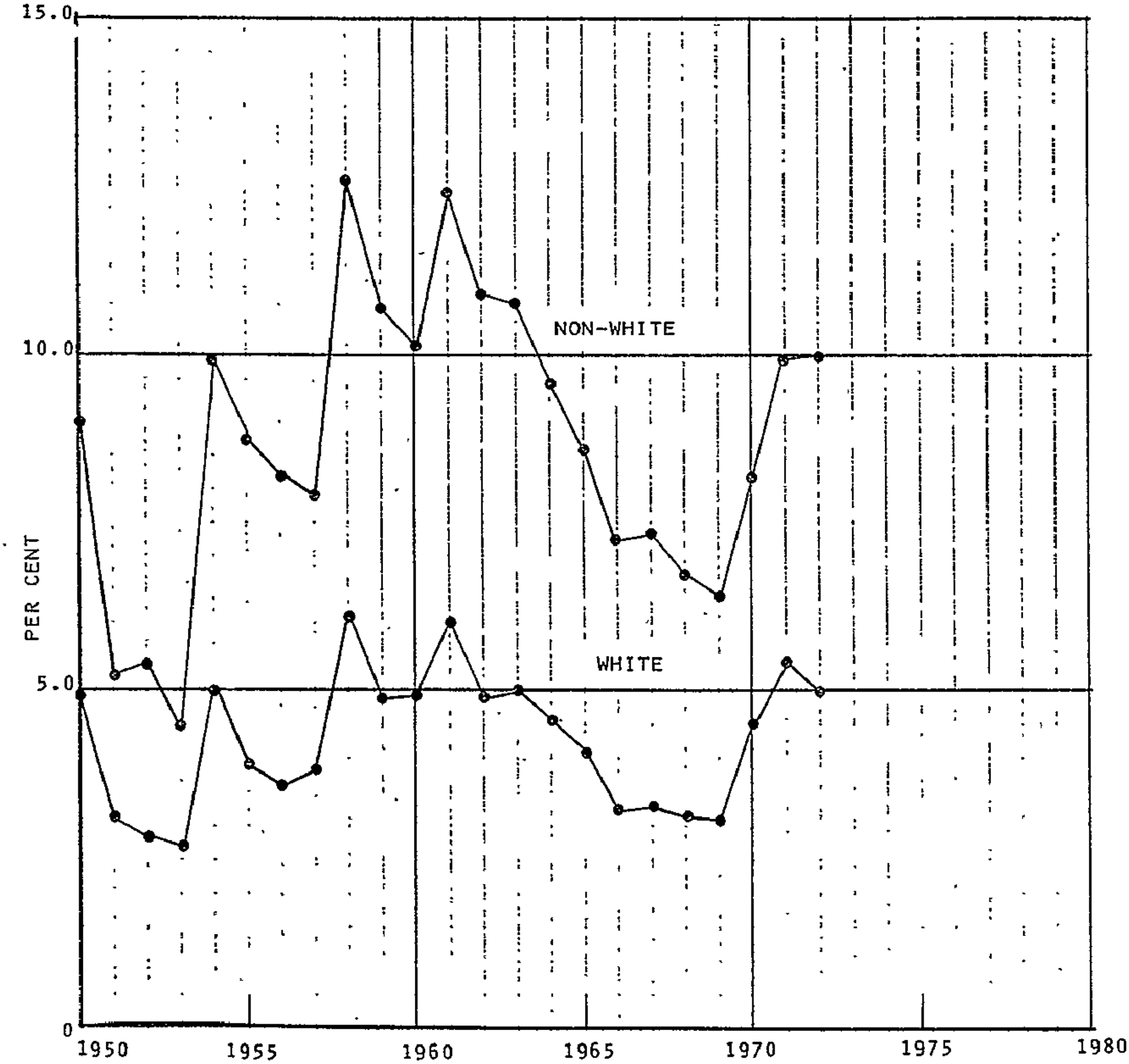
[23] "Unemployment Becomes an Explosive Issue," Business Week, November 9, 1974, p.158.

A second approach is the reliance upon wage and price controls. While such wage and price controls may provide short-term relief, but upon removal or relaxation of the constraints prices immediately increase rapidly. This occurred in the recent 1972-73 experience, as well as is the post-World War II time period. History suggests that it is extremely difficult if not impossible to effectively administer price and control policies. To overcome the difficulties associated with temporary controls, John Kenneth Galbraith, recognizing that inflation is a built-in phenomenon of the economy, recommends *permanent* wage and price controls to control price increases.

6. International Mechanisms: Because of this recognition that we are now in a one-world economy, it is becoming increasingly clear that the United States cannot act by itself to establish mechanisms to deal with both unemployment and inflation. As so many of the current economic difficulties are caused by activities which have occurred outside the United States, it becomes quite clear that there must be an international effort to establish and regulate such economic behavior.

Among the international actions that have been suggested is an international cooperation to conserve materials and ensure supplies of scarce materials, international action to reduce oil prices, and actions to prevent further economic warfare.

UNEMPLOYMENT: BY RACE



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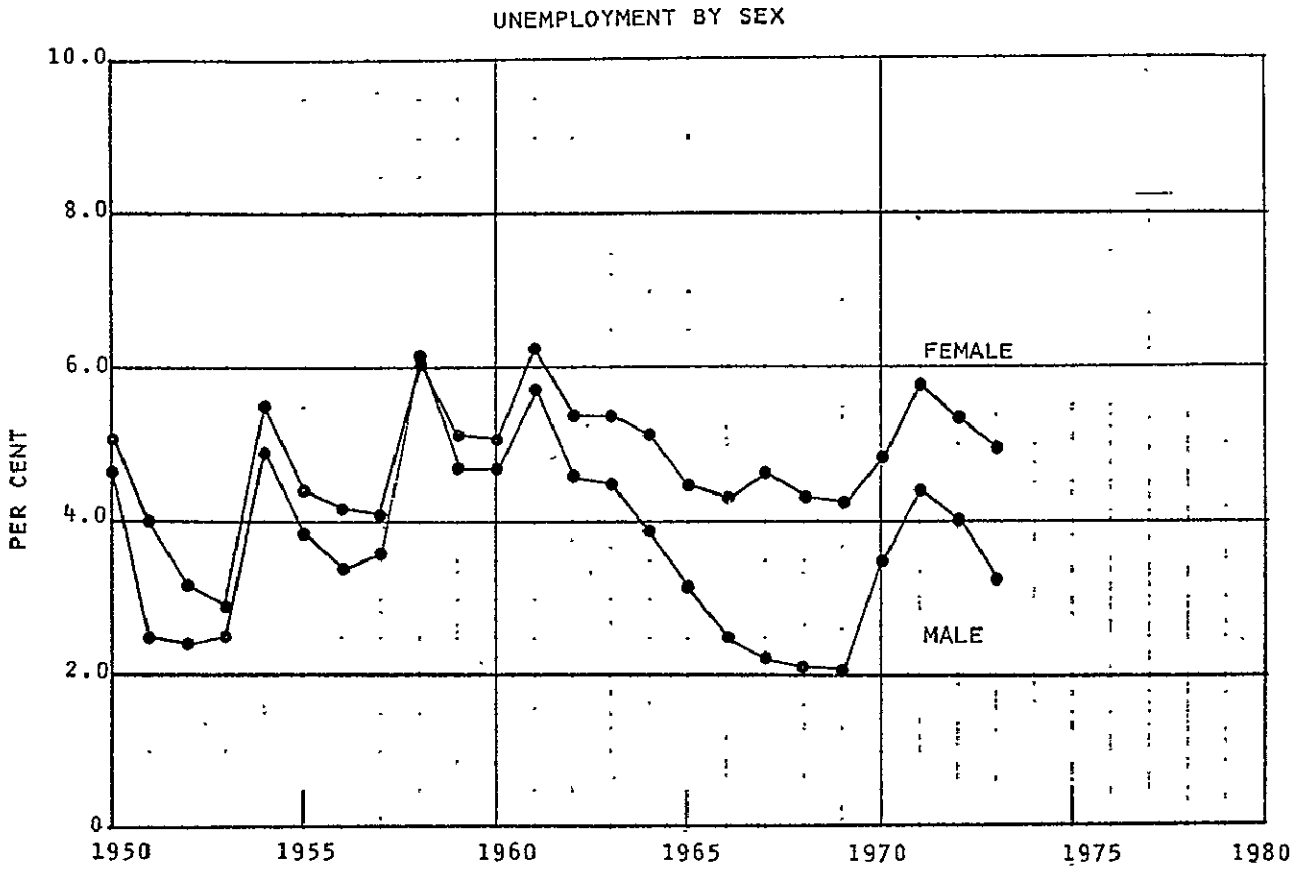
UNEMPLOYMENT BY SEX
PER CENT
10.0
8.0
6.0
4.0
2.0
0
1950
1955
1960
1965
1970
1975
1980
FEMALE
MALE

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NATIONAL AND INTERNATIONAL CAPITAL SHORTAGES SLOWING, PERHAPS PREVENTING, AMERICAN ECONOMIC GROWTH AND LEADING TO A DECLINE IN THE DOMESTIC STANDARD OF LIVING

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ISSUE: NATIONAL AND INTERNATIONAL CAPITAL SHORTAGES SLOWING, PERHAPS PREVENTING, AMERICAN ECONOMIC GROWTH AND LEADING TO A DECLINE IN THE DOMESTIC STANDARD OF LIVING

The Issue:

It may well be that the capital shortages that the United States will soon experience will be the most serious problem facing this country in the next several decades. All the problems besetting the nation have generated a host of technological research priorities, actions and strategies that should be implemented by the United States, yet all require massive capital investment.

The discussion has identified major problem areas in American society that will demand a tremendous influx of capital over the next several decades if there is any hope of maintaining the high standard of living to which Americans are accustomed. These critical problem areas include:

- obsolete plant and equipment in American industry
- demands for pollution abatement, prevention and control equipment
- fundamental retraining of the U.S. labor force to combat structural unemployment and changing labor demands of the future
- restoration, rebuilding, expansion and replacement of American cities
- substantial additions to and replacement of the nation's housing stock
- rebuilding or replacement of the nation's railroads
- tremendous maintenance requirements of the capital improvements of the last two decades including the demands of a federal highway system, proliferation of the public school and college system, and the maintenance requirements of a massive public water, sewer and sanitation system
- the massive capital investments required for research, development, construction, implementation and maintenance of an exponentially growing energy system.

It is evident that the total price tag of these demands is in the trillions of dollars; and it is also clear that the likelihood of meeting these requirements is quite slim indeed. Treasury Secretary Simon has suggested that U. S. capital requirements could approach $4.5 trillion by the year 1985, approximately three times the level of the recent past.[1] Estimates of the capital shortfall -- that is, the difference between savings and demand for investment capital -- range up to $1.5 trillion for the same time period.

A brief review of the current economic dilemma indicates the magnitude of the problem. For instance, the discussion of energy shortages elsewhere identified potential technological innovations that could, if implemented adequately supply domestic energy demands, but all require billions, perhaps trillions of dollars of investment. Simultaneously, any efforts to develop alternative sources of scarce raw materials or to develop technological substitutions for the materials also require billions, perhaps trillions, of dollars.

The most conservative estimates suggest that it will require $325 billion between now and 1982 merely to meet *existing* and currently anticipated pollution control requirements.[2] At best, one can assume that this number is a gross underestimate of the real cost to achieve the same goal (and, if there is one thing that the nation has learned, it is that the goal will change as the state-of-the-art changes).

A third pressure for scarce capital is obsolete plant and equipment of American industry. One estimate suggests that 14% of manufacturing plant

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[1] Peter Milius, "The Capital Shortage Issue," Washington Post (July 14, 1975), p.1.

[2] Council on Environmental Quality, Fifth Annual Report on Environmental Quality, 1974 (Washington, D. C.: Government Printing Office) p. 221.

and equipment was obsolete at year end, 1974.[3] Because this represents the results of a survey in which business was asked to judge the degree of its *own* obsolescence, it is likely that the numbers (see Figure 1) are grossly underestimated. The same survey estimates that it would take $197 billion to replace technologically outmoded facilities with the best available, a small number indeed when compared to industry's previous estimates of expenditures required to meet pollution abatement regulations, and further reason to suspect that these numbers are grossly underestimated. It is quite clear that the obsolescence of plant and equipment is dramatically underestimated nationwide. Stories of the United States railroad system, literally falling apart at the seams, appear on the front page of most every newspaper. The United States steel industry, for example, is considerably inferior to its European competitors because of its reliance upon obsolete technology.

It can be argued, and there is supporting evidence, that many of the basic industries that the United States has relied upon in the past for economic growth and development are now so obsolete, so old, and so technologically inferior to that of our foreign competitors that the U. S. is losing its international competitive position. The decline of the American steel industry is the best example of this trend: the European and Japanese steel industry is far superior to that of the U.S. and is slowly gaining market share.

A fourth problem area for the United States is the quality of its housing stock. The majority of the nation's housing was built before World War II,

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3 "The Rising Toll of Obsolescence," Business Week (November 30, 1974) p. 27.

FIGURE 1

HOW BUSINESS RATES THE CONDITION OF ITS PLANT AND EQUIPMENT

	Percent Outmoded Dec. 1974	Percent Outmoded Dec. 1972
All business	11%	10%
Manufacturing	14	12
Durable goods	16	12
Misc. transp. equip.	57	44
Iron and steel	20	15
Nonferrous metals	18	8
Machinery	18	15
Autos, trucks and parts	17	6
Aerospace	17	9
Instruments	15	5
Stone, clay and glass	13	17
Misc. durables	13	10
Fabricated metals	10	14
Electrical machinery	9	12
Nondurable goods	13	12
Rubber	21	13
Misc. nondurables	18	10
Food and beverages	17	14
Paper and pulp	14	18
Textiles	13	20
Chemicals	10	14
Petroleum	9	8
Nonmanufacturing		
Railroads	19	16
Misc. transportation	17	16
Communications	12	7
Mining	11	6
Airlines	10	1
Commercial	8	10
Electric utilities	5	5
Gas utilities	4	2

Source: McGraw-Hill Publications Co. Economics Dept.
Business Week, November 30, 1974.

and the lifespan of a housing unit is thirty years (clearly, housing units can be made to last longer than this, but not without substantial improvements). Almost 8% of the occupied housing is already substandard (i.e., dilapidated and/or lacking some or all plumbing), and almost 10% of the population lives in crowded housing (i.e., more than one person per room). The number of households are growing at the rate of about 1.5% a year.[4]

This means that a large proportion, perhaps as much as all, of the nation's housing stock must be replaced or completely renovated before the end of the century to replace the decaying housing stock, provide standard housing for those that do not have it, and accommodate population growth.

Finally, capital requirements are increasing because of the complexity of large-scale technological systems. Large-scale, complex, technological systems are here and they will remain in order to benefit from the economies of scale as well as the technical requirements of the processes upon which they are based. Such complexity increases cost by increasing the minimum size and increasing the start-up costs of the enterprise. Because of the large-scale of the plant, the initial investment required is, of course, substantially higher than the average start-up costs 50 years ago. The size of chemical processing plants and oil refineries that are being built today are, for instance, much, much larger than those of even ten years ago. Substantial economic benefits result from such economies of scale that accrue from centralization and vertical integration of functions; however,

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[4]Executive Office of the President: Office of Management and Budget, Social Indicators 1973 (Washington, D. C.: Government Printing Office) 1973, p. 206-210.

initial costs are substantially greater, whatever the potential average and marginal costs may be. Because of the tremendous scale involved, the risk is higher, and hence, the cost of capital will be higher.

Capital costs will be initially higher because the vulnerability is greater. Such large-scale technological systems are exceedingly vulnerable to breakdown, terrorism and accident as can be seen by the vulnerability of the Northeast to the 1965 power blackout and New York City to the February telephone disruptions. The difficulties that currently are being experienced with nuclear fission plants again indicates the vulnerability of these large-scale systems to even small and misleadingly insignificant malfunctions.

The economics of the future dictate that massive efforts be devoted to improving the efficient and effective use of such scarce resources as materials, skilled manpower, energy, capital and entrepreneurial capability. This demand for increased efficiencies implies that the reliance upon large-scale systems will increase; therefore, the cost will increase, the risk will increase, and the vulnerability will increase.

Dimensions of the Problem :

The historic rate of economic growth that the United States has achieved has been accomplished by massive capital investment and the gradual substitution of capital for labor. The United States has one of the highest capital/labor ratios in the world. The achievement of this rate of growth has largely been accomplished by increasing the productivity of capital through technological advancement. Hence, when we speak of a capital shortage we are referring to the problem of both absolute capital availability as well as the productivity of that capital. As is well known, the rate of increase in the productivity of labor in the United States has been declining in most industries. To a large extent, this reflects the productivity of capital because the major way of increasing the productivity of labor has been to increase the capital and technological intensity. A separate problem relating to capital shortages is the reliance upon the service industry. The greatest productivity gains have been made in agriculture, followed by manufacturing. Now, more than 50% of the labor force is employed in the service industry, an industry that has been largely impervious to productivity improvements, technological change and has remained a labor intensive industry.

There is considerable historical evidence that the current economic difficulty in the United States may stem in part from inadequate capital investment in the past. The fact that the United States is experiencing increases in productivity that are below those of other industrialized Western nations is well known. From 1960 to 1973 output per worker grew 2.1% annually in the United States while it grew 9.2% annually in Japan and 5.4% annually in Germany. The underlying cause for this can be found by examining the differential rates of capital investment. During this same period of time, the Japanese diverted 29% of their total economic output annually to capital investment in new plants and equipment, the West Germans 20%, the French 18.2%, the British 15.2%, and the Italians 14.4%; but the United States invested only 13.6%.

In addition to the productivity differences, the low rate of capital investment is directly responsible for many of the shortage and capacity problems in key materials industries. The shortage of petroleum refining capacity, chemicals and steel capacity (which in turn contributed to massive bottlenecks in other industries and inflation), was due to the direct results of insufficient capital investment. In fact, the steel industry has estimated that merely to meet expansion requirements they will have to spend $3 to $4 billion annually through 1980 to meet the capacity requirements of 175 million tons in 1980, up from 150 million tons in 1973.[5] Inadequate capacity of the domestic steel industry has contributed to the phenomenal growth of the Japanese and West German steel industry.

Many industries suffering from insufficient capacity have blamed it on the federal environmental standards. Requirements for pollution abatement equipment have siphoned off capital from much needed investment in capacity expansion. They also argued that strict adherence to federal pollution mandates has forced some industries to abandon some particularly old factory sites because of the prohibitively high costs of meeting the requirements of the law.

While there may be some truth to these arguments, they are rather short-sighted explanations for the problem. The capacity dilemma is a function of the industry's shortsighted economic planning, as well as the known relationship between shortages and high prices. As editoralists have indicated, the interests of the oil companies and the interests of the nation are not always synonymous. Finally, industry (especially the steel and paper industry, where capacity problems are greatest) has avoided coming to grips with the pollution problem for years. Hence, their current dilemma cannot be blamed upon "surprise" government regulations.

The great problems that face the nation in the decades ahead will require tremendous technological improvements. In most cases it does not require the development of new technology, but rather large-scale implementation of existing technology that has not heretofore been implemented

[5] "Finding Capital for U. S. Industry," <u>Business Week</u>, (September 14, 1974) p.108.

because of cost. Pollution control is an example of a problem which if it had been dealt with incrementally as it occurred, the capital costs would have been substantially less, and the marginal cost would have been tolerable to industry and consumer alike. The fact that such measures were postponed until the situation quite literally became life-threatening has increased costs of the actions which now must be taken. A similar situation is true with respect to energy shortages. Had ongoing exploration and development programs been continually underway, it is likely that the present dilemma would not be as severe.

Just how great are the demands for capital? It has been conservatively estimated that to support real economic growth of at least 4%, the U.S. must invest from $2 trillion to $4.5 trillion between now and 1985. In a similar time period between 1962 and 1973, the U. S. invested about $1.5 trillion.[6] Even these estimates are thought too low by some. Assuming a 4% rate of growth this level of investment is equivalent to about 15% of GNP, about the same as the historical level of investment. Some industry and government spokesmen suggest that because of energy and environmental problems the level of investment may have to reach 20% of GNP.

These kinds of capital demands are thought to lead inevitably to shortages. The New York Stock Exchange, not known for its radical positions, has estimated that there will be a capital shortfall of more than $600 billion through the year 1985.[7] This represents a gap between

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[6] D. W. Sonner and J. S. McClenahen, "Where Will Industry Get Its 'Survival' Funds?" Industry Week (September 9, 1974) p.36-36.

[7] The New York Stock Exchange, The Capital Needs and Savings Potential of the U. S. Economy, Projections through 1985, September 1974.

savings, both corporate and personal, and the uses of the funds, as displayed in Figure 2.

The conclusions regarding the severity of the impending capital shortages are by no means unanimous. Other organizations question the legitimacy of the problem. First National City Bank, confident that inflation as well as higher interest rates will soon be over, believes that fears of a capital shortage will dissipate with such inflation. They argue that fear of a capital shortage is a psychological concommitant to continued inflation and high interest rates and as those problems dissipate, so will the fears.[8]

Brookings Institution feels that with a near full employment economy there will be sufficient demand as well as capital. They conclude "that with normal growth and without unusual sacrifices the economy will be able to meet the capital demands that can be reasonably projected for the remainder of the decade."[9] It is this underlying assumption of these two organizations that we question. It is becoming increasingly difficult to expect or hope that the economy will soon rebound and that full employment or anywhere near "normal growth" will soon occur. Without such economic growth, even First National City Bank and Brookings question the ability of the nation to meet capital needs.

As the discussion below will indicate, it is likely that the New York Stock Exchange's estimate of a capital shortfall is, in fact, an optimistic statement. If the United States is to maintain the standard of living to which its citizens are accustomed, then a tremendously enlarged pool of capital must be made available to business and industry.

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[8] "The Facts and Fallacies of a Capital Shortage," First National City Bank Letter, December 1974, p.5-7.

[9] Barry Bosworth, James S. Duesenberry, Andrew L. Carron, Capital Needs in the Seventies (Brookings Institution: Washington, D.C.) 1975, p.3.

FIGURE 2

SOURCES AND USES OF FUNDS
Cumulative 1974-1985
(Billions of Dollars)

Sources of Funds		
Business Saving		$2,923
Capital Consumption Allowances	$2,359	
Corporate Retained Earnings	564	
Personal Saving		1,109
Total Sources of Funds		$4,032
Uses of Funds		
Gross Private Domestic Investment		$4,503
Plant and Equipment	$2,568	
Residential Construction	1,085	
Other	850	
Financing Federal Deficits		42
Net State and Local Government Financing Requirements		30
Net Sponsored Credit Agency Borrowing		103
Total Uses of Funds		$4,678
Saving Gap		($ 646)

Source: The New York Stock Exchange, The Capital Needs and Savings Potential of the U. S. Economy, Projections Through 1985, September 1974, p.16.

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How did this capital shortage come about? Part of the shortage is a supply related problem, and part of the dilemma is a demand related phenomenon. The sections below will detail the specifics of the major demand categories, but it is important to note here some general characteristics about the market forces of supply and demand of capital.

The Supply of Capital: The supply side of the question is characterized by fundamental institutional problems. There are only three methods available for industry to raise capital: drawing upon its own savings (retained earnings), selling equity in the corporation to investors, or finally, debt financing either by selling bonds or otherwise participating in the capital market. All three of these traditional avenues to capital have been adversely affected by changes in institutional and consumer behavior in recent years.

Despite the brief surge of high profits in industry in the past two years, this appears to be a short-run phenomenon that was largely inflation induced. Most experts agree that profits are likely to be severely constrained for U. S. industry over the next few years. The ability to finance internally is decreasing. The difficulty in borrowing capital is well known. In addition to unprecedented high interest rates, the capital pool used for borrowing is simply not available. Bankers themselves are predicting that they will be unable to provide sufficient loan capital if the economy rebounds as is projected by the administration. They blame an inadequate capital structure supporting the banking network as reflected in the recent failure of several large banks because of overstretching their commitments. E. H. Yeo III, the vice-chairman of Pittsburgh National Bank has said

"I personally don't believe (that the nation has) the financial base for a (sustained) economic expansion." Because of inadequate capital, "the banking system's share of total financing will shrink in this recovery from those of past recoveries."[10]

The third avenue of capital formation is selling equity positions to investors. This is the most traditional and historically successful way of raising capital, and it is this mechanism that is most severely constrained and hampered by the behavior of financial institutions. It is generally agreed that institutional investment in "favored stocks" has been so great, and the potential impact of selling and buying large blocks of stock by the institutions so great, that the institutional investor (pension funds, banks, trust funds, etc.) has had a negative impact on the availability of capital for several reasons. Business Week has said that:

> "Institutional concentration in a tiny handful of high-priced, high-visibility securities has driven most stocks down to historically low ratios. Unable to raise new equity, companies are contracting ever-increasing interest costs that cut down their existing equity's attractiveness. Except for the benefit of a few famous institutional favorites, the equity markets have ceased to fulfill their primary purpose. Stock issues have effectively ceased. In just the first six months of 1973, more than 300 offerings were withdrawn as unsalable. The stream of equity capital to U.S. industry has run dry."[11]

The lack of equity capital then forces industry into relying upon greater and greater debt financing, and the gradual shift in the debt/equity ratio renders the equity offerings continually more unattractive. The debt-equity ratios of industrial companies have shifted from 25% to 40%, in just

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[10] Edward P. Foldessy, "Bankers Doubt Ability to Meet Loan Needs if Economy Rebounds," The Wall Street Journal, (June 13, 1975) p.1.

[11] "Can U. S. Industry Find the Money it Needs?," Business Week,

the past ten years.[12] This, then, forces the firm into greater debt still or forces them to abandon expansion plans further aggravating capacity problems and contributing to the escalation of prices (as does the high cost of debt financing). The U. S. economy (government, corporate and individuals alike), is in greater debt than ever before in history. Corporate debt amounts to more than 15 times after-tax profits, compared to under 8 times in 1955.[13]

The role of institutions in the capital markets is difficult to quantify, yet all the evidence suggests that the increasing concentration of corporate assets in the hands of a few financial institutions is having a strongly negative impact on the ability of the nation to raise capital. Banks have always kept their trading positions confidential and their control of industrial equity is not well known. However, estimates suggest that banking institutions own about 40-45% of the equity of U. S. corporations, but that their role is increasing while the role of the individual investors is declining at a fast rate; perhaps the shift from individual to institutions may amount to as much as $40 billion a year.

In addition to the assets controlled by the banks and the banking trust funds, are those assets controlled by pension funds, educational endowment funds, privately controlled trust funds, tax exempt foundations and other institutions. This increasing concentration of the capital assets in the hands of a few conservative organizations intensifies the inability of the

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[12]"The Crushing Burden of Corporate Debt," Business Week (October 12, 1974), p.54.

[13]"The Debt Economy," Business Week (October 12, 1974), p.45.

"non-glamour" stocks to attract buyers, and decreases the willingness of the capital markets to take risk. Such organizations traditionally devote large portions of their portfolios to the Blue Chip stocks, to the detriment of the others. Since these organizations operate in secrecy and there is no regulation governing the percentage share of a firm that the institutions can control, the industrial organization may become increasingly vulnerable to the actions of a few large institutional investors. If one of these investors decided to unload their ownership in a particular stock, it could be sufficient to depress the value of that stock for some time to come. In hearings before Senator Bentsen's subcommittee on financial markets, C. V. Wood raised the quite legitimate fear: "Will America follow the pattern of Europe -- where the economy is controlled by a few great banking houses?" By concentrating their ownership in a few stocks they have contributed to the downward spiral of the value of stocks, as well as continued to force the individual investor out of the market.

The decline of the individual investor can be explained by several distinct phenomena. Surveys by the New York Stock Exchange, the Securities Industry Association, and Arthur D. Little have all come to the same conclusion concerning the exodus of the individual investor: over 70% believe that the market is manipulated. No doubt, many of the recent stock market frauds, the increase in stolen securities, and the alleged prevalence of insider information has done little to increase consumer confidence. Secondly, the increasing prevalence of social security and pension plans have muted the need, to some degree, for insuring financial security for the future through direct investment in the stock market. Thirdly, as an investment alternative, more and more individuals are choosing land and real estate as the only possible hedge against inflation. The increasing speculation in land and the rising ownership of second and vacation homes is a competing use for savings, and often a more successful venture. Finally, investing in the stock market is associated with overall confidence in both the national economy as well as the individual's personal economic fortune. Confidence in both aspects is probably at a thirty year low.

Venture capitalist entrepreneurs are a final source of equity capital. But since they contribute only an estimated $100 million a year, their influence upon the capital supply picture is almost negligible. In addition, the same kinds of conservative no-risk influences which are affecting other areas of the capital market are affecting the venture capitalists.

The Demand for Capital: Much of the current demand for capital results from the postponed investment and research of the past. In many areas this occurred because of artificially low prices which generated no incentive for further investment (i.e., the domestic energy industry). In other areas this occurred because the benefits that were to accrue from the investment would be for the common societal good, rather than for the corporate good; and in the absence of federal mandate, there again was no incentive (i.e., pollution abatement and consumer product improvement).

Another category of capital demand comes from the lack of maintenance and deterioration of existing plant and equipment. The nation's railroads, the city core, much of the national infrastructure and publically owned buildings and plants have drastically become dilapidated from insufficient upkeep.

A final pressure comes from changing assumptions and operating considerations of the current environment. The era of plentiful resources is over, the era of American economic, military and technological hegemony is over, and the era of unrestricted business and industrial activity is over. Instead, the one world economy has appeared, combined with a fundamental shift in the relative position of the factors of production in the United States.

The industrial machine established drives during the Industrial Revolution were based on expensive and scarce skilled labor, and cheap, easily available resources, capital and land. Hence, existing industrial processes are wasteful of material and resource inputs, allow for little if any recycling, and make most efficient use of their historically scarce commodity, labor. Now the tables are turned. Resources and material are extremely scarce, while the current labor problem is an abundance of overeducated, underemployed or unemployed productive workers. Shifts in the fundamental way that business and industry does business is capital intensive. However, many observers are optimistic about the nation's ability to accomodate to these changing circumstances.[14]

The following sections detail the areas of especially high capital demands through the end of the century.

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[14] Glenn Hueckel, "A Historical Approach to Future Economic Growth," Science Vol. 187 (March 14, 1975), p. 925-937.

Energy: One of the greatest sources of demand for capital in this country will come from the strain of increasing the national energy capacity to meet rising demands in the face of curtailed supply. The needs for massive investment in the domestic industry stem from several problem areas. One, of course, is the heightened reliance upon imported petroleum supplies and the instability of this energy supply. Extrapolation of consumption and demand trends indicate that for demand to grow as it has in the past would require that as much as 65% of the domestic energy supply would have to be provided by imports by 1985 if no new domestic sources of energy supplies could be found. This astounding reliance upon imports is up from only 17% in 1973.[15] Clearly, this increasing reliance upon imported energy in a period of such international uncertainty is a dangerous economic and security risk for the United States.

A second demand for energy capital comes from inadequate petroleum refining capacity in this country. Because of the lack of incentive to increase refining capacity during periods of low cost energy, the national refining capacity is well below national requirements.

A third pressure is that easily available domestic energy resources, in the technological and economic sense, are depleted. The only large supply of an easily available domestic energy source is 1.5 million acres of coal deposits in the Western United States that can be surface-mined (i.e., stripped).[16] However, it is estimated that the costs of rehabilitation

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[15] National Academy of Engineering, U. S. Energy Prospects: An Engineering Viewpoint (Washington, D. C.: 1974) p.20.

[16] National Academy of Sciences, Rehabilitation Potential of Western Coal Lands, A Report to the Energy Policy Project of the Ford Foundation (Ballinger: Cambridge) 1974.

of the stripped land could exceed $2,700 *per acre,* exclusive of an estimated $500 - $2,000 per mile cost of road rehabilitation.[17] Hence, these costs somewhat belie the "ease" of access.

A final pressure for capital investment in the domestic energy industry is the general insufficient capacity of the United States energy industry. Again, because of low energy prices there was little incentive for the energy industry to devote resources to exploration, and research and development of alternative sources of energy. At the same time, the financial position of electric utilities and the aggressive opposition to nuclear power plants dramatically slowed down and increased the cost of electric power plant construction. Hence, the capacity problem threatens all aspects of the energy supply and transmission system.

The petroleum situation is especially capital intensive and a major area of potential capital shortages. Even if the consumption of oil fails to grow at all beyond the present, a highly unlikely assertion, consumption of oil in the 1970 to 1985 period will still result in the use of twice as much petroleum as in the preceding 15 years. Chase Manhatten believes that a more likely projection is that the annual rate of growth in the use of oil will decline by about half, from 7.5% annually for the 1955-1970 period to about 4% annually from now through 1985. Chase indicates further that for the international petroleum industry to meet this minimum forecast for petroleum demands requires that it find and develop a total of 600 billion barrels of new oil between 1970 and 1985. They further calculate that even with the assumption of halving the growth rate in petroleum usage, the international petroleum industry will have to invest $1.2 trillion between 1970 and 1985 to meet the capital requirements for capital and exploratory

[17] Ibid, p.88.

purposes, refineries and processing facilities, tankers, pipelines, environmental equipment, distribution networks, and debt servicing, working capital and maintenance. This level of investment for the next fifteen years is *treble* the $375 billion dollars actually spent by the petroleum industry in the preceding fifteen years.

Chase expresses concern over the potential sources of this capital and suggests that because of the high risk involved in oil activities, the Western countries' capital market will be unlikely to provide more than $240 billion so that the bulk of the funds (40% or $460 billion) must come from industry profits. To meet these requirements, the international petroleum industry must have an astounding rate of profit amounting to a total level of $845 billion by 1985. This investment will be required merely to provide the world's petroleum supply, regardless of alternative energy sources.

The amount of capital required merely to meet the United States energy dilemma is equally huge. Chase suggests that the domestic oil industry will require $200 billion by 1985.[18] While the estimates for total domestic energy requirements vary depending upon the assumptions of oil prices and the level of petroleum imports, it is generally ascumed that to meet domestic requirements will require a cumulative investment of from $350 to $500 billion by the year 1985.[19] Figure 3 presents the range of estimates from different sources. All sources assume some degree of energy conservation and substantial programs designed to increase the energy self-sufficiency of the country.

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[18] "Can U. S. Industry Find the Money it Needs?". Business Week.

[19] Estimates of the National Petroleum Council, National Academy of Engineering, Arthur D. Little, Inc., and the Federal Energy Administration.

FIGURE 3

COMPARISON OF CAPITAL REQUIREMENTS ESTIMATES

Cumulative 1975 - 1985
(Billions of 1973 Dollars)

Activity	NPC (a)	NAE (b)	ADL (c)	FEA Accelerated Supply Without Work in Progress (d)	FEA Accelerated Supply
Oil & Gas (including refining)	133	149	122	80.3	98.4
Coal	8	18	6	10.6	11.9
Synthetic Fuels	10	19	6	.6	.6
Nuclear	7	93	84	105.3	138.5
Fossil fuel electric power plants	137	53	43	50.5	60.3
Electric Transmission	42	125	90	92.1	116.2
Transportation	43	-	43	25.5 (e)	25.5 (e)
Other (f)	-	-	8	2.2	2.2
TOTAL	380	457	396	367	454

(a) U.S. Energy Outlook, a summary report of the National Petroleum Council, Washington, D.C., December 1972 (Average of four supply cases).

(b) U.S. Energy Prospects, An Engineering Viewpoint, National Academy of Engineering, Washington, D.C., 1974.

(c) Arthur D. Little estimates based upon an energy conservation scenario.

(d) Assumes that imported oil price is $11/B. This column is considered roughly comparable to the NPC, NAE, and ADL estimates with the exception of oil and gas capital and the inclusion of replacement capital costs for each activity. The FEA estimates for oil, gas and refining do not include lease rentals and bonus payments, hence these items must be added to obtain comparable costs. In order to make the FEA oil and gas figures comparable to the other estimates, $107.4 billion should be added to the FEA oil and gas estimates. Work in progress consists of investment spending made prior to 1985 for new plant and equipment which will not come on line until after 1985.

(e) Does not include investments required for tanker fleets, but does include $5.5 billion targeted for Trans-Alaska pipeline.

(f) Solar, Geothermal, Municipal Waste Treatment Plants, and Shale Oil.

Source: Federal Energy Administration and the Federal Reserve Board, Project Independence: Task Force Report - Finance (Government Printing Office: Washington, D. C. November 1974, p.21.

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It is not clear whether either the national lending institutions or the utilities and energy companies themselves can meet these levels of investment. Historically, energy capital investment has accounted for about 23% of the total fixed business investment, which in turn has comprised about 10.4% of total GNP (less than other Western industrialized countries). To meet the energy investment demands, total business fixed investment must command a larger portion of GNP (perhaps up to 12% of GNP) and energy investment in turn must command a larger portion of fixed business investment, from 25 to 30% of business investment. Even then, it is not at all clear if the capital investment needs can be met.

The ability to meet these demands for capital are a function of the investment capital pool that is available, and this in turn is a function of the savings ratio and the GNP growth. While the savings ratio has been consistently high in recent years; high unemployment, declining GNP growth, and declining rates of growth in personal income are all having a negative impact on the capital pool available for borrowing. The ability to internally finance large scale projects is hurt drastically by the declining rates of profit and the high costs that must be paid for equity participation.

While the Federal Energy Administration is confident of the ability of the nation to meet the capital requirements of the energy industry, their analysis is made on the assumption of an annual real GNP growth of 4%, a figure unlikely to be met for some time. A second constraint, which the FEA admits to, is that while the aggregate levels of capital may be attainable (a conclusion which many analysts do not believe is warranted), there are likely to be sectoral problems within the industry. For instance, electric utilities will require $365 billion by 1985 (compared to only $75 billion in last ten years), only about 35% of which is expected to be funded internally.[20] The particularly unfavorable investor position of the utilities is expected to make capital financing of the remainder particularly difficult.

There is no question that the continuing energy crisis will put extreme pressure on the nation's ability to provide sufficient capital investment. Yet the continuing lack of a coordinated energy policy is likely to exacerbate the capital shortage problem because of the continuing drain of dollars to the OPEC nations -- another stress on the capital supply system.

Housing: Another major category of demand for capital that will strain the nation's productive capacity is the demand for new and improved housing. The housing crisis is not new and has been the object of concerted government policy since the passage of the Housing Act of 1937, the first efforts to provide housing for the poor. Government housing policy, whatever its intention, has resulted in massive increases in home ownership by the middle and upper income groups, with little impact upon the housing needs of the poor. However, the subsidy of home ownership has contributed substantially to the now unrealizable goal of single family housing for all. The National Commission on Urban Problems concluded in 1968:

> "The intent of Government policy [i.e., housing policy] -- and its effect -- has been to increase substantially the rate of home ownership. The extent to which Government policy has subsidized the private homeowner is not generally recognized or acknowledged...This generous but generally unacknowledged Federal subsidy to the affluent or middle-class homeowner needs to be emphasized in view of the self-righteous opposition often expressed toward subsidized housing for the poor."[21]

The Commission noted the importance at that time of the necessity of the rates of housebuilding to exceed the rate of household formation to

[20] Sommer and McClenahen, op.cit., p.38.

[21] Building the American City, Report of the National Commission on Urban Problems to the Congress and to the President of the United States, (Government Printing Office: Washington, D. C.) 1968, p.66.

compensate for crowded, substandard, and required vacant housing. During the fifties and early sixties this ratio was 1.5-1.7 (that is, 1.5 housing units were built for every household formed). Assuming that the 1.5 ratio could be maintained, the Commission thought it was possible to be well on the way to solving the nation's housing problem by 1990. If the ratio could be sustained through 1990, at that time the aggregate national housing need would be only 5.7 million units, a little more than one-third of the 1960 figure.[22]

However, these figures have *not* been maintained and while the housing situation has improved since the drastic shortages of the post World War II era, there is every indication that the nation will essentially have to build the equivalent of the existing housing stock to meet the needs of the year 2000.

The demands for housing come from several sources. The first is the obvious pressure from a growing population and the need to provide housing for new household formation. Between 1970 and the year 2000 the number of households is expected to increase about 37% from 63.4 million to about 101 million. Hence, immediately, all other things equal, an additional 37 million housing units are required.

An added pressure is that the rate of household formation is growing even assuming the lower birth rates. This is a cultural change, largely due to increased mobility and affluence of the population. In the past, children, especially women, lived at home with their parents until their marriage, and

[22] Ibid, p.71.

even after that until the young couple became financially secure. Concomitantly, the elderly and retired population often lived with their children, especially if widowed or otherwise left alone. The gradual collapse of the extended family as well as the change in attitudes made possible by increasing affluence have since increased the tendency for these population groups to form their own households. Despite the growing communal movement, it is still likely that households will become smaller, putting further demand on the housing supply.

A second pressure on the demand for housing is the quality and age of the existing housing stock. While tremendous gains have been made in the improving of the quality of the available housing stock, a substantial amount of inadequate housing still remains. In 1940 more than 48% of the households lived in substandard housing units (defined as dilapidated and/or lacking in some or all plumbing); by 1970 this had declined to slightly more than 7%. However, of rental occupied housing, that which the poor most often occupies, over 11% is substandard.[23] It is important to remember that maintaining a standard housing supply is an on-going, up hill battle. Because the average life span of a housing unit is about thirty years, constant renovation and rehabilitation of the existing housing stock must be made. Hence, while the percentage of substandard housing can be effectively reduced to zero, housing rehabilitation must be maintained to sustain the quality of housing.

While there was a surge of housing construction during the sixties, the current housing supply is extremely tight. The national vacancy rates are approximately 2%. In addition, the cost of housing is such that the majority of the American public can no longer afford a single family home. The

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[23] Office of Management and Budget, Social Indicators, 1973, (Government Printing Office: Washington, D.C.) 1973, p. 207.

average price of new homes is $36 - 37,000, a purchase price which requires a minimum of income of $18,000 to sustain. The age of the housing stock is increasing as well. Over one third of the nation's housing was built in 1939 or before. This represents a potential drain on capital resources because the average housing unit life expectancy is only 30 years. After that time, the housing unit requires capital investment equivalent to its replacement costs to refurbish roofs, electrical, plumbing and heating systems, etc.

It seems quite likely that it will be necessary to build at least the equivalent of our existing housing stock by the year 2000 to meet population growth between now and the year 2000; to meet the rising expectations about standards of living and household formation; to accommodate vacancy allowances, existing crowding and substandard dwellings; and to allow for those dwellings which will deteriorate. The capital costs for this level of construction will be substantial. A minimum investment cost would be $1 trillion exclusive of land, site, and development costs. This grossly underestimated number assumes that there is no further deterioration of the housing stock (a futile assumption), that new housing units will be high density, multi-family units (again, a futile assumption given today's values), and finally, that housing costs do not increase over their current level (in constant dollars).

It seems more likely that the total cumulative investment required for new housing construction, land development and maintenance costs will exceed $3 trillion between now and the year 2000, an investment equivalent to $100 billion annually for thirty years, beginning in 1970 (in constant dollars), and an investment equivalent to *four* times the total housing investment in 1970.

The dimension of the investment required is confirmed in a recent study by General Electric. They conclude that housing will be the major capital need of the country between now and 1985, and the capital requirements exceed those of electric utilities and the energy industry. GE estimates that between 1974 and 1985 the housing industry will require capital investment amounting to over $1.1 trillion.[24]

It is evident that the United States cannot quadruple, or even double its level of housing investment in the critical capital shortage years ahead. It is clear that the housing standards of the average American -- a single family detached dwelling on a privately-owned plot of ground -- is no longer an achievable goal for the nation's future. In addition to the extraordinary high construction cost of a conventional single family home (the average price of a newly constructed single family home is currently $36,500), the conventional mode of residential construction and sprawl is highly wasteful of material and land resources, as well as inefficient in its use of utility services such as heating, sewage, water and electricity. A recent study[25] of the comparative costs and impacts of alternative residential development schemes concluded that the low density sprawl community (that is, the entire community is made up of single family homes, the typical configuration of suburban development) requires 44% higher total investment costs than the high density planned community (that is, 40% high-rise, 30% walk-up apartments, 20% townhouses and 10% clustered single family homes), and 21%

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[24] Reginald Jones, Chairman of General Electric Co., in Sommer and McClenahen, op.cit., p.37.

[25] Real Estate Research Corporation, The Costs of Sprawl: Detailed Cost Analysis, Executive Summary (Government Printing Office: Washington, D.C.), April 1974.

more costly than the combination mix community (that is, a community mix of 20% of each of the following, single family conventionally located, single family clustered, townhouses, walk-up apartments and high-rise apartments). The largest cost savings in the high density planned community accrue from the construction costs of residential dwellings, although important savings are attributable to reduced costs as well in roads and utilities, which are about 55% lower in the high density than in the low density community.

Probably of even greater interest is the fact that the higher costs of conventional low density single family dwellings are not limited to the initial investment costs but are manifested elsewhere as well. For instance, while seemingly counter-intuitive, pollution is greater, and the costs of abatement higher, in the low density development. Air pollution in residential areas stems from automobiles and heating -- both of which are more efficiently used in high density planned areas. The concluding remarks of the study are strong in their advocacy of high density planned communities: "The results of the study, show a surprising consistency: 'planning' to some extent, but higher densities to a much greater extent, result in lower economic costs, environmental costs, natural resource consumption, and some personal costs for a given number of dwelling units."[26] It appears that the United States cannot afford the single unit conventional residential plan in the future.

There is another avenue of policy intervention which is likely to facilitate more inexpensive housing. This has to do with the possibilities of

[26] Ibid, p.6.

industrialized housing and the relationship of low cost housing to housing codes and standards and the position of the craft unions.

It seems clear that the only way to stem rising housing costs and ensure a supply of adequate housing in the future is to reduce the unit costs of housing. While high density living reduces unit housing costs, further economies of scale could result from industrialized housing; that is, the reliance upon prefabricated housing components and appliances, considerable economies of scale accrue from modules and service cores. Essentially, industrialized housing reduces housing costs in two ways. One, considerable economies of scale are obtained from the assembly line manufacture of particular housing components (e.g., kitchen cabinetry/appliance networks) which reduce unit costs. Secondly, by increasing the amount of fabrication and construction that can be done off-site rather than on-site, the ratio of industrial labor to craft labor can be increased, thereby reducing the costs of labor.

However, two factors impede the more widespread and rapid growth of industrialized housing: unions and housing standards. Union intransigence is often cited as one of the obstacles to lower cost housing and industrialized housing. This is a legitimate complaint. However, the unions have a legitimate complaint as well -- their work is dangerous, seasonal, subjective to ever so slight economic disturbances and the whims of Federal Reserve Board policy. Hence, their intransigence is the only method they perceive available to ensure economic security. This barrier could be overcome through enlightened labor-management bargaining.

A more difficult barrier is the variety and differences among local building standards and codes. The variety of requirements has effectively precluded extensive use of industrialized housing components to date. Housing specialists have long cited the need for national housing standards that are uniform except where specific local anomalies, such as earthquakes, necessitate more stringent requirements. Such uniform standards would permit greater factory preparation of housing components, and hence, reduced costs.

Another argument recently advanced against the current housing regulations is that the codes demand a higher quality of housing than the population can afford, and higher than that which is required for maintenance of health and safety. This argument suggests that the poor, who can ill-afford it, are forced to pay for level of housing in excess of what they desire and in excess of what they can spend. Rather than improving their quality of life, this housing standard actually detracts from their lifestyle because the large proportion of their income that must be allocated to housing reduces the amount of money available for other necessities.

While the housing situation appears bleak, it is a situation which is readily amenable to implementation of existing technology. However, as with other fundamental social problems, the questions is not one of technological amelioration, but rather institutional flexibility and adaptability.

Environmental Protection and Pollution Abatement: There is little argument that cleaning up the environment will be a costly venture, but at that point the agreement breaks down. Estimates of the cost of meeting environmental standards range from the low estimated of the government of $325 billion to industry's high estimate of close to $1 trillion by 1983 -- the real figure is probably somewhere in between the two estimates.[27]

[27] Council of Environmental Quality, op.cit., p.221.

There is considerable controversy among government, industry and the public concerning the dangers of pollution versus the dangers of pollution abatement programs. There is a growing consensus that "we ought to do something," yet this consensus dissipates when the costs and potential impacts are discussed. One reason that pollution abatement programs have not been more successful is the lack of a strong national consensus and commitment to the goal. The public is committed to the program until the reality of additional auto purchase costs of $200, more costly no lead gasoline, and poorer enginer performance hits them. It is not clear that the consumer is willing to bear the costs of environmental protection and pollution abatement, even though he demands such programs.

Industry, of course, is the most outspoken critic and opponent of current environmental legislation and they argue that stringent environmental regulation will have the following negative impacts:

- strain the nation's capital supply
- divert scarce capital from needed exploration, research and development and capacity expansion aggravating material supply problems and contributing to inflation
- render American industry increasingly non-competitive with foreign firms because of the additional costs of pollution abatement
- increase the flight of industry and employment centers from this country to foreign manufacturing sites where pollution legislation is less destructive to industry
- force plants and industry to shut down because the costs of pollution abatement will bankrupt them, thereby causing substantial unemployment and recession
- preclude the possibility of solving the nation's energy crisis thereby contributing to further economic regulation

- reduce the productivity of the nation's farms and raise good prices domestically and reduce the ability of the nation to contribute to solution of the world food problem

- because environmental science is not well understood, the impact of some pollution abatement technologies could be equally hazardous as the pollution itself

- force unnecessary environmental control far in excess of what maintenance of health and safety dictates and merely cause economic dislocation

Of course, industry's opposition to pollution abatement regulation is easily understood and explainable: for the industry itself, it is much cheaper to pollute than to not pollute. As this paper argued earlier, one of the sources of the current dilemma is the development of an industrial machine that is based on the assumption of scarce labor and cheap and abundant materials and resources. This encouraged wasteful and polluting activities and discouraged efforts at recycling or reclaiming some of the useful industrial wastes.

To some degree, the industry arguments are accurate. Some firms undoubtedly will be forced to close; however, it seems reasonable that such marginal plants and firms would soon be forced to close anyway because of other economic measures. The difficulties of the American textile industry clearly cannot be blamed on environmental protection. Many of the plant sites that are most severely hurt by pollution control legislation (small paper and pulp mills, foundry mills, textile mills) are already in serious economic difficulty due to old and obsolete plant and equipment, and the serious competitive influx of more technological competent foreign firms. It is not logical to conclude that environmental protection legislation is forcing them out of business.

Secondly, the economic disbenefits are grossly exaggerated. It is clear that small, marginal and inefficient plants may close and that these plant closings will cause some employment displacements regionally. However, the pollution abatement and control equipment industry is one of the fastest growing new businesses and will continue to grow in the future, employing large numbers of the work force. Just as the computer industry and automation contributed to the nation's GNP and employment base, so will the environmental protection industry. Hence, the obsolete industries will be replaced by sophisticated and technologically intensive industries such as pollution abatement. In fact, despite the massive unemployment that the nation is experiencing, environmental scientists and technologists are in extreme shortage and in great demand.

There is some legitimacy to the observation that environmental science is not well understood, and the recent debacle of the catalytic converter gives added credence to the assumption. However, it is equally foolhardy to wait until the exact interaction of man and pollutants is precisely understood and quantified before beginning to act. The science is so currently sufficiently sophisticated to indicate which pollutants are harmful to man, animals and the biosphere. Postponing action merely adds to the costs, both dollar and human.

The estimated costs of pollution control and abatement vary considerably. The Council of Environmental Quality estimates that the costs of meeting federally mandated standards will reach $325 through 1983 (see Figure 4). This figure excludes non-point source pollution and storm and agricultural runoff, estimated to represent half the water pollution problems. Brookings

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FIGURE 4

ESTIMATED TOTAL POLLUTION CONTROL EXPENDITURES

(In billions of 1973 dollars)

Pollutant/medium	1973			1982			Cumulative -- 1973-82		
	O&M[1]	Capital Costs[2]	Total Annual Costs[3]	O&M[1]	Capital Costs[2]	Total Annual Costs[3]	Capital Invest-ment	O&M[1]	Total Annual Costs[3]
Air pollution									
Public	0.1	0.1	0.2	0.5	0.2	0.7	1.7	3.8	5.4
Private									
Mobile	1.2	0.2	1.4	8.4	4.9	13.3	31.3	49.9	74.4
Stationary	1.1	1.1	2.2	4.7	3.1	7.9	21.4	35.3	62.6
Total	2.4	1.4	3.8	13.6	8.2	21.9	54.4	89.0	142.4
Water pollution									
Public									
Federal	0.2	NA	NA	0.2	NA	NA	1.8	NA	NA
State and Local	1.4	4.1	5.4	4.2	8.3	12.5	50.6	27.4	88.5
Private									
Industrial	0.9	1.1	2.0	2.8	2.2	5.0	16.5	21.6	40.4
Utilities	NA	NA	0.01	0.4	0.3	0.7	4.4	2.2	3.5
Total	2.5	5.2	7.4	7.6	10.8	18.2	73.3	51.2	132.4
Noise	NA	0.1	NA	NA	1.0-1.4	NA	6.0-8.7	NA	NA
Radiation									
Nuclear power plants	NA	NA	NA	0.05	< 0.05	0.07	0.3	0.08	0.3
Solid waste									
Public	1.1	0.3	1.4	1.9	0.5	2.4	4.2	15.5	19.3
Private	1.9	< 0.05	1.9	3.0	0.1	3.1	0.4	25.2	25.6
Total	3.0	0.3	3.3	4.9	0.6	5.5	4.6	40.7	44.9
Land reclamation[4]									
Surface mining	0.3	0	0.3	0.6	0	0.6	0	5.0	5.0
GRAND TOTAL[5]	8.2	6.9	14.8	26.7	19.7	46.3	132.6	185.9	325.0

[1] Operating and maintenance costs.

[2] Interest and depreciation.

[3] O&M plus capital costs.

[4] Includes only coal mining.

[5] Does not include noise control

Source: Council of Environmental Quality, Fifth Annual Report on Environmental Quality - 1974, (Washington, D.C.: Government Printing Office), p.221.

Institution "conservatively" estimates that pollution abatement will require at least $500 billion through 1982.[28]

Industry, of course, estimates the costs higher still. A coalition of electric utilities (the Utilities Water Act Group) estimates that the costs of meeting the water regulations for steam electric plants would require over $48 billion by 1983,[29] while the Council on Environmental Quality estimates that it would require less than $4 billion. Further, the utilities blame costs (as well as inflation) for raising the costs per unit of capacity from $100 per kw to nearly $500 per kw.[30]

Specific industries have estimated the costs of pollution abatement for them. Arthur D. Little, Inc., estimates that it will require $12 to $14 billion over the next nine years for the steel industry to meet the mandates of the Clean Air Act.[31] The National Academy of Sciences estimates that it will require an investment of $23.5 billion per year for all automobiles on the highways to meet the Clean Air Standards.[32]

Clearly, pollution abatement will be expensive, and it is also likely that it will have some economic dislocations in individual sectors and regions; just as some sectors will benefit greatly from the impact of the legislation.

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[28] Bosworth, et al, op.cit.

[29] "House Units Probe EPA's Handling of Air, Water Laws," Industry Week (July 29, 1974) p.16.

[30] "Cash-Shy Power Firms Trim $8 Billion From Spending Plans," Industry Week (August 26, 1974), p.24.

[31] "Study Pinpoints Costs of Steel Plant Clean-Up," Chemical and Engineering News, (May 26, 1975), p.15.

[32] Bosworth, op.cit.

Yet the costs of pollution are great as well. One study estimates that the direct economic costs of air pollution alone in 1970 was up to $18 billion.[33]

Obsolete Plant and Equipment:

Another major category of demand is likely to be the costs of maintaining, replacing and renovating deteriorating plant and equipment in the nation. Since implementation of the gasoline tax and establishment of highway fund over 40,000 miles of interstate highways have been built, all requiring extensive maintenance. The nation's railroad system is close to unusable, the nation's rapid transit system non-existent. Despite the overabundance of schools in this country, communities are building additional schools because the existing schools are deteriorating from lack of maintnenace. Industry as well has equipment that is inferior to its competitors, both domestic and foreign.

It is unclear what the costs of maintaining and replacing such equipment are. In 1970 industry estimated the costs of replacing obsolete equipment at over $144 billion, probably an unreasonably low number even then.[34]

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[33] Thomas E. Waddell, The Economic Damages of Air Pollution (Environmental Protection Agency: Washingtion, D. C.) 1974.

[34] McGraw Hill, How Modern is American Industry?, June 1970.

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CONFLICT AND FEAR OVER THE IMPACTS OF SCIENCE AND TECHNOLOGY MAY RETARD, OR MAY HASTEN, SOCIETAL PROGRESS

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ISSUE: CONFLICT AND FEAR OVER THE IMPACTS OF SCIENCE AND TECHNOLOGY MAY RETARD, OR MAY HASTEN, SOCIETAL PROGRESS

The Issue:

Anthropologists looking back at our time a hundred years or a thousand years from now may well name it the age of transitors, computers or even synthetics. They will describe our late twentieth century as a complex civilization functioning through the grace of a well-oiled technology. Our era will seem to them like a society which, in advanced countries at least, ate what the machine manufactured, wore what the machine created, traveled where technologies explored and lived where synthetically controlled environments stimulated our senses and promoted our well-being. Despite certain embarrassing pockets of poverty, they will find that we had greater wealth, more widely distributed, than any society before us.

Having noticed only our technology and affluence, anthropologists will have missed the point; for not only have we created this glittering era, we have also come to question both our motives and the consequences of our affluence. Such introspection is the essence of our time. Those future anthropologists, granted sufficient insight about these self-doubts, might call our time either the Age of Conscience or the Age of Cowardice; only from the perspective of history will we be able to tell which name fits us best.

However, this concern with the fruits of our affluence and technological success is not new. In fact, the beginning of such disillusionment with science could be seen in the early 1920's. Bernal, writing in The Social Functions of Science argued that:

> As long as the results of science appeared, at least to the more respectable classes, as unmixed blessings, the social function of science was so much taken for granted as not to need examination. Now that science appears in a destructive as well as constructive role, its social function must be examined because its very right to exist is being challenged. The scientists, and with them a number of progressively minded people, may feel that there is no case to answer, and that it is only through an abuse of science that the world is in its present state. But this defence can no longer be considered to be self-evident; science must submit to self-examination before it can clear itself of these accusations.[1]

More recently, another writer interested in the sociology of science identified the post World War I era as the origin of the anti-science movement:

> The social atmosphere surrounding science during the period (1920's to 1930's) was one of disillusionment. The First World War and subsequent dislocations of political and social life shook the belief that science (and rational thought in general) would lead to uninterrupted human progress, and the Depression raised the problem of technological unemployment. Things went so far that there were suggestions to declare a 'moratorium on inventions'.[2]

The fears of that period spurred serious analytic inquiry into the social nature of science and resulted in the birth of a new field: the sociology of science. What characterizes the current period as unique is the emotional anti-science, anti-technology feelings expressed by the entire population and the general recognition that technology has costs as well as benefits associated with it. It is this emotional concern with the risks of progress that epitomizes this period of history.

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[1] J.D. Bernal, The Social Function of Science, (Routledge and Kegan Paul: Cambridge, London) 1939, p. 1.

[2] J. Ben-David, "Introduction" to Special Sociology of Science issue: International Social Science Journal XXII, No. I (1970), pp. 7-27.

It is often argued that fear of progress is an attitude that only a very rich society can afford. A society without food for its people must make progress in agriculture; a society without goods for its people must make progress in manufacturing. But when food and required material things are available to most people and free time becomes a form of wealth, it is no longer a luxury for society to question where change is taking it -- it becomes a necessity. The issue is how to direct science and technology to better serve the interests of humanity, whether these interests be economic or material problems, man's intellectual needs, or the fundamental values that guide men and societies. The developed countries of the world today are uniquely in that position.

We do question where change is taking us, and properly so. The issue is how to direct science and technology to better serve the interests of humanity, whether these interests be economic or material problems, man's intellectual needs, or the fundamental values that guide men and societies.

The world, in the next three decades, is facing problems of unprecedented complexity and importance: increasing agricultural production, distributing food, providing and conserving energy, finding alternatives to depleting non-renewable resources, protecting the world's environment, stabilizing the problems implicit in maldistributions of wealth, and recognizing that all of these problems have in the past been causes for conflict. All of these issues face us now and promise to intensify in the immediate future. They elude solution for many reasons: they are systemic -- acting on one may intensify another; they require global perspective -- attempts to correct the issues may require abandonment of nationalism and unprecedented international cooperation; they are oriented to the long term -- they require giving priority to long-term considerations over short run payoffs.

Additionally, there is one more important characteristic of these problems: their interaction with science and technology. Future scientific and technological developments could help solve or intensify most of these issues. The nature of this interaction between science and the complexities of survival is the focus of this paper and the discussion is developed in the following sequence:

1. Recognizing that advancing science and technology has sometimes had significant costs in terms of social and human impacts, intellectual criticism of both science and technology has been mounting. The view that technology can continue to solve problems is challenged; critics believe that further technological development may bring a net social loss.

2. Both in response to or in leading this criticism against science, public attitudes toward science and technology have been changing as well. Science and technology are recognized as having societal costs; also society wants what science does.

3. In fact, some scientific and technological developments of the recent past have been threatening, and have had obvious deleterious consequences.

4. Science occasionally produces intrinsically threatening developments because its structure is asocial, that is social need has not been a major determinant of the direction of research. In addition, science is perceived as having failed because it addresses the wrong problems or has not delivered according to expectations.

5. Technology is directed by sources of funding. Funding is largely controlled by mission-orientation of government agencies and industrial interests.

6. Despite the rise of an intellectual, anti-technology movement and a similar popular sentiment, the need for innovative contributions from the basic and applied sciences and from the physical and social technologies has never been greater.

7. However, the institutional difficulties which inhibit these contributions are enormous. If they could be overcome to some extent, science and technology could make more important contributions to the solution of world problems to improvements in the state of man, and to man's image of himself.

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The Criticism of Science and Technology

Professor P. Siekevitz, Professor of Biochemistry, The Rockefeller University, summed up the arguments against further development of technology in this way.

> As an extreme, I would suggest further that technology has badly outraced the political and social means of handling the problems it generates, that research and development are so intertwined that the former leads invariably to the latter, and that, to give political methods a chance to work, or to devise new political methods, technology advance and thus research, should stop....
>
> I would thus suggest that the present environmental mess is caused by rapid technological growth, driven on by haphazard research, during the past thirty years; that this research and development are inexorably linked; and that, in spite of this research, we scientists have only little understanding of the natural world around us. Given these beliefs, it seems to me to be disastrous to think that further refined technology, directed though it may be, will cure the past technological mistakes. So is it to be the ultimate responsibility of scientists to society that they discontinue their existence as research scientists?[3]

As Professor Siekevitz says, this is an extreme position, but it is mirrored in arguments of other articulate critics of science and technology. Here are some of their points:

- Science and technology may, through inordinate growth, become increasingly irrelevant to any human interest except that of the technologist or corporate enterprise.[4]

- Scientific projects, as practiced today, require that the human being stand apart from nature as an isolated spectator or pit man against nature.[5]

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[3]Science Policy Reviews, Vol. 4, No. 2 (Columbus, Ohio: Battelle Memorial Institute, 1971), p. 10.

[4]Lewis Mumford, The Myth of the Machine: The Pentagon of Power (New York: Harcourt Brace Jovanovich, 1970), p. 234.

[5]Theodore Roszak, Where the Wasteland Ends (New York: Doubleday & Co., 1972), p. 234. (Hereafter called Where the Wasteland Ends.)

- When scientists argue that it is their task to understand nature, not to determine how knowledge of nature will be used, critics answer: Why has science systematically taught our society to regard knowledge as a thing apart from wisdom?[6]

- Science is being used to create new technologies which have nothing to do with human need—only to create new human wants.[7]

- Scientific and technological knowledge can be equated with power; as knowledge and specialization grow, power based on knowledge becomes increasingly centralized.[8]

- Scientific and technological achievements which seem to have beneficial primary consequences often have pernicious side effects.[9]

- Technology can be put to bad as well as good use--but as we develop more powerful technologies, the deleterious applications can become much more pronounced and more often outweigh the benefits.[10]

The image is of science serving technology and technology serving a non-reasoning economic drive--aquisitive, depleting, polluting--moving in directions which cause dehumanization, desensitization, and unexpected side effects which are most often deleterious.

Public Attitudes toward Science and Technology

Are these attitudes reflected in public opinion or are they the isolated feeling of a small articulate group? In 1972, the Opinion Research

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[6] Where the Wasteland Ends, p. 234.

[7] Rene Dubos, So Human An Animal (New York: Charles Scribner's Sons, 1968), p. 190.

[8] Jean Meynaud, Technocracy (London: Faber and Faber, 1964), p. 301.

[9] Herman Kahn and B. Bruce Briggs, Things to Come (New York: MacMillan Company, 1972), p. 20. (Hereafter called Things to Come.)

[10] Things to Come, p. 208.

Corporation conducted an opinion poll for the National Science Foundation to determine public attitudes toward science and technology.[11] They found a generally optimistic picture:

- Seventy percent felt that science and technology had changed life for the better.
- Forty-nine percent felt a sense of satisfaction or hope in describing their reaction to science and technology.
- Fifty-nine percent valued the prestige of scientists as "excellent."
- Fifty-four percent felt that science and technology on balance did more good than harm.

Figure 1 presents a summary of these portions of the poll.

These generally optimistic findings were challenged in a second opinion poll conducted some two years later by LaPorte and Metlay.[12] They attribute the earlier optimistic response to the fact that the public made discriminations between science and technology and that they were considerably happier about science than they were about technology. In fact, the second poll found that:

- The public's reaction to the impact of technology upon society is one of wariness and some scepticism.
- The public applies a rather wide range of sometimes contradictory values to its evaluation of technology.
- The public has a distrust of the institutions associated with decisionmaking in the technical policy areas.
- A clear element of political ideology is present in the evaluations of technology made by an important segment of the public.

Figures 2 and 3 summarize their major findings.

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[11] National Science Foundation, Science Indicators, 1972 (Washington, D.C.: U.S. Government Printing Office, 1972). (Hereafter called Science Indicators, 1972.)

[12] Todd R. LaPorte and Daniel Metlay, "Technology Observed: Attitudes of a Wary Public," Science (April 1975), p. 121. (Hereafter called LaPorte and Metlay.)

Do you Feel That Science and Technology Have Changed Life for the Better or for the Worse?

Response	*Percent*	*Percent of those having an opinion*
Better	70	77
Worse	8	9
Both	11	12
No effect	2	2
No opinion	9	—

Which One of These Items Best Describe Your General Reaction to Science and Technology?

Response	*Percent*	*Percent of those having an opinion*
Satisfaction or hope	49	58
Excitement or wonder	23	27
Fear or alarm	6	7
Indifference or lack of interest	6	7
No opinion	10	—

Overall, Would You Say That Science and Technology Do More Good Than Harm, More Harm Than Good, or About the Same Each?

Response	*Percent*	*Percent of those having an opinion*
More good	54	61
More harm	4	4
About the same	31	35
No opinion	11	

SOURCE: <u>Science Indicators</u>, 1972, pp. 96-97.

FIGURE 1

SUMMARY OF PUBLIC ATTITUDES TOWARD SCIENCE AND TECHNOLOGY

Statement	Strongly agree 1	2	Agree/ disagree 3	4	Strongly disagree 5
	SCIENCE				
1. Unless scientists are allowed to study things that don't appear important or beneficial now, a lot of very beneficial things probably won't ever be invented	54.2	32.1	3.8	5.9	4.0
2. Basically all scientific discoveries are good things; it is just how some people use them that causes all the trouble.	45.9	29.0	5.4	13.5	6.6
	TECHNOLOGY				
3. Any attempt to control which inventions are widely produced or made available will make our lives worse.	14.7	22.5	11.0	29.8	21.9
4. No one should attempt to regulate which inventions are produced because it interferes with the individual's right to decide what he wants to buy.	18.1	26.8	8.3	27.1	19.6
5. No one should attempt to regulate which inventions are produced because they do not know how to do it.	21.4	25.1	10.8	27.4	15.3

SOURCE: Science, Vol. 188, No. 4184 (April 11, 1975), p. 122.

Figure 2 Should science and technology be controlled? (percentage of those answering)

	Low disenchantment 1	2	Intermediate 3	4	High disenchantment 5
1. It would be nice if we would stop building so many machines and go back to nature	32.3	24.6	8.7	22.1	12.2
2. Technology has made life too complicated	24.5	33.3	8.0	24.3	10.0
3. People have become too dependent on machines	9.2	12.8	5.7	34.3	38.0
4. People shouldn't worry about harmful effects of technology because new inventions will always come along to solve the problems	5.5	10.3	5.2	30.9	48.3

SOURCE: Science, Vol. 188, No. 4184 (April 11, 1975), p. 123.

Figure 3 How disenchanted are people with technology (percentage of those answering)

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If these findings are representative of public opinion, they indicate that in 1974, at least, almost 80 percent of the people no longer believed that new technologies would come along to solve their problems while 72 percent felt that people had become too dependent on machines.

LaPorte and Metlay also inquired about the public's evaluation of certain current technological developments, such as household appliances; automobiles, automated factories, the space program, and atomic weapons. They found, in general that,

> ...positive public response to past and present technological development, overlaid with a set of concerns about the more general consequences of that development. This combination of attitudes appears to reflect a tension in values, visible in the priorities held by the public which determine whether a technological development is "advantageous."[13]

Science is Asocial -- The Structure of Science is a Determinant of the Content of Science

Science is not unconstrained for it moves in directions which are largely determined by the scientific reward system and the scientific method itself. These guiding factors however, are not related in any reliable way to social need; on the contrary, they may produce results which are socially catastrophic.

That there are fashions in basic science is clear. In the decades after the Second World War, interest centered around the development and application of controlled nuclear reactions. Today, interests center around understanding of genetic mechanisms and inventing techniques for transmitting genetic information in biology; in particle physics, around the

[13] LaPorte and Metlay, op.cit., p.124.

further disaggregation of matter; in astronomy, around the remote exploration of planets through unmanned probes and the exploration of the heavens using new regimes of the electromagnetic spectrum. Such foci of interest largely result from spectacular discoveries and new capabilities which have fired the imaginations of scientists and opened new domains of knowledge to prospecting. In the case of nuclear physics, the trigger for the new fashion was the atomic bomb and the research which surrounded its development; the current interest in biology can be traced back to the publication by Watson and Crick of the model for the DNA molecule. It would be fascinating to catalogue these tides of interest, using various scientific abstracting media as a data source, since the ebb and flow of scientific fashion may give some warning about the raw materials of tomorrow's technology.

Why do researchers rush into newly opened problem areas? The answer seems to be that the reward system which society and science itself has devised for scientists involves reputation, that reputation requires discovery and publication, and that discovery and publication require the performance of spectacular and original work. Clearly, most opportunity for spectacular and original work exists at the new frontiers of knowledge. The problem is that the new frontiers too frequently do not coincide with the needs of society.[14]

Furthermore, the scientific method itself provides constraints on science which limit the areas open to "acceptable" investigation. In his book, The Structure of Scientific Revolutions, Thomas Kuhn defines "normal science" as distinct from "scientific crises".[15] The majority of scientists pursue normal science most of the time, which involves the probing

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[14]Theodore J. Gordon, Ideas in Conflict (New York: St. Martins Press, 1966).

[15]Thomas Kuhn, The Structure of Scientific Revolutions (Chicago, ILL: The University of Chicago Press, 1962).

of the discipline's paradigms, testing their application in new domains, and increasing their precision and generality. "Normal" basic research is this not directed toward the novel, but toward the refinement of previously stated positions. Sometimes a paradigm fails in a new application; and in consequence, a crisis develops in which old ideas no longer prove viable. Today we may look back at many old ideas, which science once held inviolate that have been replaced and buried. For example, phrenology, phlogiston, and caloric, all dead ideas, have been replaced by more viable concepts of nature. Unfortunately, only in crisis situations are proposals which challenge the old paradigms usually admissable. An idea presented before its time is in trouble; its author is likely to be treated with derision and disrespect.

In other words, the processes of both "normal" basic research and the efforts to handle the crises of paradigm revision lead to a survival of the fittest among ideas. This progress, however, represents and evolution toward an ultimate state of knowledge dictated not by social need but by the mechanics of scientific progress.

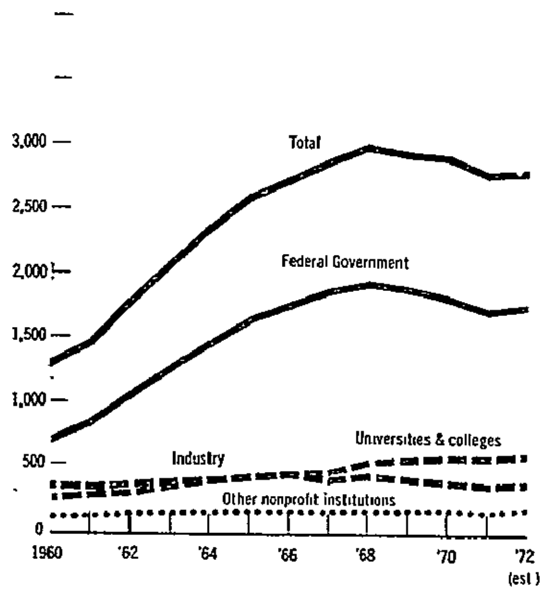
Funding is a Determinant of the Directions of Technology

When President Eisenhower departed from office, he made a well remembered speech about the dangers of the military-industrial complex. In the same address, he said that "the prospect of domination of the Nation's scholars by Federal Government, project allocation, and the power of money, is ever present, and is gravely to be regarded." In other words, he who pays the piper still calls the tune.

While it can be argues that basic research produces inventions that are asocial because of the methods of science and demands of monied groups, R & D as a whole does have links to social needs insofar as the missions of the agencies which fund it are directed toward social interests and needs. By far, the largest funding source for basic research (65%) is the Federal Government. (See Figure 4) Figure 5 illustrates that the preponderance of these expenditures were made by universities and colleges (57 percent). Most of these funds for research and development flow from the Federal Government through various mission-directed agencies. The Department of Defense is the biggest single mission-agency, and most of its support is related to weapons systems. Only in the case of the National Science Foundation is money available for research without specific mission orientation. But of the billions spend for research, NSF's contribution is miniscule.

Figure 6 shows the Federal R & D expenditures for selected functions for the period 1963-1972. Expenditures for national defense and space predominate, although the rise and fall of expenditures for space is clearly apparent. Defense R & D expenditures between 1963 and 1972 ranged from 48 to 64 percent of all Federal R & D expenditures. R & D expenditures for space in 1972 were 19 percent of all Federal R & D funding. Expenditures in the "civilian" areas--that is non-defense and non-space - have grown significantly in recent years. In 1963, "civilian" areas accounted for 14 percent of the total R & D expenditures; by 1972, they accounted for 27 percent.

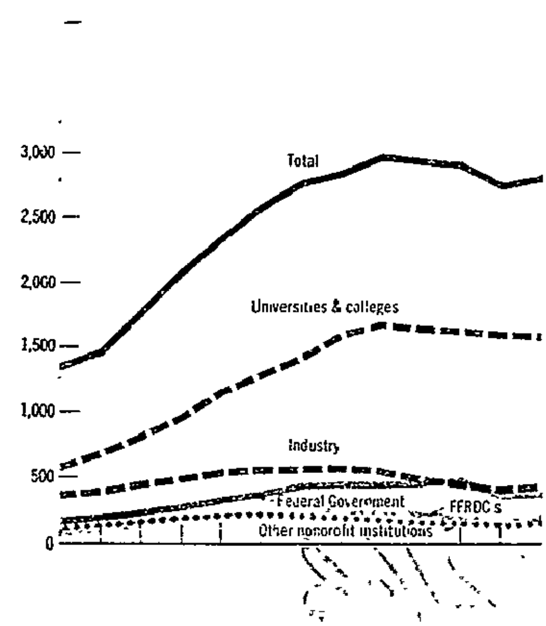
That portion of R & D which is not government funded is largely supported by industry, which justifies its expenditures in terms of the talent it attracts and the possibility of developing new and important proprietary products. Corporate-sponsored research is usually very much in the interest of the corporation.



SOURCE: National Science Foundation, Science Indicators, 1972, p. 35.

FIGURE 4

BASIC RESEARCH EXPENDITURES -- BY SOURCE OF FUNDS
(Constant 1958 Dollars)



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SOURCE: National Science Foundation, Science Indicators, 1972, p. 35.

FIGURE 5

BASIC RESEARCH EXPENDITURES -- BY PERFORMER
(Constant 1958 Dollars)

The United States currently devotes about 2.5 percent of its GNP to the performance of research and development (Figure 7).[16] The federal contribution to this R & D has been decreasing while the industrial contribution has been rising. In view of the problems which face us two questions remain: should a nation such as ours be content to spend only 2.5 percent of its GNP on R & D, and are we spending that money in the places where it will do the most good?

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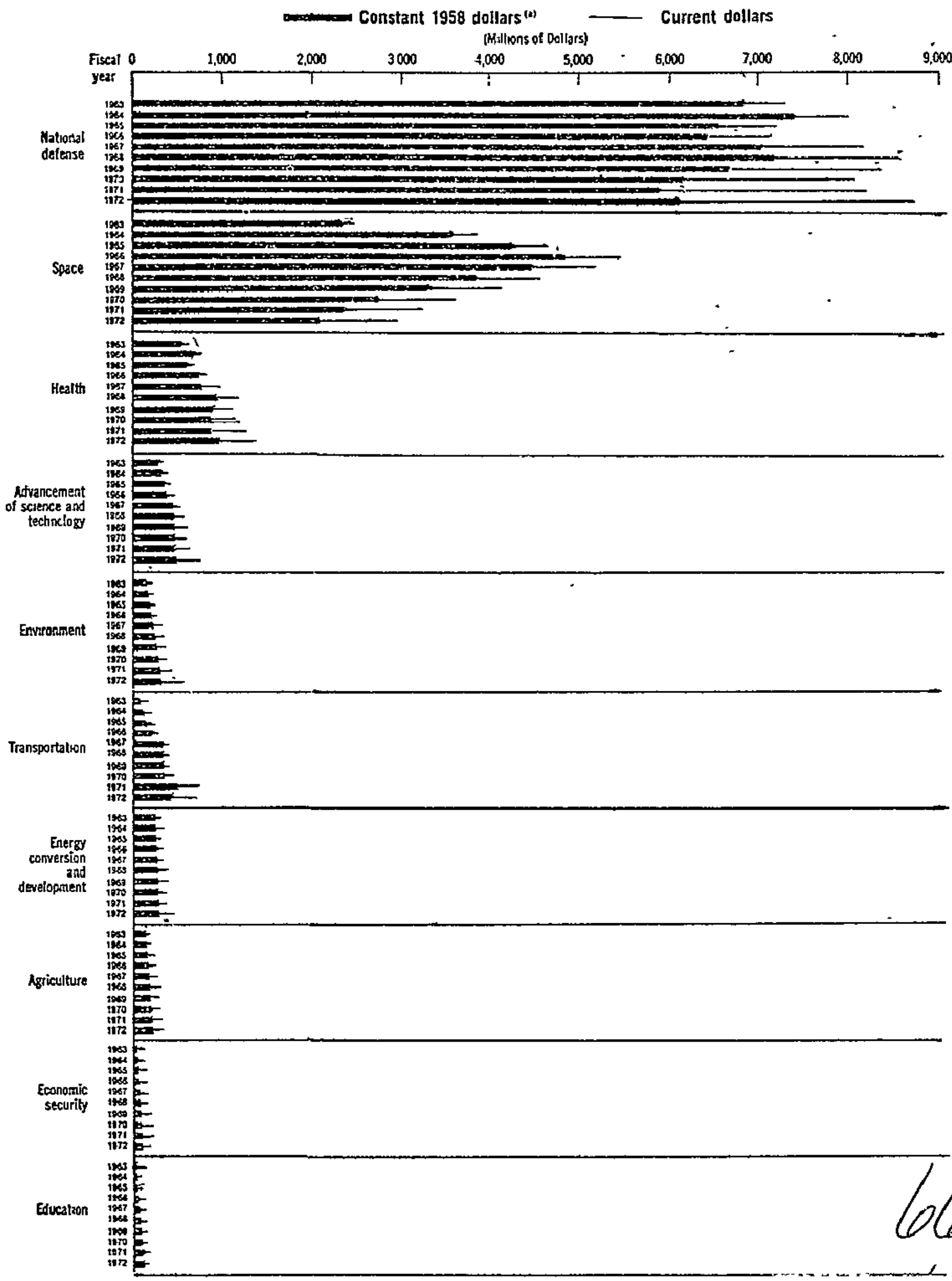
[16] Compared with 3 percent for the U.S.S.R. and 2.1 percent for the United Kingdom.

FIGURE 6

FEDERAL R&D EXPENDITURES FOR SELECTED FUNCTIONS, FY 1963-72



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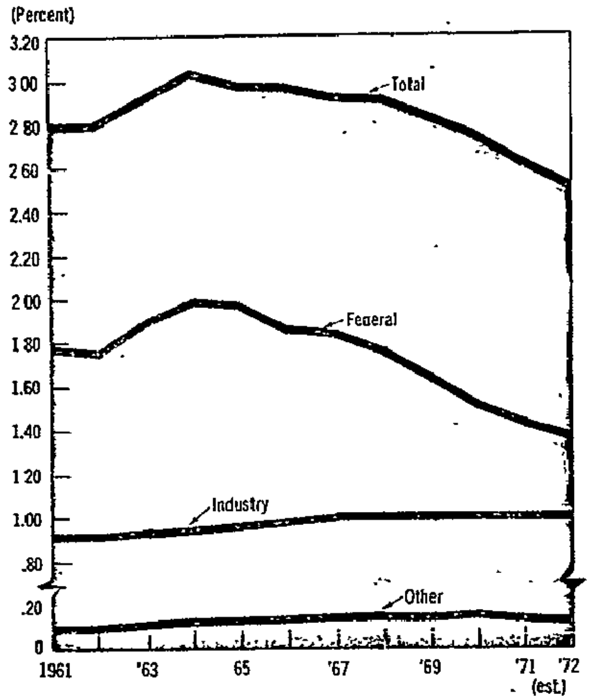
SOURCE: Science Indicators, 1972, p. 25.



Source: Science Indicators, 1972, p. 22.

Figure 7 National R&D expenditures, 1961-1972, as a percentage of GNP

Science, Technology, and Social Values

In the previous section it was argued that science produces results because of an internal reward system which favors certain directions over others. In essence, science functions to expand the boundaries of knowledge while technology often responds to economic drives. Technology produces information and mechanisms for accomplishing new ends which may be based on science or folklore but, nevertheless, respond to a kind of economic need. When these kinds of innovation are introduced into society, value changes sometimes occur. This is the kind of dynamics that Jacques Ellul refers to when he describes the technological juggernaut descending on society, ready or not.[17] The machine of science and technology

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[17] Jacques Ellul, The Technological Society, (New York: Vintage Books, 1967).

grinds out change and these changes descend on society, which must adapt in its wake. Ellul argues that the mechanisms of science and technology are so strong and immutable that whatever man is capable of doing he will do. We have built the system that way. There is, of course, some data which support his argument. If his argument were false, we would see around us many examples of technology discarded in the interests of society. There are a few such examples including nuclear aircraft, supersonic aircraft, and chemical and biological weapons. But who among us could argue that these technologies have been put aside for all time? Furthermore, the Ellul argument depends considerably on the nature of the impact of the technologies and whether the impacts themselves can be distorted in a favorable direction. What is seen as an imposed enslaving condition by one generation, through minor changes to impacts, could be seen as desirable, useful and natural by the next.

There are other examples of social values changing in response to science and technology. For example, some sociologists believe that the advent of simple, effective contraceptives in the form of birth control pills has resulted in changes of sexual mores.[18] The automobile, through the improved mobility which it brought, changed patterns of living, family styles, and other aspects of our culture. In Ellulian fashion, novelty itself has become a value; new technology is an antedote to boredom. "Technology gives us a never-ending parade of things to try in the unbounded search for the meaning of self which after all, may be the base of all values."[19]

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[18]Edward Pohlman, "Contraception In and Out of Marriage," Lester A. Kirkendall and Robert N. Whitehurst, The New Sexual Revolution (New York: Donald W. Brown, Inc., 1971) pp. 183-196.

[19]Theodore J. Gordon, "The Feedback Between Technology and Value," Kurt Baier and Nicholas Rescher (eds.), Values in the Future (New York: The Free Press, 1969) p. 164.

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Thus, an important vector is from self-generated change within the dynamics of science and technology to changes in social values. Science and technology function through a dynamics essentially of their own, and the changes which are produced create a framework for new values within society. Value change is inevitably disturbing to the social order. Each generation somehow feels that its values are best and that its values are the culmination of an evolution of values to the present. Without this feeling, there would have to be guilt for having lived according to the wrong set of beliefs. Therefore, as new generations profess to believe in different values, older generations sense the foundation on which they have based their lives as being undermined. Thus, science and technology, giving society values based on inventions and giving novelty a value in society, produce uncertainty and unrest.

All of this neglects perhaps the most important question of all. Why should the vector only move from science and technology to society; why not from society to science and technology? Emmanuel Mesthene dealt with this problem when he said:

> A major consequence of the prevalence of power of our modern technologies, however, is that we begin to realize that the end--the probable social consequences--must henceforth inform the process of science and technology, since the cost of treating science and technology as ends in themselves is becoming too high. In different words, as our knowledge and technical capability grow, their inherent value takes a lower place in our system of values relative to other values that they serve.[19]

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[19] Emmanuel G. Mesthene, "Technology and Humanistic Values," Max Kaplan and Phillip Bosserman (eds.), Technology, Human Values and Leisure, (Nashville: Abingdon Press, 1971) p.57.

What is argued then is that we have the need for a mechanism which feeds back into science and technology the social and humanistic values which would guide those enterprises so that they may produce innovations valued by society. The mechanisms for this feedback exist but they are primitive, unstructured, and relatively weak. For example, when a large scale problem is detected at the federal level, our government often creates a mission-oriented agency to tackle the problem. This mission-oriented agency, through its funding, can create institutional support and thus ultimately produce technology designed to cope with the problem. A number of institutions have been created (e.g., the RANN program at NSF, the Office of Technology Assessment, etc.) to improve this feedback mechanisms by which social values can be reflected back into the evolutionary directions of science and technology. These feedback mechanisms appear to be inadequate for several reasons, including:

- The magnitude of the problems which loom in the immediate future is enormous and the time available to mitigate these problems is short. The response which requires the existence of the problem before action will result in widespread human suffering. In the decades immediately ahead response must be made not to problems, but to their anticipation.

- The institutions which have been created to call forth specific kinds of innovation from science and technology have viewed their functions in different perspectives; they see themselves not as shapers of science and technology, but rather responding to political forces or, to a degree, serving "a national need."

- There is no science policy within the United States and those institutions which could have brought it into being have been reduced in power or eliminated.

- Even if science and technology could be produced to mitigate some of the large scale world problems which appear on the horizon, there will be institutional inertia and other barriers of diffusion which will slow their use.

The Role of Science and Technology

A recent National Science Board report probably best summarizes the role of science and technology - dealing with the challenges facing the nation and the world.

> Science and technology, by themselves, cannot solve any of these complex problems. As part of a broader commitment and larger strategy, however, science and technology can play a pivotal role in helping to alleviate many of them. But these contributions will be neither immediate nor costless.
>
> The principal role of science and technology is to provide more and better options than are now available for meeting the problems. Science can supply the basic knowledge required for understanding the origins and dynamics of the problems; for measuring their magnitudes and directions, and for devising and assessing possible approaches for coping with them. And technology, drawing upon scientific knowledge, can provide many of the practical tools and techniques for attacking the problems.
>
> Together, science and technology provide the means for:
>
> - Understanding and measuring human needs for energy; determining their trends and trade-offs; developing policies and technologies for efficient energy use; assessing the availability and implications of the use of potential sources of energy; and developing new energy sources.
>
> - Comprehending the dynamics and trends of population growth and developing alternative means of control.
>
> - Understanding diseases for the purposes of preventing them and developing improved methods of treatment and more effective and efficient delivery of health services.

- Investigating natural and synthetic foods and materials, their development and their use, their disposal or recycling, their efficient use or substitution, and their interaction with human lifestyles and their change.

- Improving the understanding of interpersonal, institutional, and social problems, and developing and gauging the success of alternate approaches for alleviating them.[21]

<u>Institutional Difficulties and Directions</u>

The problem with implementing structured planning leading to more relevant and helpful science and technology is, of course, primarily institutional. Here are some of the more important institutional considerations:

- The predilection of many scientists is to resist structured planning

- Within the U.S. and most countries, funding agencies respond to problems which are popular, national in scope, and already in existence; unpopular, global forecasted problems have little attention.

- Within the United States, science policy is essentially non-existent.

- There are few organizations with global perspective which have any prospect of making large-scale contribution to the solution of world issues through science and technology.

As pointed out earlier, all of these institutional problems exist in a social context in which the adverse consequence of prior and forecasted scientific and technological developments are real and in which, as a result, anti-technology sentiments are apparent.

The need for initiating a cohesive policy for Federal Scientific research has long been recognized by Congress.[22] For example, in 1967 the House Com-

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[21] <u>Science and the Challenges Ahead</u>, National Science Board, National Science Foundation, Washington, D.C., 1974.

[22] T. J. Gordon, and M. J. Raffenperger, <u>The Philosophy of Science Journal</u>.

mittee on Science and Astronautics undertook a critical review of the operations and functions of the National Science Foundation.[23] This investigation indicated that Congress was concerned about the directions into which science was carrying us and the mechanisms of its transport. The Committee made it clear that in the future, Congress was likely to pursue questions related to the establishment "of a broad strategy for science in public affairs, ...a framework for considering the effect of science and technology in regard to the national economy, and priorities for choice among different possibilities for Federal basic research... (identification of issues) before they reach the crisis stage..."[24] They concluded that focusing on "areas of appropriate research and education could be a major factor in maintaining the stability of a civilization which is today seriously threatened by the surfeit and concentration of people and their problems."[25]

Today, Congress is again criticizing the National Science Foundation. The issue this time is not stated with such clarity; the issue is posed in terms of expenditures which are perceived as largely irrelevant. On April 9, 1975, the House of Representatives voted to requrie that NSF submit research grants to Congress for review. This state of affairs occurred after a long and acrimonious debate which originally concerned an elementary school behavioral science course call "Man: A Course of Study" (MACOS). Opponents of the course, which was developed under NSF funding, argued that "it is absolutely unacceptable for NSF to continue using taxpayers' money for aggresssive promotion and marketing activities for their own preferred social

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[22] The National Science Foundation; Its Present and Future, A report to the Committee on Science and Astronautics, U.S. House of Representatives, (February 1, 1967). (Hereafter called, NSF: Its Present and Future.)

[24] Ibid., p.99.

[25] Ibid., p.xiv.

studies courses, undercutting competition from regular textbook publishing houses."[26] The argument spread to include research projects dealing with subjects that seemed irrelevant and far afield from the national interest. In the end, the debate had a much larger effect than simply ruling on one of NSF's programs: it resulted in a bill to have Congress review *all* NSF grants.

In trying to come to grips with the issues behind the debate, the question has been raised about whether Congress is loosing its nerve "where science and technology are concerned."[27] The scientific community was urged:

> ...not merely to sit back and take a bad rap. If open season is being declared on long accepted processes for determining scientific merit and social value in the funding of research, a very great deal is at stake. Summary judgments may spread to science as a whole because of dissatisfaction with a few fields.[28]

It is too early to say whether this recent confrontation marks a deep split between government and science and technology, or merely a temporary rift. One hopes that the issue is not fundamental, because government support of science and technology is necessary to meet the challenges ahead.

Although this action has raised significant and justified concerns in the scientific community about undue constraint on "scientific freedom" and the laying of a high inertia decision process on one which is already ponderous, the underlying message may be the same as the one delivered seven years earlier: science should be more relevant to problem solving.

The desirability of planning scientific research is challenged by those who hold that science, intrinsically, is not amenable to forecasting or

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26 National Science Foundation, "Congress Taks Hard Look at Behavioral Science Course," Science (May 16, 1975).
27 "The Shaming of Science," Science (May 16, 1975).
28 Ibid.

planning. They argue that the uses made of the products of research are so obscure at the time research is performed that planning cannot possibly be effective. Using Kistiakowsky's example, who could have foreseen, at the time of their research, "that the Curies would make a major contribution to the cure of cancer. Similarly, no man today is wise enough to know from what field will come a critical discovery that, directly or indirectly, will solve the problem of the control of insects."[29] Sometimes the research which seems to be the least promising proves to be the most fecund. The future, they observe with justification, is particularly obscure in the region of new applications of scientific research.

Some philosophers of science, such as Thomas S. Kuhn, have argued that science has progressed at its impressive rate *precisely* because it responds to forces other than logical planning.[30] Kuhn believes that the disparity in progress between the physical and social sciences results from the desirable isolation of the natural scientist and his ability to choose his research using criteria other than those established by society. The social scientist does not enjoy the isolation of the physical scientist. He must choose his problems and defend his solutions not only among his peers but in front of society as well. This concern with goals, the argument goes, has cost him progress.

These then are the contrasting views on the organization of scientific research: one holds that a goal structure is becoming more necessary in our

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[29] G.B. Kistiakowsky, "On Federal Support of Basic Research," Basic Research and National Goals, a report to the Committee on Science and Astronautics by the National Academy of Sciences, March 1965.

[30] Kuhn, Thomas, op.cit.

modern society; the other, that a visible goal structure is inimical to scientific progress. It is apparent that many scientists responsibly recognize this dilemma.

When national issues become apparent, new mission agencies are created and funding to these agencies increases greatly. From the energy shortages, the creation of FEA, and ERDA, and the accelerating funding of those organizations and others supporting energy research, serve as obvious examples.

However, there are several crucial elements missing from discover-a-problem, build-an-agency, and fund-with-intensity" approach to science and technology planning. To be most useful, any cohesive system should include:

- A future perspective; we should have been working on energy problems before the embargo; we should be working now with much greater urgency on problems associated with world agriculture, war prevention, and materials recycling.

- A priority scheme so that resources can be allocated to the most important issues first - not to the problem which is momentarily most notorious.

- A throughgoing analysis of higher order consequences of contemplated actions.

- A global rather than a national orientation.

In the United States we are very distant from this sort of planning; in fact, there is no single science policy in the United States. Mission agencies are created ad hoc in response to problems which have already been perceived; and these agencies, in the course of executing their mission, create limited R&D goals. The President's Science Advisory Committee (PSAC) consists of non-governmental scientists and engineers which, in theory, contribute to the formulation of political decisions based on scientific capability. The Office of Science and Technology (OST) is designed to provide support to executive agencies in establishing and reviewing programs with science and technology content. Finally, the Office of the President's Special Assistant for Science and Technology has been moved out of the White House and has been attached to the National Science Foundation. If there were a cohesive science policy, where would it originate : from any of these organizations, from the National Science Foundation, or from the National Academy of Sciences? The roles and missions of all of these organizations overlap and with the changing of administrations, their power and responsibilities shift.

Nevertheless, there are some important (but largely uncoordinated) trends in the directions suggested for organization by this paper. For one, the National Science Foundation Research Applied to National Needs (RANN) is designed to seek out problems of national importance to which science can make a contribution and to initiate research designed to mitigate the problem. The group is specifically admonished to avoid areas where other government agencies might have responsibility and are already supporting science. The program has chosen to concentrate in the fields of energy, large-scale systems analysis, materials, and experimental R & D incentives.

The General Accounting Office and the Congressional Reference Service of the Library of Congress have introduced a future perspective to much of their work. In the House of Representatives, committees are now charged to initiate a "foresight" function.

The Office of Technology Assessment (OTA), created as an arm of Congress, has begun a series of studies directed toward reaching an understanding of the policy consequences of physical and social technologies of interest to Congress. The subjects for these studies are generated by Congress itself and, for the most part, OTA contracts with outside organizations to perform this work.

Within the executive department, there is a growing effort to study the problems which they are charged to solve using holistic analysis tools which are future-oriented and are designed to search for higher order consequences of contemplated actions; examples are the SEAS model being developed by the Environmental Protection Agency, the agricultural systems models being developed by the Economic Research Service of the U.S. Department of Agriculture, and the National Aviation System models being studied by the Federal Aviation Administration.

Technology assessment is not confined to Congress. It has become a style and many organizations in government and industry have performed analyses which generally conform to the intent of technology assessment. That is, the studies focus on forecasting the future evolution of a particular technology or problem, understanding the policies that might be used to modulate the development of the technology or problem, and determining, to the extent possible, the primary, secondary, and higher order consequences which flow from the evolution and policies. The point of such studies is to determine, before the fact, the potential consequences of action or inaction.

Many new "lookout" institutions have been created in order to call public attention to future crises and the need for policymaking. Among these institutions are:

- United Nations Institute for Training and Research (UNITAR), an organization of the United Nations which, through its Commission on the Future, intends to identify world problems which should be brought to the attention of the U.N. General Assembly.

- The International Institute for Applied Systems Analysis (IIASA) in Vienna, Austria, which is attempting to develop energy, urban, and environmental (water resource) models.

- Potomac Associates, the Washington firm that published The Limits to Growth (1973), the first in a series of books entitled State of the Nation. Each of these volumes will be concerned with developments and trends in a U.S. policy area such as arms control, the defense budget, social change, urban affairs, the environment, and foreign policy.

- The Timetable Project. John McHale of the Center for Integrative Studies, State University of New York, has called for The Timetable Project, which has as its major objectives:

  - The appraisal of the global status of given problems
  - The systematic analysis of their causal interrelationships
  - Projection of crisis points of key world problems
  - Assessment of human and physical resources available for problem solving
  - Identification of value and goal priorities, options, and alternatives.

- Mankind 2000 and the Union of International Associations (UIA). Another proposed activity is presently being jointly undertaken by Mankind 2000, an informal association with headquarters in Rome, and the UIA in Brussels. This effort calls for establishment of a network of persons to identify, structure, and seek out the policy implications of the world's "major problems." The unusual aspect of the project is the plan to arrange all of these problems in a hierarchy, an intellectual framework that will make is possible to (1) establish priorities for research and action, and (2) develop procedures to follow every program (anywhere in the world) relevant to individual problems.

- Club of Rome, the funder of the Meadows' "Limits to Growth" model and the Mesarovic-Pestel "Mankind at the Turning Point" model. Their work in the systematic exploration of world issues and policy approaches to their solution is continuing.

- The International Institute of Applied Systems Analysis, set up in Vienna in 1972, by the scientific academies of 12 countries, including the United States and the USSR. This organization is designed to perform detailed systems analyses of global problems and to make the information about these problems publicly available.

Within the scientific community itself, concern over unintended consequences has, in one notable instance at least, begun to shape the directions of research. At a symposium of biological researchers held at Davos, Switzerland in October 1974, Carl Scherrer of the Swiss Institute for Cancer Research said, "we are in the same place as nuclear physicists were in 1938."[31] He was referring to genetic experiments, in particular to research in which genes of different species were crossed to obtain live hybrid cells. For example, Nils Ringertz and his collegues of the Swedish Institute for Medical Cell Research and Genetics have combined human cells with chromosomes of rats, mice and insects.[32] In addition, artificial genes, with over 100 units and capable of directing the production of the pyrosine transfer of RNA within a bacterial cell, have been produced.[33] Experiments like these have led to tremendous excitement and concern. One researcher at the Davos conference, Max Birnsteil of the Zurich Institute for Molecular Biology, said,

> This new approach is likely to revolutionize not only our knowledge of gene and chromosome organization but possibly of genetic disease, perhaps cancer. The potential benefits are so great that this sort of research is gaining uncontrollable momentum....The possibilities include the suggestion that isolated genes for insulin might be introduced into bacteria, which could then be grown to produce insulin on a technical scale.[34]

Paul Berg of Stanford University, however, warned that these same techniques might result in the creation of bacteria which could not be cured by any known medical treatment. These artificial genes could be used as a short cut to genetic manipulation to achieve very desirable consequences (such as the introduction of nitrogen fixation capability into various grains.) But

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31 "Genetic Engineering: Clashing Views," Science News (November 2, 1974).

32 Ibid.

33 "On the Brink of a Functioning Artificial Gene," Science News, (September 21, 1974).

34 "Genetic Engineering: Clashing Views," op.cit.

this capability could also lead to widespread suffering if a bacteria capable of reproducing and causing an incurable disease were to escape into the environment or if this technology were to be used as a biological agent in warfare.

In July 1974, Berg called for a moratorium on research involving the formation of bacteria resistant to antibiotics and research which linked DNA molecules with tumor causing viruses. In late February 1974, 140 scientists involved in genetic experiments gathered at Asilomar, California to discuss how the scientific community might manage this two-edged sword.[35] After intense and dramatic discussions, the group agreed to initiate a policy in which certain experiments on the transplantation of foreign genes into bacteria would be deliberately renounced. This decision came about despite concern by the group that any specific document might be codified into too rigid a law; that police powers did not exist within science; that cheating might go on; that any such restriction diluted academic freedom; and that the issue was more than just scientific--it also hinged on moral and ethical considerations. Yet the judgments were made on the basis of perceived benefits versus perceived risks. How they will work in the future remains to be seen.

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[35]Janet H. Weinburg, "Decision at Asilomar," Science News (March 22, 1975); and Science News (March 7, 1975).

THE BROADENING OF THE CONCEPT OF EQUALITY

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The Issue:

The problem of inequality is as persistent as civilization itself. However, the United States was founded upon and dedicated to the principle of equality -- equality of opportunity. The essence of this concept meant that no man could be denied the chance for advancement because of his background or genetic heritage; however, it was always recognized that some individuals were likely to be more successful than others. Alexis de Tocqueville found this concept of equality so pervasive that it dominated his observations and interpretations of early nineteenth century America. His first two paragraphs of Democracy in America dealt with his perception of American equality.

> Amongest the novel objects that attracted my attention during my stay in the United States, nothing struck me more forcibly than the general equality of condition among the people. I readily discovered the prodigious influence which this primary fact exercises on the whole course of society; it gives a peculiar direction to public opinion, and a peculiar tenor to the laws; it imparts new maxims to the governing authorities, and peculiar habits to the governed.
>
> I soon perceived that the influence of this fact extends far beyond the political character and the laws of the country, and that it has no less empire over civil society than over the government; it creates opinions, gives birth to new sentiments, founds novel customs, and modifies whatever it does not produce. The more I advanced in the study of American society, the more I perceived that this equality of condition is the fundamental fact from which all others seem to be derived, and the central point at which all my observations constantly terminated.[1]

[1] Alexis de Tocqueville, Democracy in America, ed. Richard D. Heffner (Mentor Books: New York) 1956, p.26.

Despite the adherence to equality as an operating principle, inequality of achievement has persisted. Blacks have not yet joined the mainstream of American life; women are still denied equal treatment; poverty still exists; and wealth continues to be concentrated in the hands of a few. The existence of unprecedented levels of affluence side by side with abject poverty and the continuing inability of large groups of the population to achieve the promise of the American dream has now led to this "era of rising entitlements" -- the notion that the population is entitled to a minimum standard of living solely by virtue of citizenship and regardless of the individual's productive contribution to society. The welfare worker demonstrations, food stamp program, and demands for a guaranteed income are all examples of this trend.

Speaking of the broadening of the concept of equality, Daniel Bell has noted: "The equality that Tocqueville wrote about was generally considered to be equality of opportunity . . . In recent years the demand for equality has broadened considerably, and the term now refers to a wide range of political, economic and social demands. The demands, furthermore, are now defined as *rights*."[2]

The heart of the issue is the broadening of the concept of equality of opportunity. This has been a gradual phenomenon and the analogy of a foot race may be helpful in understanding the transition. Originally, the concept of equality of opportunity merely meant that all individuals could enter the race. Recognizing that this by itself may only perpetuate inequality, the concept has been expanded to make not only all contestants as evenly matched as possible, but also to make the course of the race as equal as possible for all contestants. And herein lies the problem: trying to equalize the contestants and their backgrounds. It is this process of equalization which

[2] Daniel Bell in "The Revolution of Rising Entitlements." Fortune (April 1975).

has been expanded and broadened. For instance, we no longer believe that individuals can equally compete if some begin each day hungry and suffer the long term effects of malnutrition.

To some degree, this expansion of the concept of equality of opportunity is a natural consequence of the level of affluence that has been achieved in this country -- level of affluence sufficient to ensure that no one need starve, go without medical care or adequate housing. These kinds of amenities are increasingly viewed as fundamental rights derived from the concept of equality just as equality before the court of law is viewed as a right. Notice that even the latter view of equality has been broadened. Equality before the court of law now includes state-provided legal service, recognizing that such equality requires legal representation for all.

The broadening of the concept of equality is not without conflict as many groups view the granting of the rights and amenities of equality as threatening to their own position. This leads to conflicts among groups, demonstrations, complex litigation and class action suits, increasingly vocal, media-based campaigns, occasional spurts of violence, and increasing federal government intervention.

The challenge to the U.S. is to respond to these changing concepts of equality, the notion of "entitlements" and to satiate these rising demands to the degree possible and to do so with minimum conflict and tension. The fact that such widespread inequality has persisted -- and in some areas even grown -- attests to the difficulty, even impossibility, of meeting these expectations. Increasingly, it becomes the role of the federal government to provide these amenities and to serve as the "equalizer."

The Dimensions of the Problem:

The heart of the problem is the persistence of inequality. While the United States is enjoying unprecedented wealth and affluence, there is still a large sub-population that exists outside this mainstream, and for whom the possibility of ever achieving even the average American level of affluence is declining. Real median incomes of Americans have consistently grown (see Figure 1); a larger and larger proportion of the population enjoy the ownership of automobiles, single family homes, and rely on extensive travel, long distance telephone, television -- all while spending a declining portion of their income on essentials. At the same time these average levels of income have increased, the public's perception of the level of income necessary to sustain an acceptable standard of living has increased as well.

Increases in the Minimum Acceptable Standard of Living:

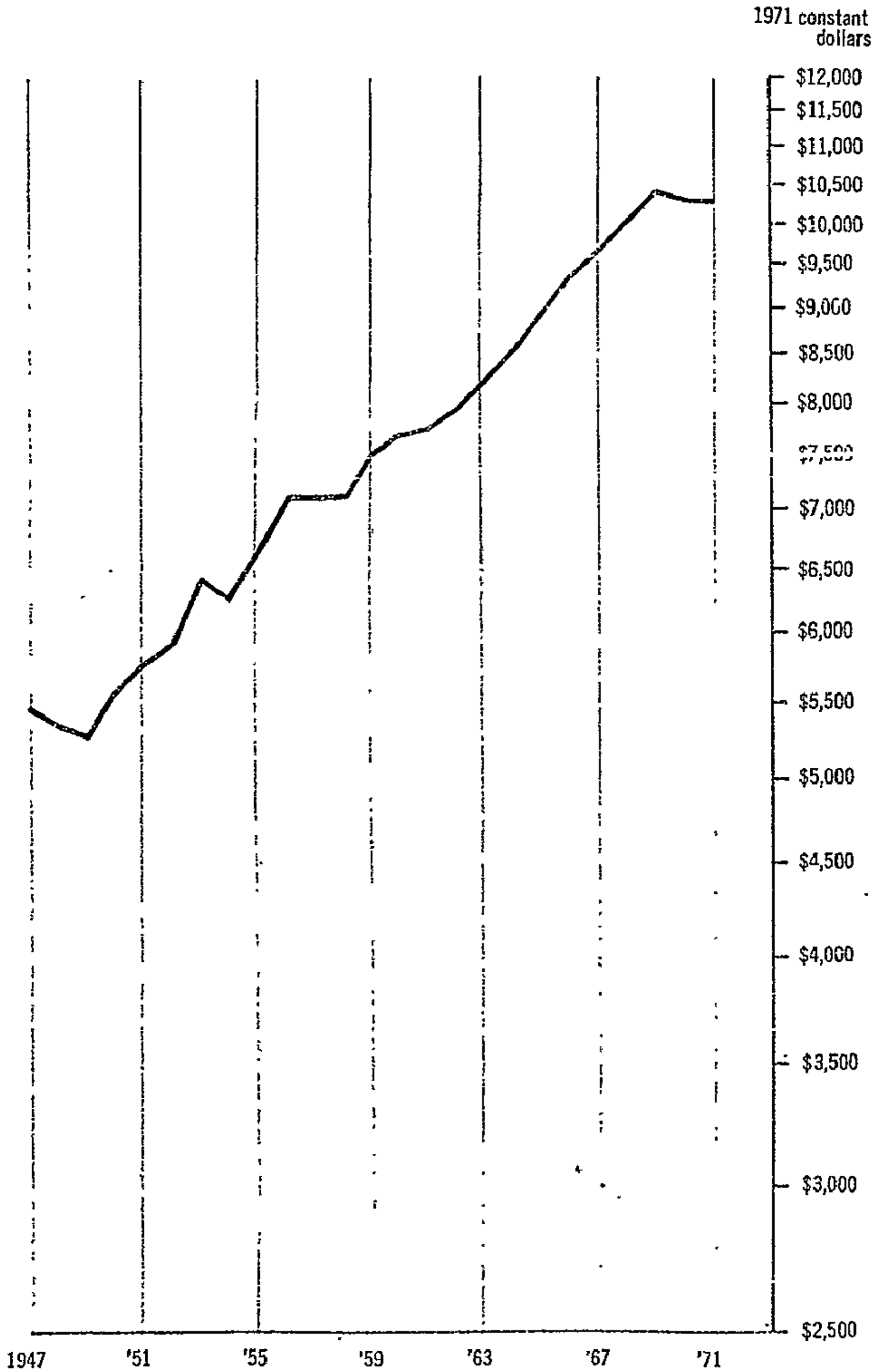
As affluence increases, so does the public perception of the minimum acceptable standard of living. A good example of this is the public response to the quality of housing. It is not that the housing market has failed, but rather that the quality of housing that is available at affordable prices through the market allocation mechanism is below the minimum acceptable standards for the population.

When a product is affordable by a few it is a "luxury." When its availability and consumption becomes widespread, then it is clearly an "essential" good. This transition from luxury to essential status is largely an irreversible proces because an infrastructure develops to support the essential good which in turn *makes* it indispensable. Consider, for example, the dependence upon the

FIGURE 1

GROWTH OF MEDIAN FAMILY INCOME

1947-1971



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Source: Office of Management and Budget, Social Indicators 1973 (Washington, D.C.: Government Printing Office) 1974.

automobile. In many areas the dependence is so great (Los Angeles) that the entire urban development has evolved around the availability of the automobile and there is not an adequate rapid transit system available. Another example is the refrigerator. It would be almost impossible to exist without a refrigerator in this country -- it would require at least daily trips to the grocery store.

The Persistence of Domestic Inequality:

The most compelling factor behind the transition in the concept of equality of opportunity is the persistence of inequality -- especially income inequality. There are many indicators of this income equality. Figure 2 displays the inequitable distribution of income since 1929. While there were some improvements during the Depression and World War II, the degree of income inequality did not change between 1946 and 1960, and then this inequality trend of improvement was reversed in 1968. It is important to note two aspects of the income inequality. First, everyone's real income has risen despite the relative differences. Secondly, the absolute gap (measured in real dollars) between the rich and the poor has increased. In 1950 the income gap was more than $12,000; by 1970 it had almost doubled to more than $21,000 (see Figure 3).

FIGURE 2

PRETAX INCOMES OF FAMILIES AND INDIVIDUALS IN EACH QUINTILE AS
A PERCENTAGE OF NATIONAL MEAN: 1929-1968

	1929	1935-1936	1941	1946	1960	1968	1970
Poorest Fifth	20	21	21	25	25	29	28
Fourth Fifth	45	46	48	56	55	57	55
Middle Fifth	70	71	77	80	80	80	79
Second Fifth	95	105	112	109	115	115	115
Top Fifth	270	259	244	231	225	218	223
Top 5 Percent*	600	530	480	426	400	334	344
Mean (Current Dollars)	$2,340	$1,630	$2,210	$3,940	$6,820	$8,840	$10,100
(1968 Dollars)	$5,210	$4,340	$5,380	$6,620	$7,860	$8,840	$ 9,040

*Excludes capital gains.

Source: Christopher Jenks, Inequality: A Reassessment of the Effect of Family and Schooling in America (Basic Books: New York) 1972.

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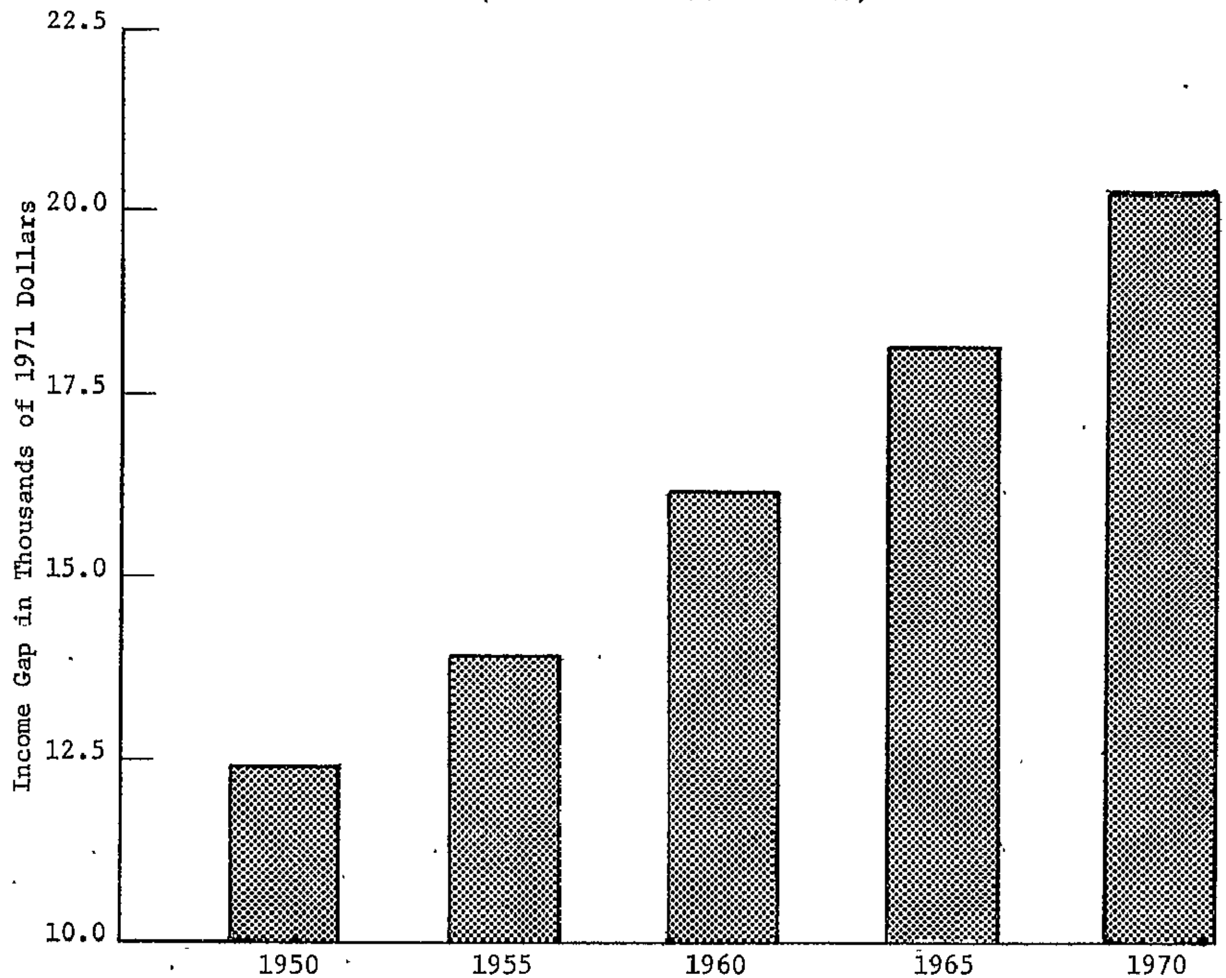
FIGURE 3

THE RISING INCOME GAP

Difference Between Mean Family Income of the Highest
Income Quintile and the Lowest Income Quintile
(In Constant 1971 Dollars)



SOURCE: Office of Management & Budget, Societal Indicators, 1973 (Washington, D. C.: Government Printing Office), 1974.

The poverty gap: While the number of families living below the low income level (that level of income necessary to sustain a minimum standard of living) has dropped, there is still a considerable segment of the population living in poverty. In 1959 22% of the population was below the low income level; by 1969 this had dropped to just below 14%, still a substantial portion of the population.[3]

Among the lower income population, it requires more and more members of the household to sustain the family. Hence, on a per capita earner basis (rather than on a family/household basis) the widening income gap would be even greater. For instance, well over 40% of all wives below retirement age work, compared to only 15% in 1940.[4] This increase is occurring for both white and black households. In 1959 only 34% of white families had both husband and wife working to support the family; by 1972 this had increased to 45%. In black families the trend has always been stronger: in 1959 44% of black families had both partners working to support the family, by 1972 this had grown to more than 56%.[5] In addition, the rate of second job holdings is gradually increasing. In other words, it requires the efforts of more people, perhaps for longer hours, and at lower hourly pay to earn the low income household's money -- and still they are falling further and further behind.

The income gap among the minorities: Despite impressive gains during the optimism of the sixties, black family median income is still only slightly more than 70% of white median income. In some categories it has actually been declining in recent years, as shown in Figure 4.

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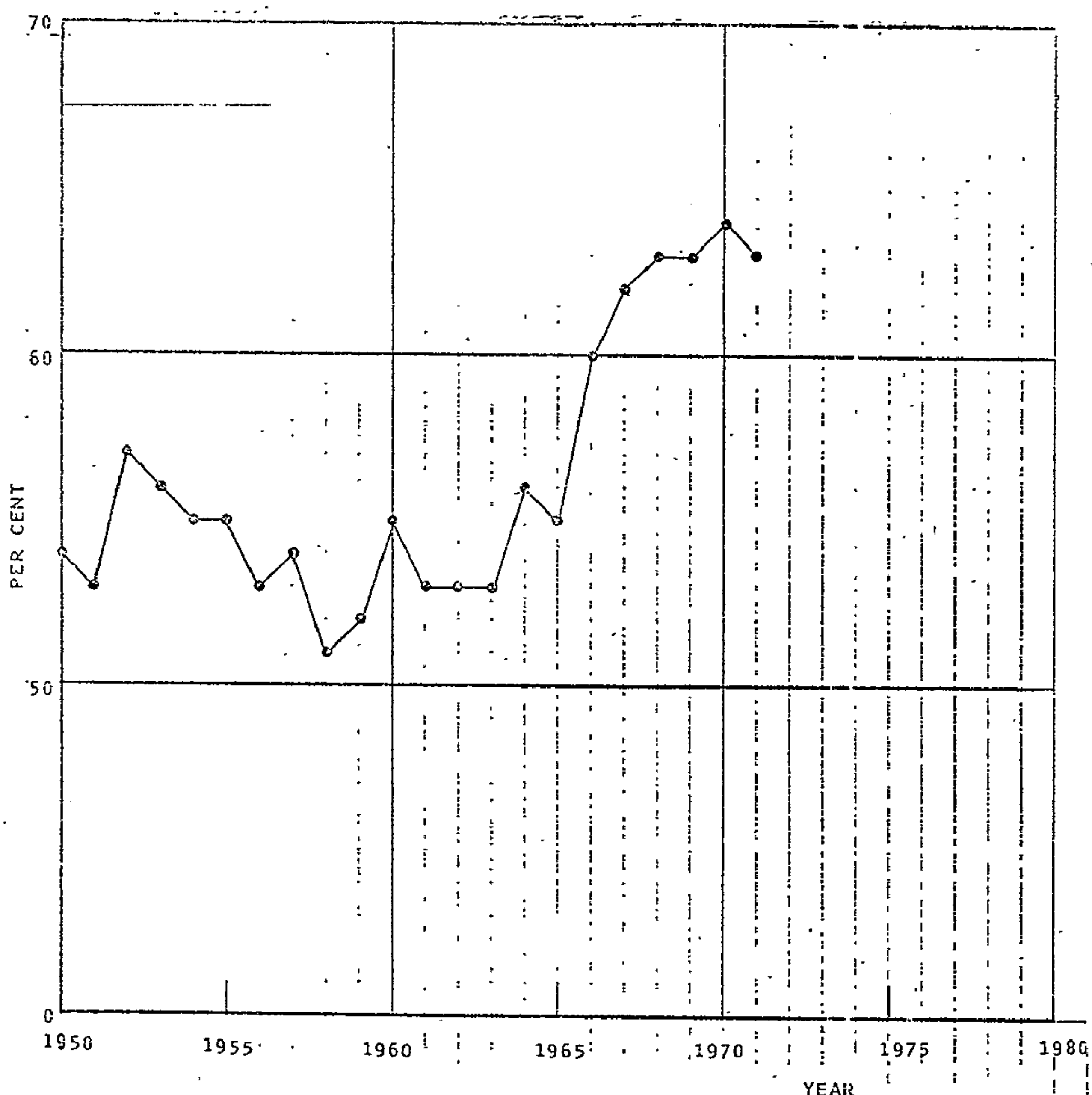
[3] U.S. Bureau of the Census, Statistical Abstract of the United States 1974 (Washington, D.C.: Government Printing Office) p.391.

[4] Ibid, p.340.

[5] Ibid, p.341.



Source: Bureau of the Census, Current Population Reports, Series P-60, No. 85.

FIGURE 4

MEDIAN INCOME DIFFERENTIAL -

RATIO OF NONWHITE EARNINGS TO WHITE EARNINGS

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Median female income is well below that of male income as well, as shown in Figure 5. This is true even within the same occupational levels.

The recent economic downturn has been especially harsh to females and racial and ethnic minorities because of the "last hired, first fired policy." In addition, many more women are likely to work part time than men and part time workers are among the first laid off in recessions. Of all employed women in 1972 about 25% worked part time, while less than 5% of the employed men worked part time.[6] Hence, women are likely to work less hours, at lower hourly pay, and be more prone to lay offs.

The quality of life gap: Achievement indicators as well as quality of life indicators for blacks are still considerably below that for whites. Infant mortality is higher, educational achievement consistently lower, crime indices higher, and indicators of family instability and social disorganization are consistently higher. Even when shackled with similar disadvantages black families are inequitably treated. For instance, black families headed by a female head of household earn considerably less than white families headed only by a female head of household.

There is still a considerable portion of the population that has inadequate housing. While considerable progress has been made in providing standard housing, over 7% of the households still live in substandard housing (defined as dilapidated and/or lacking some or all plumbing) and over 8% of families live in crowded conditions.[7] The difficulty in

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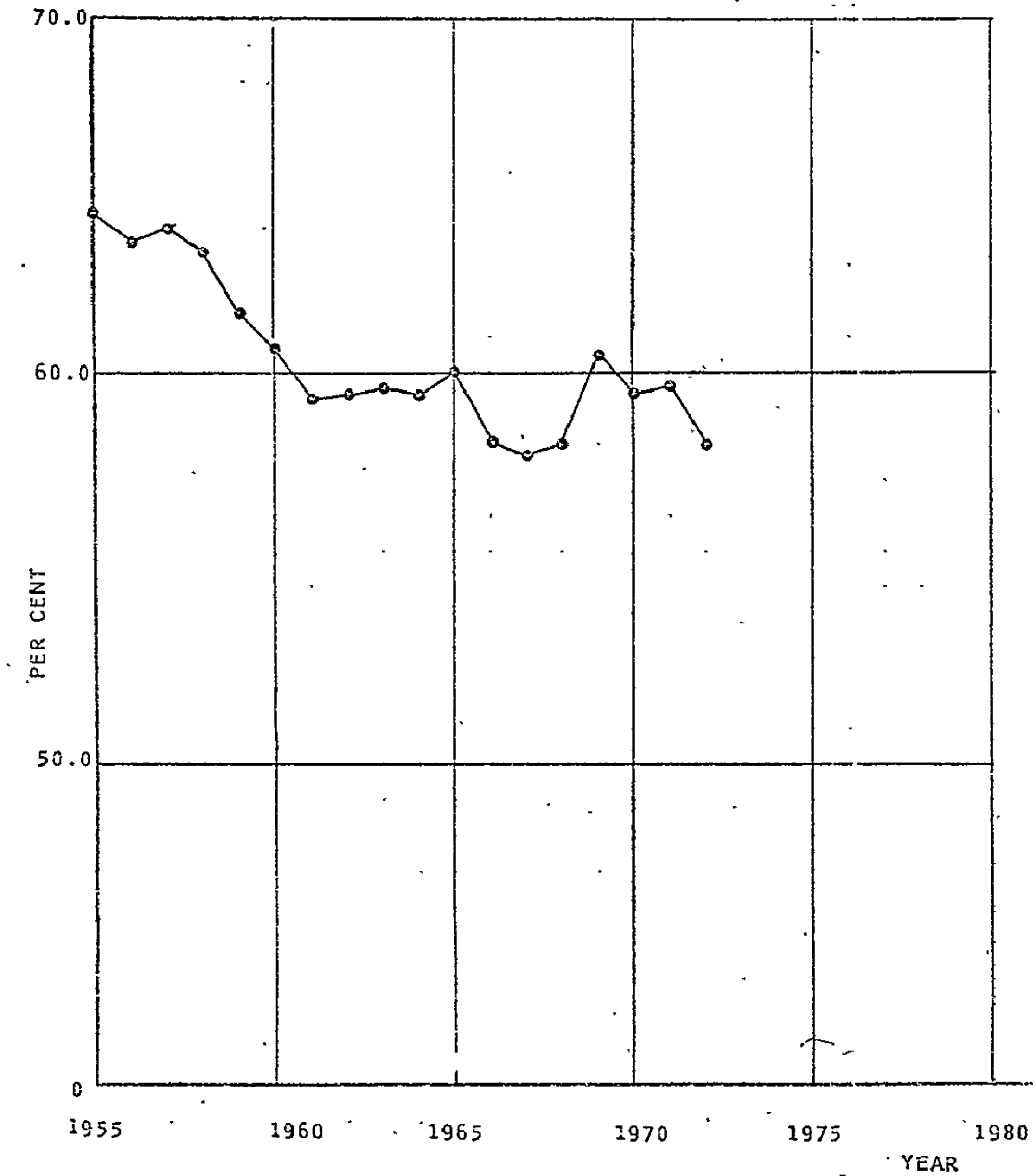
[6] Statistical Abstract of the United States, op.cit., p.339.

[7] Office of Management and Budget, Social Indicators 1973 (Washington, D.C.: Government Printing Office) 1974, p.206.



Source: U.S. Department of Commerce, Current Population Survey Series P-60.

FIGURE 5

MEDIAN INCOME DIFFERENCES -

SEX RATIO OF FEMALE MEDIAN EARNINGS TO MALE eradicating this last segment of substandard housing will be substantial. In fact, it may be increasingly difficult for the housing sector to maintain even its current level of quality. It is likely that the deterioration of the nation's housing stock combined with the escalation in housing costs will become a major social issue in the next decade. The problem stems from several factors. One, the large portion of the nation's housing stock is old and will require major renovation within the next decade, at a cost equivalent to replacement costs. Two, the rising costs of housing materials combined with the escalation of interest rates and the shortage of any kind of mortgage funds make the prospect for meeting this housing demand dim indeed. Inevitably, this will call for greater government intervention in the housing market to provide construction subsidies, rent subsidies, mortgage guarantees, and even mortgage funds.

The concentration of wealth: While the distribution of income is inequitable, the distribution of assets and wealth is even more highly concentrated in the hands of a few and the concentration is increasing. The top 20% of the population hold over 76% of the national wealth while the bottom 60% of the population hold less than 9% of the wealth (see Figure 6). The inequity is further demonstrated by noting that over 50% of the population has a net worth of less than $3,000.[8]

Much of the national wealth is not owned by individuals at all but is owned by corporations and foundations. Corporate assets are not only growing but the concentration in a few firms is increasing. In 1960 firms with assets over $1 billion controlled almost 28% of the total corporate assets; by 1973 this size-class controlled almost 53% of the assets.[9]

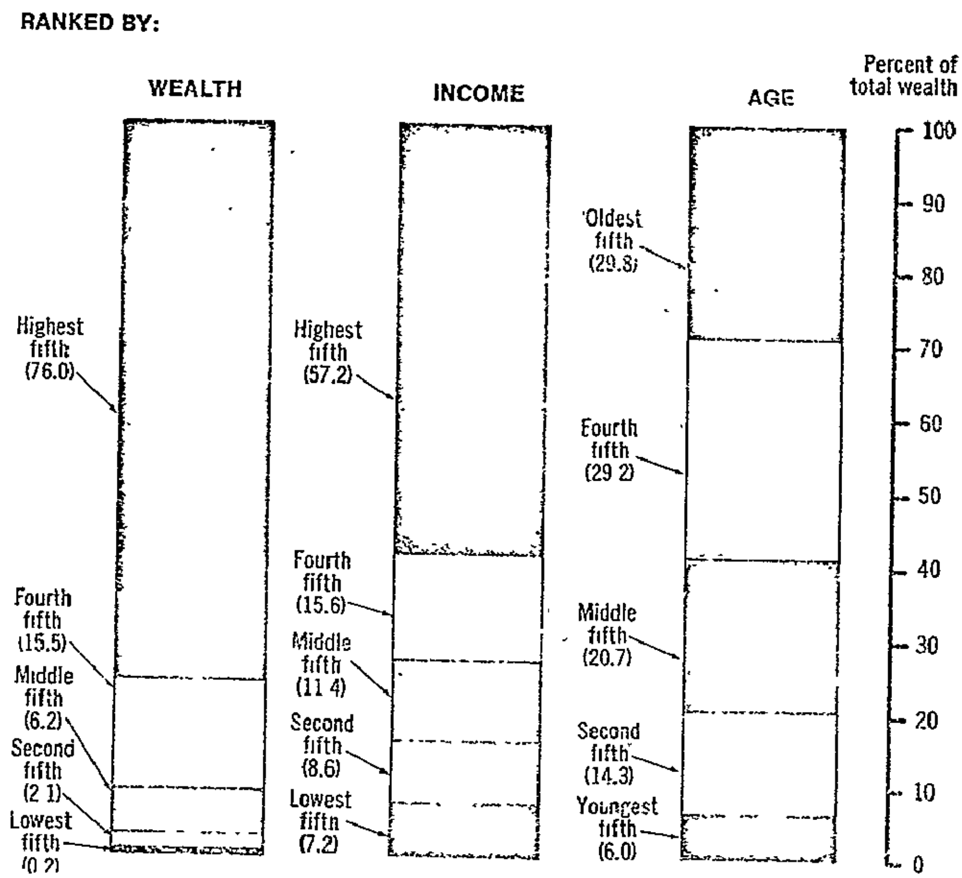
[8] "Distribution of Financial Assets" by James D. Smith, Steven D. Franklin, Douglas A. Wion. Based on 1969 data.

[9] Statistical Abstract of the United States, op.cit., p.4-8.

FIGURE 6

DISTRIBUTION OF WEALTH: 1962

Fifths of Consumer Units Ranked by Wealth, Income and Age



Source: Office of Management and Budget, Social Indicators 1973 (Washington, D.C.: Government Printing Office) 1974.

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The inequitable allocation of income and wealth in this nation is not atypical internationally; and in fact, income is more equitably allocated here than in most other Western countries with the exception of the more equitable allocation in Sweden. What makes the persistence of inequity so critical is that the American myth and the American dream led to the conclusion that not only was equity desirable, but was, in fact, achievable. It was firmly believed, especially in the euphoria of the early sixties, that poverty *could* be eliminated. In fact, much of the current dilemma and the changing perceptions of equality stems from that belief that poverty could be "cured." At that time the federal government accelerated the level of social welfare programs with the expressed goal of eradicating poverty and equalizing opportunity once and for all. Such programs fueled the level of expectations higher yet, and when the rhetoric and promises of the programs were not met, the level of frustration increased and the violence of the sixties and disenchantment of the seventies resulted. The result of the persistence of inequality is the evolution in the concept of equality itself, and the current demands for broadening the conept of equality.

The Development of Equality and Inequality in the United States:

The central assertion of this issue is that the concept of equality of opportunity in this country is being broadened substantially to permit more equal participation and competition in the mainstream of American life. Equality of opportunity has been a fundamental tenet of liberal political thought for the past three centuries and the notion of a broadened concept of equality is clearly within the mainstream of American political thought. What has contributed to the expansion of the concept of equality?

(1) Historical Political Heritage: The nation was founded on the liberal tenet of equality. We have spoken of Tocqueville's fascination with equality in America. Thomas Jefferson was similarly enthralled with the American concept of equality.

As Daniel Bell notes, the transformation of "equality" is not a recent phenomenon. While the founding fathers spoke frequently of equality, at that time there was no consensus on the meaning of the concept. Equality as used by the Puritan forefathers was equality in a virtuous sense, Bell called it the "equality of the elect."[10] The writers of the Federalist papers saw equality more in the sense of independence from an external force as well as equality of opportunity. But this liberal notion of the equality of opportunity implied an aristocracy of sorts: the notion of equality of opportunity meant that men of equal talents and intellect would have equal opportunity. As Bell again notes, it implied an aristocracy of intellect. Since thought was prized, it was assumed that some men thought better than others, were more able, more intelligent -- and so formed the natural aristocracy.[11]

The foundations of the nineteenth century liberal view of equality were based on the concept of the rights of the individual: the state and government existed so that the individual could best maximize his potential. It is clear that the American system has been extraordinarily successful at this, as the previous discussion of the concentration of wealth indicates. Beginning sometime in this century the notion of good for the greatest number, but for all, a minimum, began to be expressed. This was to some extent the natural

[10] Daniel Bell, The Coming of Post-Industrial Society: A Venture in Social Forecasting (Basic Books: New York, 1973) p.424.

[11] Ibid.

outgrowth of the level of affluence the nation was experiencing, as well as the recognition that merely opening the doors did not guarantee equality. The concept of the "group good" was expanded as well to include the protection of the environment and the individual from the onslaught of unrestrained industrial and technological growth. This recognition of the need for the federal government to intercede in the market system paved the way for the role of the government in affecting the broadening of the concept of equality.

(2) The Protestant Ethic and the Myth of Horatio Alger: A natural outgrowth to the individual oriented concept of equality of opportunity was the Horatio Alger myth that sprang up during the economic growth of the Industrial Revolution of the late nineteenth century. This reinforced belief in the land of plenty: any one can become rich and famous in the United States if they go to school, learn their lessons, and work long hours. (Hard work always pays off with success, and there is room for success for all. People who did not become successful clearly did not work hard enough.)

There were enough "poor boy makes good" and "immigrant man makes a million" stories to keep the Horatio Alger myth alive for almost two centuries. This in turn led to the further belief that poverty was the fault of the poor: poor people are lazy and if they wanted to improve their lot they could "pull themselves up by their bootstraps." But, the Horatio ALger myth has turned out not to be true -- and especially irrelevant to the problems of religious, ethnic, and racial discrimination and to those trying to break from the "vicious cycle of poverty." Regardless of the level of effort, an individual expends, there may be barriers so great that hard work alone will be insufficient to overcome them.

There is increasing evidence that everyone *cannot* make it, that there are not enough jobs to go around regardless of educational level, and hard work simply may not always pay off. Recent public opinion polls indicate a declining belief in the rewards of hard work. In one study 83% of the sample indicated that they believed that people who work hard and live by the rules are not getting a fair break.[12] Another study indicated that among college age youth only 56% agreed with the statement "hard work always pays off," a substantial decline from 79% in 1969.[13] This represents a significant change in values from earlier generations.

(3) Education as an Equalizer: Another major premise of the founding of the republic was the role of education as an equalizer and the route to success; hence, the commitment to universal free education. There can be no question that universal education has served as an equalizer, especially during the great influx of immigrants. In fact, this argument of education as an equalizer is still being used to justify free undergraduate tuition at CUNY in the current debate over New York's impending bankruptcy. The New York Times noted,"Despite the high cost, CUNY provides high-level manpower of the type essential to the city's survival, while integrating poor American and foreign newcomers into the mainstream of urban society.[14] Universal education is undoubtedly responsible for the pervasiveness of a common single language, a common values and universal expectations about the future.

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[12] Study by Yankelovich, Skelly and White for the American Jewish Committee, Described in Boardroom Reports (December 30, 1974) p.6.

[13] New Morality, Daniel Yankelovich, 1974.

At the same time universal education was creating common value systems and common expectations, it was also the purported route to achievement of these expectations and goals. In the past, education clearly provided one of the routes to economic success as well as upward mobility. But as the median level of education increased, higher and higher (and more and more expensive) levels of education became necessary for economic success. This, in turn, served to further discriminate against economic, ethnic, and racial minorities who were unable to meet the prerequisites. Hence, while decades of universal education had succeeded in generating a pervasive set of common values and expectations about the future, higher education was now becoming closed to a large portion of the population. This, in turn increased further the levels of frustration, and undoubtedly contributed to the violence of the sixties.

During the social advances of the sixties one of the major thrusts of federal government programs was to improve quality of education and the access to education, based on the assumption that broadening the access to education would broaden equality of opportunity. In addition to desegregation efforts, scholarship assistance was increased, reduced or free tuition policies were established, and "open" admissions policies were implemented. In lower education federal assistance was increased and many programs were established to compensate for the inadequate education background of disadvantaged students. This policy did indeed open up college and graduate education to large segments of the population -- for instance, over one-third of the undergraduates at the

[14] "State of the City: School and Campus," The New York Times, May 19, 1975.

City University of New York come from families with annual incomes below $7,500 -- at a time when a typical college year costs $5,000.

Despite these efforts, it is becoming increasingly clear that education is not the route to success and is not effective policy to reduce inequality. It is important to determine what the role of education has been in the past. There is no question that universal education has made possible the integration of immigrants from disparate cultures and it has enfused a common language and culture across the country, a feat that has not been duplicated in any nation of similar size.

Education did serve as the route to success for a long time in this country. During the era of scarce skilled labor and abundant cheap resources, education was the path to success. The current situation is reversed: abundant skilled labor and scarce, expensive resources. This combined with a change in the kind of business being conducted in this country and the way business is conducted spells a different future. Automation, computer control and continuous processing mean the decline of labor in manufacturing. The transition of the economy to a service based economy hardly is the way for meaningful, skilled employment. Technological innovation not withstanding, service jobs are still low skilled. Hence, education is unlikely to serve as the route to success (at least occupation and income success) in the future.

Despite these efforts, it is becoming increasingly clear that education is not the route to success and is not effective policy to reduce inequality. In a major examination of the role of education in reducing inequality, Christopher Jenks concludes that: "None of the evidence we have reviewed suggests that school reform can be expected to bring about significant social changes outside the schools. More specifically, the evidence suggests that equalizing educational opportunity would do very little to make adults more equal...Eliminating all economic and academic obstacles to college attendance might somewhat reduce disparities in educational attainment, but the change would not be large. Furthermore, the experience of the past 25 years suggests that even fairly substantial reductions in the range of educational attainments do not appreciably reduce economic inequality among adults."[15]

Jenks suggests that the reason education has failed as an equalizer is because of erroneous assumptions underlying education and poverty policy. The strategy of the "War on Poverty" was to equalize job skills so that everyone would be competitive in the job market. Jenks identifies three implicit assumptions of this strategy:[16]

1. Eliminating poverty is largely a matter of helping children born into poverty rise out of it;

2. The primary reason poor children cannot escape from poverty is that they do not acquire basic cognitive skills;

3. The best mechanism for breaking this vicious circle is by educational reform.

Jenks' analysis concluded that these assumptions are invalid.

Specifically:

1. Poverty is not primarily hereditary. For instance, there is nearly as much economic inequality among brothers raised in the same house as in the general population.

2. The primary reason some people end up richer than others is not that they have more adequate cognitive skills. In fact, economic success appears to be a function more of luck and on-the-job competence which in turn seems to depend more on personality than on technical skills.

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[15] Christopher Jenks, Inequality: A Reassessment of the Effect of Family and Schooling in America (Basic Books: New York) 1972, p.255.

[16] Jenks, op.cit., p.7-9, 255-257.

3. Finally, there is no evidence that school reform can substantially reduce the extent of cognitive inequality. Neither school resources nor segregation has an appreciable effect on test scores or educational attainment. Even when a school does exert an enormous influence on a child, the results rarely persist into adulthood. It takes a huge change in elementary school test scores to alter adult income by a significant amount.

Another study prepared for the Carnegie Commission analyzed the contribution of a college education over a high school education to income.[17] While an undergraduate education increased earnings by 31% over a high school degree, further education cannot be justified on the basis of its contribution to earnings. In fact, graduate education *decreased* earnings potential compared to undergraduate education alone. Graduate work (but no degree) increased earnings by only 26% over a high school diploma and a Ph.D. by 26% -- evidence of the underemployment and over-education of the labor force. The study further tried to analyze the relative contribution of mental ability, family background, age, marital status, health and quantity and quality of education to earnings and found that the most significant correlation (more significant than either education or ability) was between earnings and marital status, interpreted as a proxy indicator for motivation and the need for income. The study further concluded that there is little reason to justify education on the basis of its contribution to earnings and the nation has over-invested in education -- the costs of education greatly exceed the social rate of return.

Hence, the entire premise of education as a route to success appears to be invalid. Despite the educational and psychological evidence to support this contention, the myth persists and the level of educational attainment keeps

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[17] Paul Taubman and Terence Wales, College as an Investment and a Screening Device. A Report prepared for the Carnegie Commission on Higher Education and the National Bureau of Economic Research (McGraw Hill: New York) 1974.

rising. This is generating a new series of problems because of the *over*-education of the labor force for the existing jobs. There is no system that encourages or even permits matching of college/vocational training with job market requirements; and as a result the nation is creating surpluses of teachers, engineers and Ph.D.'s, among others. Graduate school is quickly becoming one route to unemployment or underemployment. Myron Clark, past president of the Society for the Advancement of Management, estimates that 80% of all American workers are underemployed.[18] Daniel Bell has noted in The Coming of the Post Industrial Society that the nation may be moving towards establishment of a new meritocracy composed of the 20% of the population holding all the "good" jobs.

The problem of underemployment is serious for society as a whole. Studies at the University of Michigan indicate that when a worker feels under-utilized he eventually develops physical and mental health problems. According to a Sandia Laboratory study, it is the intelligent creative blue collar worker, not the dull ones, who are probably the most responsible for damages, low productivity, errors and accidents in the work place.[19]

So what can be done now? Generations have been led to believe that education was the way to the American dream. The only solution is to cease misleading the public about the role and contribution of education. A recent article on education and unemployment concludes: "Simply put, the most constructive thing that can be done to improve the relationship between the worlds of education and work is to stop implicitly and explicitly selling education as an economic investment -- and instead to make students and then

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[18] James O'Toole, "Too Much Education for the Job," Washington Post May 18, 1975.

[19] Ibid.

parents understand that education is a goal unto itself but not automatically a formula for economic escalation."[20] Jenks concludes that "...school life is largely an end to itself rather than a means to some other end."[21]

(4) Mass Communications as a Divisive Force: Advances in mass communications in this century have brought into the home the vivid picture of inequality. It can be argued that widespread inequality can be tolerated rather peacefully by a society for long periods of time *if* those that are inequitably treated by society as a whole are not aware of their relative position. Television shattered this by bringing the Hollywood glamorized version of middle class American life into every home. Television and radio further contributed to the level of rising expectations by re-inforcing the Horatio Alger myth and re-inforcing the rewards of education as well as creating a proliferation of needs and wants. This kind of constant socialization contributed to the growth of a common but growing set of expectations about the future.

While the relation cannot be proven, it is probably not a coincidence that that the most active and violent period of the civil rights movement occurred just as television was permeating the majority of American homes. The proliferation of television drew attention in a dramatic way to the differences between the standards of living enjoyed by blacks and whites in a way never before seen.

The recognition of the persistence of inequality has been exacerbated by the increased mobility of the population. Spurred by the growth of the highway system, the widespread availability of automobiles and frequent job changes, Americans are probably more mobile than any other population group

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[20] O'Toole, op.cit.

[21] Jenks, op.cit., p.257.

in the world. This mobility brings many Americans into contact with people who are "more equal" than they are which further aggravates frustration and anger.

(5) The Rise of the Welfare State: As it has become increasingly difficult for individuals to provide a minimum level of existence for themselves, the federal government has increasingly begun to assume this responsibility. The movement of the government into the areas of providing individual wants and needs began in earnest with with New Deal during the Depression. It was then that Keynes convinced Roosevelt to try his revolutionary approach to stimulating the economy. That, combined with Roosevelt's concern for the unemployed, led to the development of job creation strategies as well as to the implementation of the first social security insurance legislation. The Social Security Act was passed in 1935 and provides old age, invalid and death benefits. Legislation authorizing unemployment insurance was passed the same year. Public assistance (aid and cash allowances to the aged, disabled, blind, and families with dependent children whose need arises from certain approved causes) are largely state programs except for the assistance of Federal funds granted to the states under the authority of the Social Security Act.

This period was the beginning of the federal government commitment to the individual. Since then the number, kinds and expenditures devoted to public welfare programs have grown enormously. The growth of federal government involvement in providing social welfare services is not likely to be reversed. Daniel Bell has noted that: "The government has made a commitment, to not only to create a substantial welfare state, but to redress all economic and social inequalities as well. And the commitment is largely irreversible."[22] Another commentator has noted: "The System has always lacked a reverse gear, especially in those movement that represent an ethical advance."[23]

This commitment had resulted in an extraordinary growth in the number of government employees, government expenditures and benefactors of the social welfare programs. Daniel Bell tells of a one-day survey of California in 1969. Out of 19.8 million people in the state, around 8 million were under social care of the government on any one day. The social care services included schools, hospitals, prisons, old age homes, daycare centers, and the like. Bell notes that the number under care was equivalent to the entire California labor force, 8% of which was employed looking after the government cared-for population.[24]

Nationally, only about 8% of the population receives direct welfare (see Figure 7), yet a far larger number receive a host of direct and indirect government services and subsidies. The cost of these programs has been tremendous.

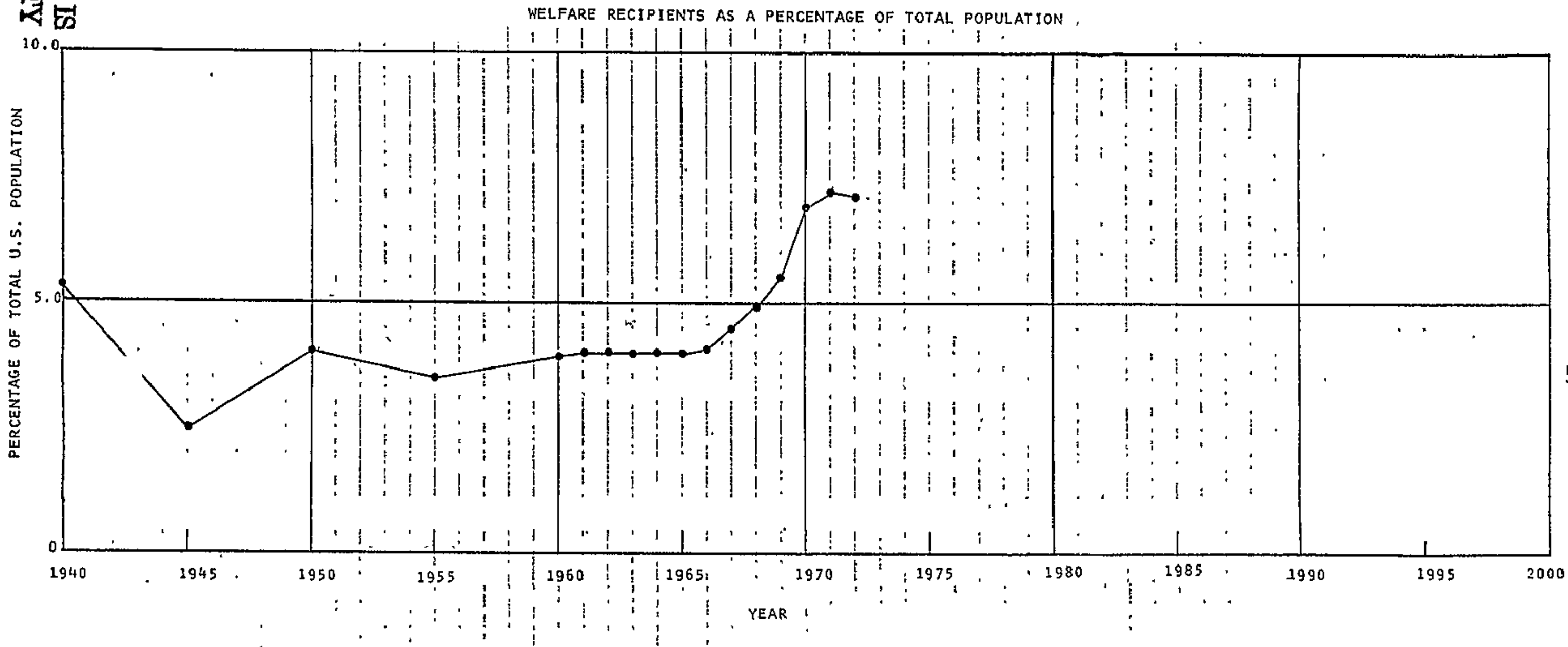
Since 1950 federal expenditures for social welfare has risen from \$10.5 billion to almost \$170 billion, from less than 25% of the federal budget to almost 50% (see Figure 8) and state and local governments spend an additional \$250 billion. Total outlays for these programs amount to 15% of the national income, up from only 4% in 1950. For the foreseeable future the costs of these programs cannot continue to grow at this rate as there is simply not the resource base available to meet these demands without massive changes in federal expenditure patterns. Already there are

[22] Daniel Bell,"The Revolution of Rising Entitlements," op.cit., p.100.

[23] Max Ways, "A Proposition that Freed a Torrent of Individual Energies," Fortune (April 1975) p.86.

[24] Bell, "The Revolution of Rising Entitlements," op.cit.

FIGURE 7



SOURCE: SOCIAL SECURITY ADMINISTRATION, SOCIAL SECURITY BULLETIN, ANNUAL STATISTICAL SUPPLEMENT

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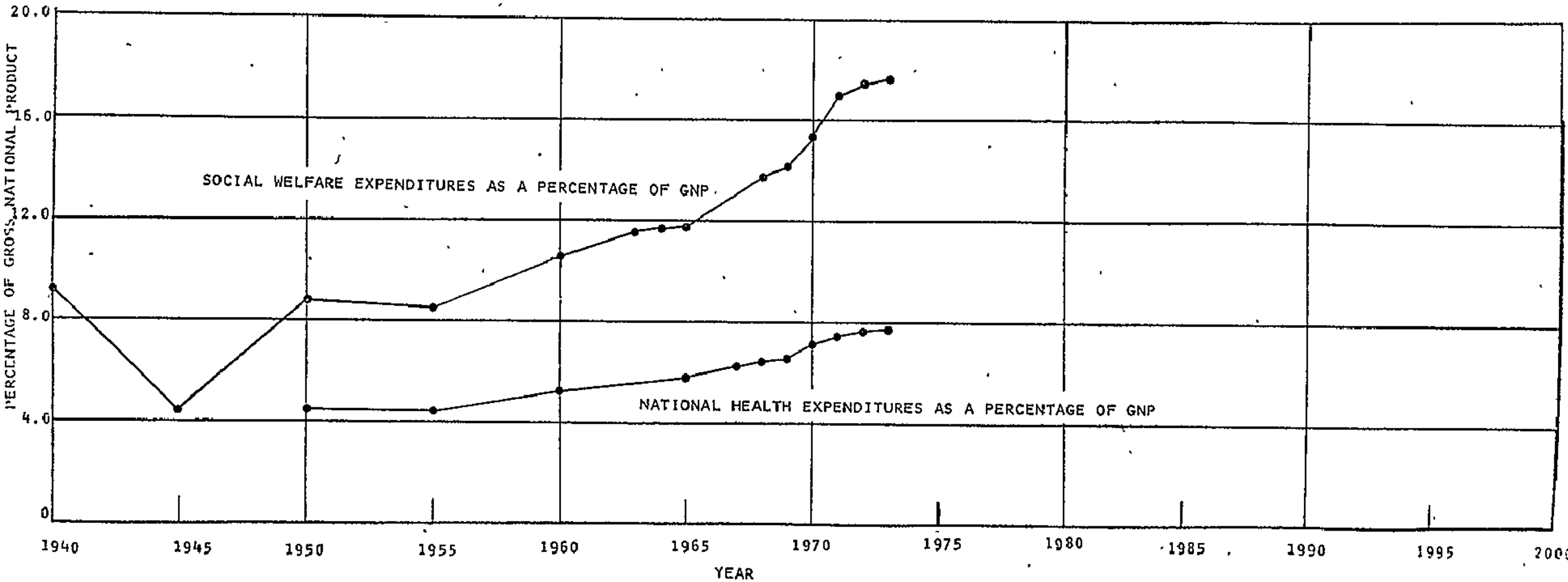
FIGURE 8

NATIONAL HUMAN RESOURCES EXPENDITURES



SOCIAL SECURITY ADMINISTRATION, SOCIAL SECURITY BULLETIN.

concerns that the Social Security program will be bankrupt because of the impact of demographic changes and inflation. New York City (which pays $1 billion out of the City Treasury for the support of the welfare population) is weeks away from bankruptcy. Regardless of the efficacy or agreement about the worthiness of these programs, reliance upon the traditional means of financing will not be feasible for long.

There are numerous kinds of government social welfare programs. The characteristics of these programs have evolved and changed over the decades since the Depression. The major changes have been in that the areas of *eligibility requirements* and the *individual responsibility* for the expenses. As the programs have evolved, the trend has been towards broadening the eligibility so that the programs are more universally applicable, and secondly, to minimize the recipient's direct share in the financial responsibility of the programs. Thirdly, the focus of the efforts have shifted gradually from merely charitable activities to the beginning of an income redistribution mechanism as the taxes of the middle and upper income population have been used to subsidize the lower income groups.

Finally, control over the recipient's behavior is declining as well. An example is the transition in the food assistance program from surplus food commodities in the form of a nutritiously balanced diet, to cash grants redeemable at grocery stores. Transition in the housing assistance program is another example of the declining role of the government in deciding what is best for the poor. Most federal government low income housing programs emphasized with subsidizing construction. The largest federal housing program (FHA and VA mortgages assistance) were not even for the low income but rather existed to help the middle class achieve the great American dream.

In fact, a minimum adequate income level was required to qualify for low income housing -- it was commonplace to be too poor for low income housing! These efforts are slowly giving way to direct rent subsidies, as authorized by the Housing and Community Development Act of 1974. This program will provide direct rent subsidies to low income families so that the individual family will be required to pay no more than 15 to 25% of their income for rent.

In summary, there are five categories of social welfare programs that have gradually evolved in a patchwork fashion in this country. They include:

(1) Special Purpose Assistance: It has always been recognized that there is a small subset of the population that because of physical and mental handicaps will be unable to care for themselves. Hence, the blind, disabled, handicapped, incurably insane, have always been viewed as legitimate concerns for government assistance. As well the nation has always felt a commitment to care for its war injured and maimed. The concept of "handicapped" has broadened somewhat recently so that individuals injured on the job have been included. These programs have rigid eligibility requirements and provide only minimum subsistence.

(2) Insurance and Income Maintenance Programs: There is another set of programs which provides income insurance and employment insurance. Largely involuntary and begun during the Depression Era, the Social Security Program and unemployment insurance program are the major examples. While these programs affect a huge portion of the population, they all have the common requirement that the individual must work in order to qualify. Unemployment benefits, for instance, are not available unless the individual has been employed. These programs typically require a financial contribution from the employee himself. These programs are often erroneously called "welfare" programs. Because the employee must contribute to these programs they are really no different from any other insurance program.

(3) Family Maintenance Programs: These programs are the most controversial and provide cash, rent, and food subsidies to low income families. Measured in terms of both federal government expenditures and number of recipients, these programs are probably the smallest of all social welfare programs, but these programs are the heart of the "equality of results" debate. Again, these programs have strict eligibility requirements; one can be "too poor" to qualify, and the presence of an able bodied male threatens the chance of benefits. Ablebodied adults without children are unlikely to receive benefits either.

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(4) Guaranteed Minimum Standard of Living: First proposed by Milton Friedman in 1962, there has been continual debate ever since. The negative income tax is the most popular method of implementing the concept because of the ease of administering it through the Internal Revenue Service mechanism. Essentially all residents would file income tax reports. Those whose incomes fell below a specified level would receive money, while those whose incomes exceeded the designated minimum income level would pay taxes. Advocates of this stress the ease of implementation, the relative inexpensiveness of administration, the lack of arbitrary rules requiring constant interpretation, the ease of avoiding scandal and "welfare cheaters," and the use of objective criteria. Opposition to the concept generally falls into several themes: opposition to getting something for nothing ("I work for my money, why can't he go get a job like everyone else?"), and fears that it would be disincentive for individual work and the entire nation would sit back and wait for the money to roll in. All experimental and case study evidence suggests that the latter fear is completely unsubstantiated and that in comparison to the current welfare system (in which income is taxed by 100%) would, in fact, *increase* the incentives to work.[25]

(5) Programs Based on Economies of Scale: There is a final category of government provided goods and services which are provided on the basis of economies of scale. An example of this is education. A second kind of service are those that are too expensive to be provided solely by the individual or private sector medical and heath care is increasingly becoming one of these services. Inherent in this category of programs and services is that the entire group or society benefits as well as the individual. For instance, the group benefits from police and fire protection are abvious. Society also benefits from an educated labor force and healthy labor force.

The greatest dispute and the greatest growth is in the last two categories of programs. It is here that the conflict over the relationship arises betwen individual contribution and individual benefit. It is also the area where the evolving value change and the perception of changing equality has its greatest impact.

(6) The Emphasis on Growth: A final factor that contributes to growing expectations and entitlements is the emphasis upon growth in the economy. The orientation and success of the national economy is based on the premise of continued growth, it is argued that without growth the economy cannot sustain itself; the structure of the economy dictates that

[25] David N. Kershaw, "A Negative Income-Tax Experiment," Scientific American (October 1972).

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it either grows or declines, it cannot maintain itself in a stationary position. This economic reality, combined with the corporate boardroom requirements of rising profits and sales, dictate policies that continually increase and stimulate demand. New "essential" products are continually being introduced which are often both wasteful of energy and materials as well as of questionable utility (witness the electric can opener, the electric shaving cream heater-upper). This escalation of needs and the gradual transition of goods from "luxury" status to "essential" status all contribute to the general pattern of rising expectations for increased standards of living. However, many of the so-called "essential" luxury goods are becoming increasingly beyond the means of a large percentage of the population. For instance, large cars, color televisions, luxury appliances -- all once symbols of the American dream -- are being replaced by an emphasis on durable, long lasting and utilitarian tools and appliances.

The standard American symbol of "success" -- the single family home -- is becoming an increasingly elusive goal for the majority of the population. The average price of a single family home is $36,000 to $37,000, while the average family income is only about $12,000. A standard rule is that a consumer can afford a home only costing twice his income. Hence, a minimum income necessary for the average new home is $18,000, an income level reached by less than 20% of the population.

The entire structure of the manufacturing industry in this country is built on this notion of stimulating higher and higher levels of unfulfilled wants, all of which tend to reinforce higher and higher levels of expectations.

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Some Positive Actions:

So what can be done? What can be done is largely a function of what the consensus on the evolving dominant value structure and national goals turns out to be. If, as we argue, the demands for a minimum share of the national wealth and income as a right of citizenship continues to increase the nation must respond to these demands to avert conflict, tension and even violence.

Jenks points out that the basic problem is not that of strategies to equalize incomes, but of convincing the public that this is a worthy effort for the American people. He comments:

> ...the best way to equalize competence is to make this an explicit objective of social policy and to encourage employers to reorganize work with this objective in mind. ....Nonetheless, kibbutz experience suggests that some disparities will also persist, even in a society that deliberately tries to reduce them.
>
> If we want to equalize the distribution of income, then, we need a more direct approach...
>
> However, the selection of a suitable mechanism for equalizing incomes is an interesting but politically irrelevant exercise. The crucial problem today is that relatively few people view income inequality as a serious problem...
>
> If egalitarians want to mobilize popular support for income redistribution, their *first aim should be to convince people that the distribution of income is a legitimate political issue*....Until they come to believe that the distribution of income is a political issue, subject to popular regulation and control, very little is likely to change...
>
> Nonetheless, if we want substantial redistribution, *we will not only have to politicize the question of income inequality but alter people's basic assumptions about the extent to which they are responsible for their neighbors and their neighbors for them.*[26] (Italics added)

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[26] Jenks, op.cit., p.263-264.

RAPIDLY CHANGING SOCIETAL AND INDIVIDUAL VALUES IMPACT THE COURSE OF MAN'S FUTURE WITH ACCOMPANYING CONFLICT, TENSION, AND ALIENATION

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ISSUE: RAPIDLY CHANGING SOCIETAL AND INDIVIDUAL VALUES IMPACT THE COURSE OF MAN'S FUTURE WITH ACCOMPANYING CONFLICT, TENSION AND ALIENATION

The Issue:

"Americans currently face a period in which few institutions, beliefs, or values can no longer be taken for granted. All are under strain, all are challenged. Basic transformations of man and society are now underway, and many vital choices of values must be made."[1] If the value system is irrelevant to the need of the emerging twenty-first century as this paper argues, then the search for new values and myths is conflict-ridden as the actions of today, even the search for new values, are determined by the current values, however irrelevant they may be. This conflict and the clash between "old" and "new" is the essence of the struggle for the re-definition of values in this country.

One of the more popular pastimes of the American press is examining new behavioral phenomena of the current times: changing lifestyles, the "generation gap," the implications of the communal experience, the transcendental meditation movement, "drop outs," and the return to nature. Columnists devote pages to the search for "meaning" in individual lives, to improving interpersonal relations, to communicating with their children. Part of this national debate derives from the need of individuals to be reassured about the transition from "traditional" values.

At the heart of these new behavioral experiences is a series of fundamental value changes which alters the rationale that underlies the basic legitimacy and motivations for man's activities. The popular

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[1] Robin M. Williams, American Society: A Sociological Interpretation (A. A. Knopf: New York) 1951.

analyses of the "generation gap" and the "counter culture" belittles the fundamental and rapid change taking place. There are momentous value changes occurring which are altering the course of man's future in this century from what it might have been had not these societal and individual goals been changed.

John D. Rockefeller has noted that the cause of this value change may be the conflict between the ideals that evolved in the first American Revolution and those of the Industrial Revolution. The American Revolution was based on humanistic values concerned with equality, justice, "life, liberty and the pursuit of happiness." These values rested on faith, goodness, dignity and the rationality of people generally. However, the values of the emerging industrial society -- the work ethic, the growth ethic, acquisitive materialism, the dominance of man over nature, the marketplace as the criteria for assessing worth and success, and a tendency to view profit and property as the highest priority terms tended to subordinate human considerations to the goals of scientific, technological and economic progress.[2]

Rockefeller believes the current era of change and value conflict is a result of the clash of the ideals and expectations of the founding fathers with the real world of the Industrial Revolution. His thesis is "that we can no longer continue on our present course. We can no longer tolerate two sets of values which are often in conflict, one dominant over the other. The time has come when we must synthesize these values in a coherent ordering of our lives and our futures."[3]

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[2]John D. Rockefeller, III, The Second American Revolution (Perennial Library: New York) 1973, p.36-37.

[3]Rockefeller, op.cit., p.39.

A synthesis of values is likely to emerge from this conflict according to Rockefeller. Most value theorists would dispute Rockefeller's interpretation of history. It is more likely that the synthesis of which he speaks has already emerged from the Industrial Revolution. The conspicuous consumption, materialistic values emerged *from* and were made possible by the Industrial Revolution, and were not dominant value themes before then. It is the values of the Industrial Revolution -- materialistic success measured by wealth, work (and therefore wealth) as the route to success and status -- that are currently being rejected and transformed, not the values of the founding fathers. The basic tenets of liberal thought -- equality, freedom, individualism, justice -- have always been maintained in this country, although their application has been broadened and transformed within recent times.

Technological advancements of the Industrial Revolution itself interacted with and fundamentally changed the value structure in a way that we are only just beginning to perceive. Does technology dictate values as Marx argues, or do values determine technological progress as Weber asserts? The synthesis of which Rockefeller speaks emerged in the early 20th century. It is the irrelevance of this synthesis, and its accompanying myths, to the emerging 21st Century and its problems that is the cause of the current conflict over the transition in values.

Daniel Bell argues that the values and spirit that were motivations for the Industrial Revolution were destroyed by capitalism itself. "Through mass production and mass consumption, it destroyed the Protestant ethic by zealously promoting a hedonistic way of life. By the middle of the twentieth century capitalism sought to justify itself not by work or property, but by the status badges of material possessions and by the promotion of pleasure. The rising standards of living and the relaxation of morals became ends in themselves as the definition of personal freedom."[4]

Yet it is the fact that these early 20th century ideals and values are irrelevant to the impending demands of the twenty-first century that is generating the transition in values. It is the conflict between the 20th century value structure and the requirements of the 21st century that is at the heart of this issue. The Puritan ethic and the Horatio Alger myth as motivations for the Industrial Revolution are two myths that are irrelevant -- perhaps even counterproductive -- to the emerging Post-Industrial Society.

Why are we concerned about values? Along with the innate drives (hunger, sex) values and other attributes that result from the personality development and socialization process are the major determinants of individual and group behavior. Socialization -- that process of transmitting culture and accommodating the individual into the societal mainstream -- is the basic process of transmitting, maintaining, and homogenizing the dominant value system. While societal values may not be uniform (non-conformity may be a value in itself), it is likely that there is a dominant set of values or behavioral themes of a society which provide the motivations and guidelines for that society. Essentially, violation of values or non-achievement of values is a major source of conflict. Hence, if we wish to understand group interaction, attitudes, the basis for behavior, the rejection or acceptance of new ideas and policies, then values must be understood. To the degree

[4]Daniel Bell, The Coming of Post-Industrial Society (Basic Books: New York) 1973, p.477.

that the future is determined by man's interaction with man and societal group interaction, values play a dominant, perhaps supraordinate role in the determination of group behavior.

Values: A Definition:

We have spoken at some length about values without precisely defining them. Professor Kurt Baier of the University of Pittsburgh has defined values essentially as an attitude for or against an event or phenomenon based on a belief that it benefits or penalizes some individual group or institution. This definition rejects the concept of values as intrinsic; instead, values become a manifestation of behavior and as such, observable and measurable.[5]

The sociologist Kluckhohn defined values somewhat differently: "values do not consist in 'desires' but rather in the desirable, that is, what we not only want but feel that it is right and proper to want for ourselves and for others. [Values are] standards that transcend the impulses of the moment and ephemeral situations."[6]

Values then become an important assessment device, permitting the determination in advance, however unconscious, of the appropriateness of a given activity. Hence, to some degree values in our definition can easily be the basis for goal statements.

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[5] Kurt Baier, "What is value? An Analysis of the Concept," in Baier & Rescher, Eds., Values and the Future: The Impact of Technological Change on American Values (Free Press: New York) 1969, p.5.

[6] Clyde Kluckhohn, Culture and Behavior (Glencoe Free Press: New York) 1962, p.289.

A society has a host of devices to re-inforce its cultural values: the dominant themes of beliefs or sentiments that some activities, relationships, feelings or goals are important in the community's sense of well-being. One of the strongest ways of maintaining this cultural value system and re-inforcing adherence to its basic tenets, as well as maintaining a uniform cultural base, is through a *mythic structure.*

Myths: The Foundation of Societal Institutions:

Societies create these elaborate *myths* about specific ideal states to reinforce belief in the values they represent, and encourage activities that may result in their attainment. One student of the role of myths has noted that "they are not to be considered as describing any existing state of affairs (though they may be) or as asserting logical truths. Rather, they are expressions of what is to be considered as right or as ...'natural'... Myths also contain, usually covertly, an imperative or prescriptive meaning which directs individuals to seek to achieve the state which they purport to describe... myths are taken to be descriptions of how things would be in and of themselves (i.e., naturally) if men would be what they 'naturally' are."[7]

Myths, then, serve as powerful forces to reinforce and shape man's behavior along socially desirable and acceptable lines. The primary function of the myths is to underwrite the basic institutions of society, that is, myths serve to establish the rules of the game.

[7] John D. Shier, "The Myths of the American Family," in A. R. Doberenz, Ed., The Family Unit: Population Growth Symposium No. 3, The University of Wisconsin at Green Bay, 1972, p.32.

Among the more dominant myths are the *myth of the family* ("the large family is a happy family," "the family is the basic and necessary social institution," "pathological behavior results from family disorganization"), the *myth of work* (the Protestant ethic, "man's worth is in his work," "Horatio Alger" "everyone can be successful and wealthy if they work hard enough"), and the *myth of education* ("education is the route to success," "equal education makes equal people").

As can be readily seen belief in these myths reinforces valued behavior and valued personality attributes. The difficulty emerges when the mythic, supportive structure (the emotional framework man uses to justify his behavior, activities, and to some extent, his existence) is inappropriate to the cultural context. That is, like values, the myths can become obsolete and irrelevant to societal needs, and most importantly, irrelevant to individual needs and can become an important source of conflict and disillusionment. This is the case today: adherence to the traditional mythic structure (based on tradition values systems) is *not* satisfying or fulfilling the needs of the individual. The underlying premise of the myths is that if one's life is based on the myths, then a fulfilling, happy life will follow. But this is not the case. "It seems clear that we are in a period of crisis in terms of many of our social myths. This is a period in which many of the myths which have so long functioned to give order to life are losing their power. The far-reaching and even fundamental changes which have so altered the context of life in the Twentieth Century can no longer be accommodated by traditional institutions."[8]

However, adjustment of myths, like refinement of values is extraordinarily shattering to the individual and the group. In addition, myths are extremely long lived and resistant to change: "there is inevitably a massive resistance to change -- a willingness to endure considerable discomfort rather than seek alternatives."[9] At the same time, because myths are *not* the product of conscious acts of will, the ability to adjust -- even abandon them -- is limited. Because myths serve as the construct of reality and identity for those who subscribe to them, they are not easily abandoned. Psychologists have amassed a substantial amount of evidence to suggest the lengths to which individuals will go to protect and defend their self images and the amount of discomfort that they will endure to preserve them. It is a classic case of the preference for the "known evil over that unknown good."

However, as one attempts to redefine a new new value and a supportive mythic structure for it, the potential for disruption of other concepts and institutions is immense. One recommendation is to redirect our style of thinking and aim for a *synthesis*. "Whereas most of our thinking in recent decades has been conducted in the analytic and problem-solving mode, I want to suggest that it is time to redirect at least some of our energies to the task of once again seeking a synthesis of ideas."[10] It is suggested that the kind of thinking required -- the emphasis on interrelatedness and interconnectedness -- is being pursued by the young and the ecologists.

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[8] Shier, op.cit., p.37.

[9] Shier, op.cit., p.34.

[10] Shier, op.cit., p.41.

The need then, is for a holistic approach to discover the vision of man supportive and conducive to the demands of the future. The traditional myths have failed him.

Value Themes:

There are reoccurring themes and attitudes which manifest themselves in a host of specific values in this country. Before examining the changing values in society this section will attempt to describe some of the fundamental value themes that reoccur in American society. It has been noted[11] that the basic cultural attributes of American society which serve to differentiate it from other cultures include:

- basic moral orientation
- pluralism

Specifically, these attributes manifest themselves as the following reoccurring themes:

(1) Instrumental Action: The organizing principle of American society is active mastery rather than passive acceptance of any situation. This includes a low tolerance for frustration, emphasis on power and control, encourage of success, desire, and ego-reinforcement.

(2) External Physical Emphasis: The society emphasizes the external world of things and events rather than the internal contemplative experience of meaning.

(3) Open: The world view is open rather than closed, emphasizing adaptive, outgoing, assertive personalities and a world view that encourages change, flexibility, movement and flux.

[11]This section is adapted from a discussion of the characteristic American society in Robin M. Williams, Jr., American Society: A Sociological Interpretation (Knopf: New York) 1960, p.469-470.

(4) Rationalism: The culture places faith in rationalism rather than traditionalism, de-emphasizes the past and orients to the future, continually questioning processes so that things are not accepted just because they were done in the past in a specified manner.

(5) Orderliness: This refers to the emphasis on orderliness rather than unsystematic ad hoc acceptance of transitory experience.

(6) Universalism: The emphasis is on a univeralistic rather than a particularistic ethic. Such an ethic emphasizes application of uniform rules or principles, contrary to special treatment on the basis of some exclusionary criteria.

(7) Horizontal Interaction: The emphasis in interpersonal relationships on "horizontal" (i.e., peer group relations) rather than vertical relations (subordinate ordinate).

(8) Individualism: The culture emphasizes individual personality and development, rather than group solidarity and community.

These themes are manifested in a panoply of diverse values. Rescher has developed a "register" of specific values that reflect the value themes and are presented in Figure 1. It is the means of achieving these values, rather than the underlying themes, that are obsolete for the emerging Twenty-first Century and are undergoing fundamental change. It is this issue of value change that will dominate the rest of this chapter.

FIGURE 1

A TENTATIVE REGISTER OF AMERICAN VALUES

I. SELF-ORIENTED VALUES

1. personal "material" welfare (the right to life and the pursuit of happiness)
2. self-respect (the right to be treated as a person and as a member in good standing of the community; honor, honorableness)
3. self-reliance (self-sufficiency; rugged individualism and the pioneer tradition)
4. personal liberty (the right to endeavor to "shape one's own life," to work out major facets of one's own destiny and to go one's own way)
5. self-advancement ("success," ambition, diligence)
6. self-fulfillment (and "the pursuit of happiness")
7. skill and prowess

II. GROUP-ORIENTED VALUES

1. respectability (group acceptance, avoidance of reproach, good repute, conformity, the "done thing" and the "herd instinct")
2. rectitude and personal morality (honesty, fairness, probity, reliability, truthfulness, trustworthiness -- the "man of honor")
3. reasonableness and rationality (objectivity)
4. the domestic virtues (love, pride in family role, providence, simplicity, thrift, prudence, etc.)
5. the civic virtues (involvement, good citizenship, law-abidance, civic pride -- the "greatest little town" syndrome)
6. conscientiousness
7. friendship and friendliness
8. service (devotion to the well-being of others)
9. generosity (charity, openhandedness)
10. idealism (hopefulness in human solutions to human problems)
11. recognition (getting due public credit for the good points scored in the game of life; success and status)
12. forthrightness (frankness, openness, sincerity, genuineness; keeping things "above board," the fair deal)
13. fair play (the "good sport")

III. SOCIETY-ORIENTED VALUES

1. social welfare (indeed "social consciousness" as such)
2. equality
3. justice (including legality, proper procedure, recourse)
4. liberty (the "open society"; the various "freedoms")
5. order (public order, "law and order")
6. opportunity ("land of opportunity" concept; the square deal for all)
7. charity (help for the "underdog")
8. progressivism optimism (faith in the society's ability to solve its problems)
9. pride in "our culture" and "our way of life"

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FIGURE 1 -- Continued

IV. NATION-ORIENTED VALUES

1. the patriotic virtues (love of country, devotion to country, national pride)
2. democracy and "the American way"
3. "public service" in the sense of service of country (the nation)

V. MANKIND-ORIENTED VALUES

1. the "welfare of mankind"
2. humanitarianism and the "brotherhood of man"
3. internationalism
4. pride in the achievements of "the human community"
5. reverence for life
6. human dignity and the "worth of the individual"

VI. ENVIRONMENT-ORIENTED VALUES

1. aesthetic values (environmental beauty)
2. novelty

Source: Nicholas Rescher, "What is Value Change? A Framework for Research," in Baier and Rescher, Eds., Values and the Future (Free Press: New York) 1969, p.92-85.

<u>Value Change</u>:

To understand changes in society and the basis for future change, all theorists agree that understanding the driving forces of value change as well as a model of value change is essential. This implies a *science of values* -- long lacking, and clearly, a long way from development. A science of values requires a theory of value change which in turn requires a set of hypotheses which are consistent with each other, and consistent with an observable and empirically testable data base. Neither of these requirements are met, nor are they likely to be for some time. Examination of the historical data base by such theorists as Sorokin and Marx (among others) has led them to *opposite* conclusions. The lack of an observable data base, or even a consensus of what the observable or measurable variables should be, precludes a hasty solution. Yet, it is argued, that an understanding and theoretical basis for value change is essential to understanding social change, and hence, the future.

To maintain, or to further encourage the beneficient course of man's history, it has been argued, required an understanding of *value modification* to ensure that "good values" are maintained. "If the world we build is to be decent and humane (in terms of present values), if we are to place limits on, for instance, invasions of privacy or tinkering with the gene, we must understand the mechanisms by which control over technological changes can be exerted. We need to know who the controllers are -- and what values they hold."[12]

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[12] Alvin Toffler, "Value Impact Forecaster - A Profession of the Future," in Baier and Rescher, eds. <u>Values and the Future</u>: The Impact of Technological Change on American Values (Free Press: New York) 1969, p.18-19.

Modes of Value Change: There have been many attempts to generate an analytic framework for the study of social change and values. The philosopher Nicholas Rescher developed a typology identifying the *modes* of value change.[13] These modes identify the alternative mechanisms or channels by which value change occur. The modes are not to be confused with the cause of such value change, but they are merely the processes or mechanisms that occur that facilitate the value change, whatever the cause. The seven modes include:

(1) Value acquisition and abandonment: The most radical sort of value change, it is normally associated with religious or ideological conversion. Essentially it refers to an individual subscription (or non-subscription) to a particular value -- a change in his yes/no vote for a given value.

(2) Value redistribution: This refers to the change in the extent or pattern of distribution of subscription to a value in a society.[14] A value becomes a societal value when it becomes more and more generally diffused; that is, more and more extensively distributed throughout the society.

(3) Value emphasis and de-emphasis: A value may suddenly come to be emphasized because changes in the environment force it to the focus of attention.

(4) Value scaling: Values of individuals -- and to some degree, a society -- can be compared on a scale of higher and lower, and can be arranged on a hierarchy. This is an indicator of the *extent* of the individuals' commitment to the value.

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[13] The entire typology is adapted from Nicholas Rescher, "What is Value Change? A Framework for Research," in Baier and Rescher, eds., Values and the Future (Free Press: New York) 1969, p.68-72.

[14] "Subscription" as Rescher uses it merely refers to acceptance of the value. A subscriber is one who has, accepts, holds, is dedicated or gives his adherence to a given value.

(5) Value redeployment or application: This refers to the extension or limitation of the range of application. For instance, extension of equality to American blacks and Indians does not mean a change in the relative position on the hierarchy of this value, but rather, merely changed boundaries of application -- the range or domain of application has been increased.

(6) Value reassessment: This refers to a change in the standard of implementation of a value, or the measures for assessing the attainment of value within the range of application. An example would be a change in the traditional measure (education) of inequality. And this is exactly what has happened in the measurement of equality -- a change from equality of opportunity (education) to equality of results (income). The hierarchical position of the value of equality is constant, but the objective measures of its attainment or success and the domain of application, have been broadened.

(7) Value implementation retargeting: This refers to a change in the strategy used for satisfying a value or goal. Completion of a given activity, or the discovery that it cannot be done, may lead the individual to move on to another target for implementing the value at stake. This is a frequent mode of change for achieving racial equality in this country.

This discussion of value change -- using Baier's definition of values -- emphasizes the normative quality of this concept of values. The term "goal" often can easily be substituted for the world "value." This normative quality makes objective assessment of the contribution of a given event, phenomenon or activity to a value possible, and perhaps even measurable.

This discussion identified the mechanisms or processes by which values change in individuals and among social groups. It is through these modes that changes in values can manifest themselves.

The Sources of Value Change: Rescher also develops a conceptual framework for describing the sources of and forces for value change in society. He notes that value change can occur either derivatively or directly. Value change occurs *derivatively* when the value in question is subsidiary or subordinate to another value and changes because the primary value changes. This also implies value change when one is instrumental in the achievement of another such as in cause and effect relationships.

Value change is *direct* when it occurs because of the direct, immediate operation of causal factors. Here are the most fundamental kinds of value changes. Of course, a direct value change can also initiate derivative value changes, in fact, it is likely to do so. It is here in the area of induced, direct value change that the greatest concern of theorists lie. Rescher identifies several categories of induced or direct value change.

(1) Value change induced by ideological and political change. Here the basic cause of change is value indoctrination. Such value change can occur slowly and naturally through processes of conditioning, acculturation and propaganda or they can be imposed through authoritarian methods. One can see that in those areas of the world where socialist and communist political changes have been most successful, fundamental value change has occurred through a slow operant conditioning and reward process that has taken decades to achieve -- witness the massive changes in twentieth century China. Of course, this slow process of value change is more likely to change the fundamental culture of the area and persist in time than that kind of change imposed by an authoritarian government which is likely to be much more transient.

(2) Value erosion by boredom, disillusionment and reaction. This is a significant area of value change in American society and essentially refers to the erosion of importance of a value as a consequence of either the satiation of the value or the realization that it is irrelevant to society,

leading to disenchantment and disillusionment. "Is that all there is?" is indicative of this source of value change.

Material success as a goal and motivating force for human endeavor is losing favor as a dominant value through this process. Disenchantment with the boredom of work and the disillusionment with the rewards of material success have downgraded materialism and conspicuous consumption as a value.

(3) Value change induced by a change in information: Here the value change is of the purely cognitive sort typified by value changes brought about by discoveries in science. The fundamental changes brought by Keynesian economic policies may be of this sort. Familiarity with economics probably contributed to profound value changes by affecting the attitudes towards the role of government in the maintenance of full employment. Full employment became an explicit societal value. As success with Keynesian policy increased so did the value of full employment increase. This is not an uncommon correlation between the ability to attain a value and the importance of that value.

(4) Value change induced by technological and economic innovation. There is no question that this is one of the most fundamental effects upon values in our society today. Technology offers tremendous opportunities for the enhancement of traditional ideals and values; and poses grave threats to the realization of others. Consider for example the impact of the birth control pill. For the first time in the history of mankind it is now possible with full assurance to separate pregnancy from intercourse. The relationship between the birth control pill and the fundamental family and life style value change is unclear. Did sexual freedom lead to widespread use of contraceptives?

<u>Technology and Values</u>: It may well be that this is the most fundamental and profound influence upon values. The rapidity with which values have been observed to be changing is likely to be a function of the rapidity of technological innovation. Communications and increased mobility alone have had a tremendous impact on the perceptions of situations -- witness the impact of the proliferation of television upon the Civil Rights Movement.

The essence of the technology/values relationship is the question of causality: what is the leading edge of change, values or technology? This issue is at the very heart of sociological and historical debate, but we are sure of but one thing: the relationship is strong, but causality is unclear.

Marx, for instance, examining the historical basis for societal change, concluded that technology, especially as used by capitalists, so dominated society that it not only dictated values (and the seeds of the capitalist destruction) but profoundly changed the fundamental laws of history. Marx wrote:

> "...The profound intervention in the civilization base of human life signified by the scientific and technological revolution in its entirety -- viewing it in its intrinsic correlation with the whole complex of social revolution of our day -- cannot fail to impinge on the elementary laws of history. In many respects the course of civilization acquires a new logic and time scale."[15]

In other words, the influence of technology and science is so pervasive that it overrides every other aspect of society and dominates value change especially. Many "non-Marxists" would agree with this domination.

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[15] Karl Marx, <u>Selected Works, Volume I</u> (Moscow: 1933) p.210.

Other observers have concluded that ideology and values dominate the growth and development of technology. Pitirim Sorokin, an historical analyst of societal development, opposes the conclusion of Marx and has concluded that it is the non-material items of culture that are the prime movers of society; that is, ideology dominates technology.[16]

> "In a qualitative change of a system its component of meaning, values, and norms -- its ideology -- tends to change [and spread] first while its component of behavioral and material values, including technique, tends to lag in the change...Before a different airplane or gun or spade or any variation of a particular gadget is built, there is a prior variation of the controlling ideas. It is the conceived ideology that chooses its vehicles and not the vehicles that determine the ideology.[17]

This causal relationship between values and technological development is thought by Sorokin to hold true. However, just how important is causality?

Others assert that this relationship is not clear and that it is cyclic and serendipitous. While Kenneth Boulding believes the relationship is indeterminable, he does acknowledge the interplay of science and technology with values and attitudes:

> "In this great transition there has been a constant interplay between changing technologies and changing values... The interaction between values and technologies is so complex that it is quite impossible to say which precedes the other. ...It seems fairly certain, for instance, that there were changes in values, that is, preference systems, which were a necessary prerequisite for the rise of science...These changes in values, however, were not unconnected with certain preceding changes in technology... The development of the more elaborate folk technology imperceptibly changes the values of society which used it, and by giving man a little power over the material would perhaps increase his desire for knowledge about it."[18]

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[16] Charles P. Loomis and Z. K. Loomis, Modern Social Theories: Selected American Writers (Van Nostrand: Princeton) 1961, p.594.

[17] Pitirim Sorokin, Society, Cultural and Personality: Their Structure and Dynamics (Harpers: New York) 1947 p.659.

[18] Kenneth E. Boulding, "The Emerging Superculture," in Baier and Rescher, op.cit., p.345.

Other writers on the subject, such as Theodore J. Gordon, recognize the "apparent relationship between technology and values" but de-emphasize the question of causality. Gordon developed a closed loop system relating technology and values. The model implies that values influence the forces that drive technology both directly and indirectly -- but technology itself results in value change, which in turn affects the social forces doing research which, again, dominates new technology. Discounting the importance of causality, Gordon stresses the importance of the model as a way of conducting an ordered inquiry into the factors which define research.[19]

So what does the lack of consensus over the technology/values relationship mean for our inquiry into values? First, it means there is no theoretical base upon which to base any inquiry. The predictive capability is negligible, and the explanatory capability weak. Secondly, the data base is inadequate for a substantial test of any hypothesis. Thirdly, while historical evidence suggests that the relationship between technology and values is strong, and among the dominant determinants of values, the lack of understanding of causality implies extreme difficulty in developing a predictive capability. Hence, until the theoretical base exists and a model can be developed, future value changes can be explored largely by speculation assisted by historical analogy. In sum, we can only conclude that there is indeed a strong relationship -- however difficult it is to identify -- between technology and values.

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[19] Theodore J. Gordon, "The Feedback between Technology and Values," in Baier and Rescher, op.cit., p.150-151.

The study of values -- whether current or future -- is further complicated by the intrusion of values in their study. By this we mean that the observations and analyses may be tinged by the values of the observer himself. Hence, the objective study of values is obscured by the potential value-ridden bias of the researcher.

Rate of Change of Values: Until the last several centuries the rate of change of values was so imperceptively slow that it could not be observed within the lifetime of a single observer. Hence, most value studies relied on retrospective interpretations of perceptions of past events and consequences.

However, within the last three hundred years the speed of value change has increased enormously so that an individual can see fundamental change occurring within several decades. As mentioned previously, it is likely that this rate of change is related to technology and increases in the rate of diffusion. Clearly, the past two decades have been such periods in this country. This "speed up" of the rate of change may encourage observation and data collection so that the development of a theoretical base is possible.

It is the speed of the change that is at the heart of the conflict and tension. Despite our professed expertise, we really do not know very much about change -- we know that change is disruptive to social systems and in some sense painful for individuals to undergo. The entire thesis of Alvin Toffler's Future Shock is that the rapidity of this change is such that individuals cannot cope with it: the change is so rapid that it literally causes a physical illness. It may well be that the rapidity of this value change is so great that it is at the root of much of the disillusionment and alienation that is evident today.

In times past, the rate of change, whether of technology, values, institutions or whatever, was so slow that it did not wreak such social change.

Value Change in the United States:

Previous discussions have outlined the kinds of values that have dominated the American culture. We have repeatedly asserted that values are in fact changing. The purpose of this section is to explore the manifestations of these value changes. There are primarily four categories of evidence of value change. The primary indicators of value change are either direct or indirect. Direct indicators include overt changes in behavior. Indirect indicators of value change can be elicited from statements about value change, observations of friction, conflict and tension, as well as less obvious changes in behavior. Despite the use of public opinion data to support evidence of value change, public opinion data and surveys are notoriously inaccurate representations of such change. Opinions are situational and therefore, do not reflect values directly or accurately. Public opinion is relatively unstable and fluctuates with changes in the immediate situation, even in matters of grave consequences. Public opinion flows are unpredictable because the judgments are specific. Hence, public opinion data will not be cited here. The four categories of evidence are discussed below.

(1) Indicators of Social Disorganization: One of the primary manifestations of the transition from an old social order to a new social order is social disorganization. This is characterized by such things as an increase in crime and violence, mental and physical illness, juvenile delinquency, suicide, drug use and alcoholism, among others. All of these indicators of social disorganization are showing an increase. It can be argued that these kinds of social

disruptions are in fact related to urbanization and overcrowding[20] -- however, widespread urbanization is itself indicative of profound value changes.

Such social disorganization occurred in the past as well and accompanied the transition from a traditional, agrarian society to an industrial urban society. This kind of social disruption is similar to that which is occurring in many lesser developed countries as they begin the transitional process of modernization. It is not surprising that the United States is undergoing such a similar transformation as it enters the "Post-Industrial Society." The transition, however, into the Post-Industrial Society is only in its beginning stages and it is likely that as it progresses it will disrupt societal patterns of organization more substantially. Hence, we can foresee that these indicators of societal disorganization are likely to worsen in the short run.

Suicide rates, an indicator of social disorganization, has long been used as a measure of the group or societal cohesiveness. Emile Durkheim in a investigation pointed out that suicide was an indicator of social integration -- that is, the degree to which the individual was integrated into group life determined whether he would be motivated to suicide. Strangely enough either extreme was sufficient motivation for suicide: either high integration into the group or low, superficial integration into the group. The former is likely to provoke altrusic suicide, sacrificing individual life for group goals (i.e., Kamikaze pilots, the Vietnamese Buddhist monks), and the latter is likely to lead to suicide of disillusionment and alienation.

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[20] Robert J. Trotter, "Cities, Crowding & Crime," Science News (Vol 106) November 2, 1974 p. 282.

Both kinds of integration difficulties are likely to grow during transitional, conflict-ridden times. Hence, we should expect an increase in suicide rates. However, to some degree this may be tempered by the group solidarity that results from the challenge of a crisis.

(2) Indicators of Family Instability: The nuclear family has been the source and maintenance of human interaction for thousands of years and has persisted through hundreds of culture. The nuclear family based on the dyadic marriage that is so pervasive that some sociologists have viewed the conjugal unit as so basic as to differ little from the biological pairing of other mammalian species.[21] The sociologist Murdock has concluded, based on a study of 250 societies, that some form of nuclear family is found in every society.[22] Recently, rare cases of the disappearance of the nuclear family has been noted, such as the Israeli's Kubbutz.

Marriage is probably the oldest social invention, pre-dating even religion and is thought to have arisen with the evolution of Homo Sapiens. Historically, marriage has served the same functions: to legitimize parenthood and to legitimize sexual relationships.[23]

Suddenly the oldest social institution of mankind is being questioned. The nuclear family appears to be in trouble. While marriages are occurring at a higher rate than ever before, they are also failing at a higher rate than ever before -- divorce rates have been escalating since the formation of the republic, and at especially high rates in the last two decades.

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[21] Ralph Linton, "The Natural History of the Family," in R.N. Anshen (Ed) The Family: Its Function and Density (Harper & Tow: New York) 1959.

[22] George P. Murdock, Social Structure, (Macmillan: New York) 1949.

[23] Bronislaw Malinowski, The Sexual Life of Savages in Northwestern Melanasia (Harvest Books) 1929.

Concomitant with the declining stability of the marriage and nuclear family is the exploration and search for alternative life styles. The alternative life style movements, the "counter culture," is a much more fundamental manifestation of value change than the faddish quality the popular press gives it. This search for alternative life styles reflects the growing disillusionment with the traditional nuclear family. As discussed earlier in this paper, the myth of the family and the role of the nuclear family in developing and maintaining basic and desired values and personality attributes is at the heart of Western culture, and yet this very institution is being questioned, threatened and abandoned.

Some theorists[24] argue that it is the abandonment of the nuclear family and the dissolution of the family bonds that is the root cause of the social disorganization of which we have spoken. That these two phenomena are related is probably without question. However, the disorganization of the American family unit manifests the lack of fulfillment and satisfaction that it is providing the individual. Many of the alternative life styles are group oriented rather than couple oriented, and attempts are made to substitute the extended family for the nuclear family. What this may mean is that in a complex, highly technological, urbanized, information dense society the individual feels most comfortable, fulfilled and satisfied in a supportive group structure, rather than in the comparative isolation of a dyadic unit.

There are probably three other factors contributing to the decline of the nuclear family unit. One is the transition in the economic role

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[24] Urie Bronfenbrenner, "The Origins of Alienation." Scientific American (August 1974) p. 534.

of the nuclear family. In agrarian and early industrial periods the married state was essentially an economic necessity for both males and females. However, no longer do women need to be "supported" and no longer do men need to be "cared for." Hence, the economic justification of the nuclear family unit no longer holds.

Secondly, life expectancies have been extended so very much that the notion of "til death do us part" has assumed much greater dimensions than ever before in history. Rarely does mankind make a decision of any sort that he is happy with for fifty years -- and in the volatile field of human relations and differentially growing personalities, it is even more unlikely.

A final factor that is undoubtedly affecting the stability of the nuclear family unit is the advance in contraception technology that now makes it possible to separate sexual activity from parenthood. This undoubtedly reduces the need for marriage as legitimization of sexual activity.

(3) Failure of Social Binds: Another category of evidence that values are changing is the observation that the institutions which traditionally served as reinforcers of the status quo and desired values are no longer effective in this role and are themselves seriously threatened by the transformation of society.

In addition to the destabilization of the family, such traditional social forces as the church, school, social organizations and the like are not functioning in the traditional mode of socialization agents. The difficulty with the American educational system is legend and tied to the general disillusionment and alienation of American youth. At the same time the pace of education as an equalizing force and as the route to success is increasingly questioned. Recent analyses suggest that equalization of educational achievement has little to do with equalization of income. In fact, the growing over-education of the labor force is likely to become an increasingly severe problem of the future. Hence, the respect that education once enjoyed both as an activity as well as an institution is declining. And with it the function education served as a socialization agent, a force for cohesiveness, is declining.

Rigidification of traditional religious institutions has resulted in declining attendance and declining influence of religion over daily activities. Church attendance is lower than it has ever been, yet interest in meditation, ideational activities, and alternative states of consciousness has probably never been higher. A host of new religious sects are developing which are well attended and supported with tremendous furvor. There is increasing interest, even in respected academic and research circles, in the definition of life, the delineation between life and death and the quest for altered states of consciousness. The charismatic movement within the Catholic church, transcendental meditation and interest in parapsychology are but a few examples of this growing movement.

This movement indicates that the role of religious and spiritual experiences in man's life is changing. The function of religion as an explainer of the unknown and regulator of behavior is beoming increasingly irrelevant to individual needs in the emerging twenty-first century. This is accompanied by two auxiliary events: transition of the religious institutions themselves in an effort to maintain membership and influence and, at the individual level, an increasing search and exploration for meaning in life.

(4) Rejection of traditional and accepted myths: A final category of evidence of changing values is the increasing rejection of traditional myths and accepted role behavior. This, to some degree underlies all the other categories of evidence of value change. This category of evidence reflects the extensive conflict between existing, traditional myths and values and the new, emerging values of the Post Industrial Society. Much of the rejection revolves around the roles that individuals play in society. The notion that individual role types could be imposed upon individuals on the basis of gender, socio-economic status or family background is becoming increasingly rejected. This rejection is manifested in a variety of ways ranging from individuals seeking the traditional occupations of the opposite sex (i.e., male nurses, female telephone repairman), to abandonment of the traditional behavior or costume of a given role.

The rejection of traditional myths and role types is also becoming a legitimate concern of legislatures and the courts. To some extent this rejection is an expression of the broadening concept of equality of opportunity and is reflected in the Equal Rights Amendment, Anti-Age Racial Discrimination movement, and, of course, the Women's Liberation Movement. This movement essentially states that the role that an individual plays in society should be a function of the individual's desires and capabilities, rather than a function of any innate characteristics.

The Emerging Values of the Future:

Earlier discussions have described the kinds of values that have been the dominant American values. We have noted that the previous value revolution, that of the 18th century, occurred as the modernization supplanted traditional values and ethics. Talcott Parsons, the Harvard sociologist, describes this transition in terms of three sets of "pattern variables" that epitomized the change. The alternatives include "collectivity of interest versus self interest," "particularism versus universalism" and "functional diffuseness versus functional specificity." In each pair, the former pattern describes a pre-modern tendency and the latter a modern one. The collective/individual pair is self evident. The second pair, particularism versus universalism, refers to the modern value of criteria that are abstract, formal, and generally applicable to a host of situations, rather than a unique consideration of each situation. Such generalizable principles are at the root of the manageability of the bureaucracy -- "we can't make exceptions to the rules." The third pair, functional diffusion versus specificity, refers to the emergence of specialized functions within narrowly defined roles -- "that's not my job."

The current value revolution is a search for situations that can accommodate, to some degree, the pre-modern values. The Post-Industrial Society will be characterized by small group interactions in which individual interactions are dominated by the pre-modern values, but the interactions among the groups will be determined by the modern abstract values. An individual is likely to belong to several groups, of which each group is likely to have a very functionally specific role, but the individual role within the group is likely to be more diffuse.

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So what does this all mean? The abstract modern value structure that Parsons identified did not fulfill the requirements of individuals: they did not have a sense of meaning, well-being or satisfaction. One of the recurring themes is of alienation, loneliness, isolation -- all of which result in the search for meaning through group interaction.

John D. Rockefeller identifies how these new values will be manifest in attitudes and actions. His categorization includes:[25]

1) Positive view of nature: Increasing recognition of the importance of environment, conservation ethic and need for man to establish harmonious relationship with nature.

2) Positive view of man: Man is increasingly viewed as good rather than evil with an emphasis on "humanistic" values.

3) Sense of community: Underlying many of the emerging value trends is the need for community and group interaction to overcome the isolation and alienating qualities of industrialization and urbanization. The loneliness of modern life is quite pervasive, and this search for meaning through group interaction is likely to be a dominant theme of the value structure of the future.

4) Individuality: At the same time there is a growing sense of community, there is also a strong emphasis on individuality. This is not the contradiction that it may first appear; rather, within the support of a group structure the individual is freer to "do his own thing." This freedom of individual expression is consistent with the current rejection of traditional roles and myths.

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[25]Rockefeller, op.cit.

roles and myths.

Charles Reich has suggested that the loss of self is the most devastating problem facing America. "Beginning with school, if not before, an individual is systematically stripped of his imagination, his creativity, his heritage, his dreams, and his personal uniqueness; in order to style him into a productive unit for a mass technological society."[26] It is the rediscovery of self that is at the heart of the new values.

5) Freedom: Underlying many of the value changes is the expanded notion of freedom of choice of the individual. One key aspect of the emerging value system is a tolerance for diversity and a variety of life-styles and role behaviors. This increasing tolerance is essential to the broadening freedom of individual action and behavior. This broadening of freedom can be seen in such legislative changes as the reduction of the role of the state in the regulation of sexual and behavioral acts, the elimination of victimless crimes, and the increasing tolerance of previously proscribed activities.

6) Equality: As is discussed in some detail elsewhere, the basic concept of equality has been broadened so that the notion of what it is that constitutes equality is much greater than in previous times.

7) Participatory Democracy: The notion that democracy is a fundamental tenet of the nation should not be viewed as new or different. But what is new and different is the notion of participatory democracy -- each and every citizen has the right, perhaps even the duty, to make his voice heard in decisions that will affect him. In times past, this

[26] Charles A. Reich, The Greening of America (Bantam Books: New York) 1970, p. 7-8.

participation was delegated to a select body of elected officials who became an elite decision making body. As Alvin Toffler has noted, there is now a revolt of the "planees" against the "planners" and the result is that a large portion of the public is cancelling their previous delegation of responsibility to this elite. Charles Reich suggests that it is the universal sense of powerlessness that is the root cause of the dilemma America is in, "We seem to be living in a society that no one created and that no one wants." [27]

The rise of participatory democracy can be seen in the attendance at federal hearings, the growth of class action suits and the proliferation of social activist movements. Common Cause, the citizens lobby, is probably the best example of this growing trend. The reform of the operating rules of the House of Representatives is another example.

8) Social and Corporate Responsibility: The growing sense of responsibility for the consequences of a given action as well as responsibility for the entire group is a fairly new value and reflects the collectivist viewpoint. This social responsibility includes the concept of helping others, both as an individual and as a corporate body. It includes the concept of being responsible for the consequences of given actions in a very broad and general way. Caveat emptor has given way to caveat vendor in that the seller is responsible not only for delivering a product, but also for preventing, to the degree possible, the misuse of that product.

[27] Reich, op. cit. p.8

9) Changing View of Materialism: The conspicuous consumption era of the American public has come to an end. As Rockefeller notes, it is not that materialism does not count but rather materialism is placed in its proper perspective. Materialism is no longer seen as the route to heaven and happiness, but a good way to supply the basic material needs of life.

10) A Positive View of Work: Work is slowly being separated from duty, obligation, and the Prostestant ethic and is increasingly viewed as a way of expressing man's creativity and productivity. Work must be "meaningful" and enjoyable. This value will become increasingly difficult to satiate as Daniel Bell notes that soon only 20% of the jobs will be "meaningful" and the remaining 80% will be repetitive, boring experiences. The problem of overeducation of the labor force will exacerbate the difficulty.

11) A Rising Metaphysical and Religious Consciousness: Exploring altered states of consciousness and the frontiers of the mind is a new desire of man. In some individuals, this spiritual rebirth has religious significance, in others the metaphysical experiences are largely without a religious role. This exploration leads to questioning the demarcation between life and death, exploring the "hereafter" as well as trying to expand levels of consciousness.

Conclusion

So what does all this value change mean? The fundamental value change that is underway is part of the transition from the industrial era to the post industrial era. It is important to note that value change is not the *result* of this transition but it is a fundamental part, and perhaps root cause of it.

We have suggested the impetus for the value change underway today is the response to the increasing rate of technological innovation over the past century. We have also suggested that the values, institutions and myths of the industrial society are irrelevant for the emerging post-industrial society. The dominant characteristic of the emerging values will be the availability of a wide range of alternative lifestyles, roles and behaviors that are socially acceptable.

One of the characteristics that is developing is the tolerance for a proliferation of variety. No more will a single dominant life style be the only acceptable mode, nor will a single style of behavior be reinforced. "But you don't act like a banker" will be an observation of the past as there will be no such thing as "banker behavior." Society will tolerate -- even encourage -- greater diversity. Members of society who are now viewed as deviates (such as hippies) will be judged as legitimate members of society in the post-industrial society.

A second characteristic will be the search for meaning. The motivation and basic value of the industrial revolution was the demand and need for material rewards. These needs have been essentially satiated by the rapid achievement of affluence in this country. Now materialism will be superceded by the search for meaning in activities and of paramount importance is the meaningfulness of the work environment, school environment, and the interpersonal growth environment. Sorokin has called this phenomenon the increasingly sensate culture. We have noted the search for religious meaning but the search for meaning goes much beyond that to an exploration of alternative states of consciousness and an exploration of the boundaries of the mind. Examples of movements in this direction are the increasingly serious inquiry into the ESP and parapsychology and the growing consciousness movement (i.e., transcendental meditation). It is the search for meaningful activity that is leading some firms to redesign their factory layout to incorporate a greater sense of participation and meaningfulness in the work environment. Meaningful contribution will be a motivation for work where material reward will not. "Fun jobs" and the need to enjoy one's work are becoming essential.

A third characteristic is the removal of boundaries on role behavior. No longer will individuals be prohibited from certain roles or ascribed to other roles solely by virtue of certain innate characteristics such as sex, race, previous training, previous experience. Exploring and empirical learning will be rewarded so that behavior patterns become more flexible.

A fourth characteristic of the post-industrial society is increased responsibility of the group for the individual. The founding fathers viewed this nation as encouraging the individual to make the best of his life in every way possible -- yet the individual was responsible for his success or lack of success. A changing value is that society as a whole and its member groups have a responsibility to the individual members to not only assist them and maintain a standard of living but to protect them from physical and psychological harm. This notion of group responsibility for individual consequences has already been manifested in such things as the Product Safety Commission, the Environmental Protection Agency, the Consumer Protection Agency. Such organizations are predicated on the premise that the individual can be harmed as well as benefit from actions of the group; hence, the requirement for these restraints. This kind of growing responsibility stems from two factors. One is the persistence of inequality. The concept of equality of opportunity has been broadened over the past several decades as equality of results did not evolve. In fact, income inequality has been increasing in this country. A second factor is the growing realization that technology has disbenefits as well as benefits and that unrestrained technological growth can have grave negative impacts.

This value scheme described herein is the values of the emerging lost Industrial Society and are the values of probably only a small minority of the population so far. The transition to the post-industrial society and adoption of these values will be turbulent, as is any period of discontinuity.

Conflict and even violence are likely to occur over the next several decades as this evolution and transition takes place. The mass media has commented on the cessation of violence on the campuses and the streets and has assumed that the nation is once more "on the right track,"that is, the track of the glorious, blind optimism of the fifties. It would be quite erroneous to accept this analysis of the current behavior. During any mode of transition and conflict there is a continual flip-flop back and forth from old to new and new to old as the society tries to adapt to and incorporate changes. It is this kind of reaction-innovation-reaction mechanism that is currently underway. One could also note that the cessation of demonstrations and violence may have been prematurely celebrated as there is increasing evidence that with a continuation of the recession in the face of rising affluences in some sectors, some part of the population would take to the streets and demand redistribution of this income and demand employment. The major source of concern in the late sixties -- the Vietnamese War -- is gone but it may be replaced by a new concern -- the persistence of inequality. The existence of a large group of unemployed side-by-side with an even larger group of the population experiencing unprecedented affluence can do nothing but create violence and conflict.

One can foresee with a great deal of certainty that the next few decades will be conflict ridden. This discussion has implied that there is a consensus about the value structure of the future. It is quite clear that there is not a consensus, in fact, some writers have confused the processes at work and have ignored the cyclical behavior of innovation and reaction.

Values have always been changing, but never this rapidly. It is a threatening process because it strikes at the most fundamental belief and mythic structure of the individual, and it becomes especially threatening because the rate at which it is occurring is accelerating. Ideological transition and value changes is not a new phenomena and is as old as civilization itself. Great alarm and furor among generations should be understood for what it is which is a conflict between beliefs as ideologically engrained; it is the conflict between capitalists and communists. However, one can argue that one of the great current problems is that the beliefs and value structure underlying 20th Century America are inappropriate for the emerging problems of the 21st Century and it is only through this tortuous and painful process of value change that we can indeed hope to realize the promises of the future. But the transition will be filled with conflict.

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INSTITUTIONAL FAILURE CAUSED BY ORGANIZATIONAL AND BUREAUCRATIC INEFFECTIVENESS INHIBITING, PERHAPS PRECLUDING, CHANGE NECESSARY FOR SOLUTION OF SOCIETAL PROBLEMS

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The Issue:

There is increasing concern at all levels of government and industry as well as among the public that the increasing ineffectiveness and paralysis of American organizations, institutions, and bureaucracy is precluding solution, perhaps even contributing to the furtherance, of current economic, technological and societal problems. This concern is manifested in a variety of ways from declining confidence in government as a problem solver; to violation of the law; to "dropping out" of the system; to massive budget reductions, department reorganizations and personnel changes; to activist efforts to "reform" the system (i.e., the freshman House, Ralph Nader's organization and Common Cause). While this discomfiture takes many different guises, the underlying premise is that:

- organizations and bureaucracies no longer deliver services or accomplish goals as they once did or as they were designed
- the goals of organizations and bureaucracies are irrelevant, perhaps even inimical, to the goals demanded by present and emerging national problems
- the assumptions and underlying beliefs that serve as operating procedures of American organizations and bureaucracies are no longer accurate representations of reality
- organizational and bureaucratic structure is becoming increasingly rigidified, thereby preventing change and discouraging innovation, adaptability, flexibility, and willingness to take risk
- such organizational rigidification and obsolete premises is the major obstacle to solution of societal problems.

While traditional discussions of institutional failure often include descriptions of the institutions of church, family, marriage, education, government and so forth, this discussion will be largely devoted to public and private bureaucratic organizations as they affect national priorities, decision making and strategies for achieving these goals in this nation. Obviously, the societal values towards such bureaucratic organizations are a function of the societal role and attitudes towards such institutions as family, marriage, education, church and so forth, but the changing role of these institutions is discussed in another paper (see Chapter on Changing Societal Values). In this paper, we are concerned with the changing effectiveness of organizations which have the following characteristics:

- organizations which are *goal-oriented*, recognizing that the explicit and external goal statements and the implicit and internal goal statements may differ
- organizations whose existence, structure, and explicit goals are *publicly perceived and known*
- organizations whose existence, structure, and goals are, or at one time were, indicative of *consensus* concerning the legitimate activities and goals of a particular interest group, value set, regional or national grouping, or some subset of the population
- organizations whose structure and existence is *explicit* so that whether an individual or group is part of the larger organization can be determined with some certainty

It is the contention of this paper that such organizations are no longer effective in meeting the goals for which they are designed, or that these designated goals and functions are obsolete and irrelevant to the demands of the emerging twenty-first century. This organizational effectiveness retards, perhaps even inhibits, progress.

Among the specific institutional failings that will be discussed in this paper are the following:

- the inability of the economic system and federal policy makers to develop, implement and monitor effective economic policy to meet national economic goals of full unemployment and price stability as well as coherent and cogent energy policy
- the inability of the economic market system and government actions to mitigate resource shortages, inflation and capacity limitations
- the failure of a large portion of the population to gain access to national wealth and an adequate standard of living and the failure of corrective measures to have a meaningful impact on the situation
- the failure (or distortion) of the free market process to allocate goods, services and resources in an efficient and effective way
- the growing contradiction between industrial goals and societal goals; i.e. what's good for GM is not necessarily good for the country

Dimensions of the Problem:

The discussion of the failure of institutions of organizational inadequacy is faced with a troublesome problem: how do we *know* that institutions and organizations are ineffective and how do we *measure* the failure of such entities? Managers within the organizations tend to evaluate their organizations on the basis of some internally devised "performance indicators;" yet because they are internally devised, it is not at all clear whether they do in fact have any relevance to the success of the organization within its societal setting.

The question of institutional efficacy must revolve around the central forces which give the organization its legitimacy. These forces are *public confidence* and *consensus*. The definition of such indicators obviously is a subjective measurement that changes with time. In the democratic form of government and economic free market structure that we have built, the effectiveness of any institution is a function of the public confidence in the behavior and conduct of that entity which reflects a public consensus over the kinds of expectations that the public has for the behavior of such organizations. For instance, the recent collapse of the Presidency was an example of the application of such measures. There was clearly a public consensus over the kind of behavior and conduct that society expected of the President. This consensus was implicitly derived, yet specific enough so that the public could, in fact, evaluate the performance of the institution with respect to this implied code of behavior. When found wanting, public confidence in the institution dissolved, and the organization required massive personnel and procedural changes. The national intelligence community seems to be in the initial stages of such a transformation based on identical kinds of mechanisms.

The failure of a President and the failure of the intelligence community are but two examples of this generalized institutional failure that is perceived to be underway in the nation. While at first it may be difficult to relate these institutional failings to a more generalized pattern, it is clear that the same kinds of mechanisms and organizational deviations are at work. Before a more detailed discussion of specific examples of institutional failings, let us examine some of the fundamental organizational and societal changes and perturbations which may contribute to the generalized problem of institutional failure.

(1) Changing Societal Values: Another paper deals extensively with changes in societal values that are currently underway. Changing societal values have always placed a tremendous pressure on organizations, and are the foundation for changing national priorities which should, in theory, change organizational goals in a consistent fashion.

Several emerging value trends are likely to place continuing pressure upon organizational responsiveness and viability in the future. One is the new value of the nation providing a minimum standard of living for all. It is a fairly new idea and one that most probably can be traced to the impact of affluence and the concomitant feelings of guilt that starvation in the land of plenty elicits. Essentially, a national consensus is being reached that the conditions of starvation, malnutrition and absence of the bare necessities of living are intolerable and inexcusable in a nation as affluent as the United States. This, as is argued elsewhere, is a fairly radical notion when considered in light of the historical role of the Protestant ethnic. Early settlers of this country believed that all citizens (and remember how limited *that* notion of citizenship was) were entitled to the *opportunity* to make a living. Now we are arguing all citizens are entitled to *achieve* that standard of living by virtue of their citizenship. The national consensus on this value is by no means firm, but one can easily see the beginning of its impact on welfare, education, health and social security policy. Health care, housing, food and educational assistance are increasingly being accepted as automatic rights of citizenship. While in the past one can be too poor to qualify for federal or state assistance, poverty is decreasingly being viewed as an indicator of a personality or individual defect.

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A second major value change trend is the notion that growth for the sake of growth may not be beneficial and that growth can have disbenefits as well as benefits. The rising importance of externalities (pollution, congestion, wasteful use of resources, etc.) as well as the widening concept of externalities (boring jobs, occupational hazards, product dangers, etc.) in evaluating organizational success and effectiveness is having a marked impact on federal legislation, court decisions and the general procedures under which organizations must function. The rising importance of this value also may be attributed to affluence -- as well as the changing concept of the "good life."

A third and final value change which is having a substantial impact on organizational viability is freedom of choice. While obviously freedom of choice has been a mainstay of American ideology for two centuries, it is only recently that this value has been applied to a host of disparate activities such as working hours, working responsibilities, educational courses and programs of activities, etc. It is associated with the rise of the individual, the belief that the individual is most well-qualified to determine what is best for himself, rather than an omnipotent bureaucracy. We see this value emerging as, for example, conflict with and between institutions over the demand for homosexual marriages, the demand by students for "student's rights," and the demand by labor for participation in decision making and management. The value change has already affected organizations to some degree and changed, for instance, policy with respect to food assistance (the poor are now viewed as competent to purchase their own food rather than requiring the direct provision of food), and housing policy (again, a rise in the perception of the competence of the poor is occurring so that experiments are being made to provide direct rent subsidies to the poor rather than federal subsidies to the builder and manager of low income housing).

This category of value change is likely to put increasing pressure upon organizations and even threaten their very existence. A very large portion of the employment and resources of social welfare organizations, for example, are devoted to deciding what is best for the individual and his family. If we now decide that the individual is capable of making these decisions on his own, the organization's existence is threatened because it reduces their authority and eliminates some of their responsibility. This threat to organizational viability is the source to a great deal of the conflict and concern over institutions. The self-interest of the organizational members increasingly comes into conflict with the mandated goals and responsibilities of the group.

(2) <u>Changing Priorities Among National Goals</u>: Organizational and bureaucratic goals must reflect the national goals which are consistently evolving and changing to reflect changing values and continually changing social conditions. For instance, any organization operating in ignorance of the changing attitudes towards and by women will likely find itself immersed in controversy, and even extended litigation.

While concern with crime continually continues to surface at the top of any Gallup poll, it is also becoming increasing clear that the American public will not tolerate abuses of civil liberties in the name of crime control. However worthy the ends are, the mans do not justify them.

(3) Technological Change: Another pressure upon organizations can come from technological changes which may affect organizations by changing the relationships and responsibilities *within* the organization as well as changing the responsibilities and relationships with their client population. Several examples come to mind.

One is an organization created to monitor or regulate an activity or enterprise which has become or is becoming obsolete. Consider, for example, the Federal Railroad Administration. As the dominance of the railroads has been superceded by trucking and the airlines, the importance of the railroads has declined, yet the government bureaucracy has no "bankruptcy" procedure, and the work of the Federal Railroad Administration goes on.

A second, and more probable pressure on organizations, is the impact of technological innovation upon organizational responsibilities. For instance, the information explosion and computer revolution has transformed organizational relationships, changed the value of information and data, and affected the relationship among individuals in the organization and between the organization and its external audience. Such a technological innovation has revitalized Western Union, but is threatening the Postal Service because their traditional services are being supplanted by advanced telecommunications services offered by competing entities.

A third impact of technology is to affect the area of responsibility or goals of an organization. Again, the computer revolution is a good example of its impact upon organizations. It has transformed the nature of information transfer and as such has questioned the very way that such institutions such as the tax collection system, the banking and financing organizations, the postal and mail services, and the magazine, book, and newspaper publishing organizations operate.

Technological advance always threatens some organizations and some individuals because of the fear of obsolescence and unemployment. Just as the railroads and telegraph substituted and made obsolete the Pony Express so are other organizational responsibilities and goals continually been made irrelevant to on-going and emerging needs. The original organization either fights the new ways or more forward looking organizations adapt and seize upon the opportunity afforded by the change. But change implies risk, and most organizations reward the status quo, non-boat rocking activities and effectively discourage risk taking. Centralized decision making and formal procedures, characteristic of mature organizations, are also characteristic of low risk and innovation-less organizations.

(4) Societal Change: Certain fundamental changes in society often put pressures on organizations. Consider, for example, the impact of the great population transition from rural to urban areas, and then from urban to suburban areas. Thomas Jefferson once noted that our system of government was perfect for an agrarian, rural based population, but if the United States ever became dominated by large urban centers as in Europe, our government would become as corrupt as Europe. Little has occurred either in this country or in Europe to persuasively disprove his fears.

Congress is still largely controlled by rural interests. Many urban specialists argue that this is the single fundamental reason for the collapse of American cities. Influence by rural interests can also explain the construction and maintenance of a 40,000 mile network of interstate highways, and the absolute lack of federal funds for intracity mass transit.

The influence of rural interests, despite the presence of a dominant urban industrial population and a world food shortage, explains the continuing subsidy of the American farmer and the maintenance of small inefficient farming units. Free market economics would indicate that large industrialized farming so characteristic of successful American agriculture would be the only economical way to produce food. Yet in the interests of maintaining the rural way of life (Americans have always felt, or at least rural Congressmen have always felt, a reverence for things rural) the Federal government has continually subsidized the small (as well as the large) farmer.

This same conflict is increasingly being seen between suburban interests and urban interests, again with urban areas the eventual loser.

(5) Institutional Change: A final pressure can come from institutional change itself. For instance, it can be argued that the current economic dilemma is a function of fundamental institutional changes in the economic system during the past several decades. The Keynesian economic politices, implemented in the 1930's to correct the economic ills of that period, have so profoundly altered the economic system that the model upon which their design was based no longer exists in reality. That is, economic policy makers are applying policy designed for the Depression economic configuration which has been profoundly altered by past applications of the new same policy. The efficacy of this policy in the past is the very reason it is ineffective today. Hence, the model that serves as the basis for policy formulation has no correspondence with reality. For instance, monetary theorists will even admit that monetary policy has little value when the impact of Euro-dollars and an active international economic trading scene is factored into the analysis. Yet these international economic relationships are very much a fundamental characteristic of our current economic activity.

Another example of such past institutional change as a cause for current institutional failings may be seen in the intervention of government into private economic markets. Motivated by fears of excesses or the need to protect the public good, the government plays a substantial regulatory and decision making role in such markets as the utilities, transportation, insurance, finance and freight industries. Originally envisioned as an aid to competitive and efficient allocation and distribution of such services, a recent study by Brookings[1] has concluded that government regulation as currently conducted actually *detracts* from the efficient provision of services and increases their costs.

The sections below will discuss some indications of current institutional failings.

(1) The Failure of the Bankruptcy Mechanism: As Kenneth Boulding has noted, capitalism is the only economic or social system that has a built-in destruct device for organizations that do not work right: bankruptcy. Just as individuals who spend more than they take in must over the long run settle with their creditors, so must corporations. However, we are increasingly seeing the argument that "it's too big to go under, think what would happen if they folded." This distortion of market economics leads one auto giant to price its cars on the basis of Brand X's costs, stimulated by fears that the demise of Brand X would bring about monopoly regulation for the giant. Hence, the market competition mechanism which was so advocated by Adam Smith

[1] Almarin Phillips, Ed., Promoting Competition in Regulated Markets (Brookings Institution: Washington, D. C.) 1975.

is not allowed to operate and the result is higher priced cars for all.

Consider the recent economic difficulty of such super giants as Lockheed and Pan Am. Again, free market economics and the laws of competition would argue that if they cannot make it in a competitive market, then they do not belong in business. Instead, fears of economic dislocation, local unemployment, and ultimate political disaster lead to artificial attempts by government interests to keep these firms alive.

Consider, for example, the impact of such Federal policy upon the airlines industry.[2] Government intervention in the air transport industry has been justified since its inception in 1938 to control "excessive competition" that was allegedly eroding safety standards and bringing the entire industry close to bankruptcy. An immediate response of the CAB was to impose a total blockade on entry to the industry -- a total violation of a major tenet of the theory of pure competition. Since then the CAB's policy of maintaining minimum fares below which prices could not go, while fostering competition by requiring two or more airlines to serve the same route, has stimulated the great "sandwich/gourmet meal versus first run movie" campaign that has resulted in higher airline prices.

Brookings concludes that this policy has contributed to higher priced travel and more inefficient service that than would have occurred under conditions of freer market competition. In fact, Brookings concludes that service rivalry, made possible by the fare structure established by the board (CAB) drives down load factors and produces a quality of service

[2] George C. Eads, "Competition in the Domestic Trunk Airline Industry: Too Much or Too Little?" in Phillips, op.cit.

above that desired by the traveling public, particularly in long-haul markets.[3] They conclude that benefits would accrue from increasing the amount of competition in the industry which could effectively reduce the number of carriers and reduce the redundancy of parallel service (which in turn would increase load factors per airline route and lower passenger mile costs). The successful venture of California airlines in their intrastate (and hence, non-Federal regulated market) give supportive evidence to increasing competition to improve airline efficiency and lower consumer costs.

A note must be made about the role of competition and the number of firms in an industry. More competition is not synomymous with more firms. In fact, in some industries the impact of increased competition would be to *reduce* the number of firms because if free market pressures were allowed to operate, then the inefficient firms would be driven out of business. This is clearly the case of the airline example. Hence, a fewer number of would be more economically efficient and beneficial to the consumer.

However, it appears that in some industries such industrial concentration would result in higher costs than smaller firms would incur. Electric utilities seem to be an example of the diminishing returns to scale of large firms. Brookings found that competitive utility firms produce at lower average costs than monopolies, at least within certain size constraints.[4] However, this advantage to competitive firms seems to decrease as the size of the area supplied increases.

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[3] Ead, op.cit.

[4] Leonard W. Weiss, "Antitrust in the Electric Power Industry," in Phillips, op.cit.

It appears clear that bankruptcy as envisioned by Adam Smith had a very functional purpose in the economic system: that is, it rewarded firms who were successful and efficiently managed, and penalized firms that were not cost or product competitive. To remove such an effective natural regulating force from the market seems to contradict the national economic goals.

(2) The Free Market System: Can it Survive? There has been increasing concern, in terms of both worry as well as joy, that the form of capitalism which dominates the American economic system may be dying and that fundamental economic change is evolving or must be imposed to further societal and economic objectives. The business literature is filled with discussions concerning the collapse of American business in the face of rising government intervention. Let us explore this issue in some detail.

In the early days of this century the popular belief at the time was: "what's good for business is good for the country." The focus of most legislation was to maintain a good environment for business. Of course, government also tried to prevent business from abusing the public to an intolerable level; but this was a secondary goal. As one writer has indicated this pro-business attitude of government is a fundamental tenet of capitalism:

> The overriding objective of all capitalists governments is the preservation and strengthening of capitalism -- that is, of the private enterprise system. In our own economy, this means that successive postwar administrations have above all else looked out for the welfare of business corporations; and in the final reckoning they have been principally, though not exclusively, engaged in promoting the welfare of the few hundred industrial, commercial, and financial giants that define and shape the U.S. economy. Since the welfare of these huge corporations is best measured by their profits, one basic concern of U.S. administrations has been the establishment of as favorable an environment as possible for corporate profit-making, both here and abroad. [5]

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[5] John G. Gurley, "The Future of American Capitalism," Quarterly Review of Economics and Business (Autumn 1972), p.7.

It seems inevitable that large coporations will disagree with this evaluation of government activity. In fact, a recent article in *Fortune* magazine argues that further government incursion into the market system threatens the very essence of our heritage and freedom.[6] However, even this author admits the willingness of business to plead, argue, lobby and manipulate government agencies for favorable regulatory stances, (and, as recent evidence shows, business is even willing to buy and pay for such amenities) and otherwise manipulate the operations of an "objective" bureaucracy the benefit of big business.

What exactly has happened? In the era of unlimited resources, American hegemony both politically and economic, upward mobility of the population, available pools of cheap labor, what was good for business *was* good for America. More profits meant more jobs, more pay, more homes, and higher standards of living for the population. Growth in the economy was accompanied by growth in the individual standard of living. However, the underlying assumptions and working premises of that era are no longer operant or relevant in the current and emerging economic system. For instance, we are energy constrained, material constrained, land constrained in many areas, and to some degree for the short run, technology constrained. The unregulated use of technology has had serious deleterious societal, economic, and environmental effects, the magnitude of which we are just beginning to see. Until recently industry had unregulated use of the national air and water, and the quality characteristics of its products were constrained only by what the market would tolerate.

[6] Walter Guzzardi, Jr., "Putting the Cuffs on Capitalism," Fortune (April 1975). p.104+.

It was gradually perceived that the essence or quality of life that would be provided for Americans if industrial hegemony continued to dominate national policy would be inferior to that which had been previously expected and clearly inferior to what was desired. The realization of this does not represent evolution of a new goal or new expectations, rather it represents greater understanding of the interactions of various economic and technological forces. It is the consequence of these interactions which were not foreseen and which are necessitating government intervention.

It is foolish for writers to expect that the economy can operate any other way. If as Gurley argues, profits are the dominant influence over industry and the single most valuable measure of industrial success, then it is wildly inappropriate to expect that industry would *voluntarily* undertake such activities as pollution abatement, land and site reclamation, extensive product safety testing and refinement, environmental impact analyses -- all of which detract from that single motivator: profits. If one argues for the mechanisms of a free market, one also has to recognize the free market and perfect competition definition will preclude certain desirable activities from occurring (i.e. environmental protection) because these activities do not improve the competitive position of the individual firm.

A second aspect of the problem must be discussed as well. *Fortune* magazine, for instance, belabors the impending death of the free market and competition. No serious writer on the economy can generate a believable argument that perfect compeition exists or ever has existed in this country. From the middle of the last century onward American industry has been characterized by "big business," the extensive presence of oligopolistic market structures, interrupted only by occasional monopolistic market structures. The underlying assumptions of perfect competition -- which all good businessmen argue will bring unlimited wealth and high standards of living to the entire population -- have clearly *never existed* in this country during this century and probably not in the last century. Before discussing the impending death of competitive markets any further, let us review the classic characteristics and definitions of perfect competition to indicate how inappropriate this is as a model of current economic behavior. Perfect competition exists if:

(1) No single firm, entrepreneur or labor group is so large or has sufficient market share that his actions can affect the market price;

(2) There is perfect market knowledge on the part of both buyers and sellers;

(3) There are no barriers to entry to the market.

One can easily determine that there has been no such configuration in the American economy and that the American system is a mixture of monopoly, oligopoly and minor degrees of competition. "A cynic might say of perfect competition what Bernard Shaw said of Christianity: The only trouble with it is that it has never been tried."[7]

Believing that in fact market forces are important and should to the degree possible be relied upon to effect economic and societal goals, the function of government regulation and intervention in the market place has been to try to manipulate the above three characteristics to *encourage* market

[7] Quoted in Paul A. Samuelson, Economics (Ninth Edition) (McGraw Hill: New York) 1973, p.43.

in areas of improved product safety and environmental protection and rehabilitation), result in activities that would only be undertaken under such govenment influence.

Fortune argues that "every proposal for governmental action should be reviewed in the light of what it would do to competition and to freedom. When the effect would be negative, the reasons for the action would have to be especially compelling."[8]

While there is no question that our technological complexity and reliance upon large scale systems demands that any government action -- for that matter, any industrial action as well -- be assessed and evaluated in advance of their implementation, it is not clear that *Fortune* has identified the relevant evaluation criteria. If government action is being suggested, there should be explicit statements of the *goals* of this intervention and then analysis, in advance, to determine the likelihood of meeting these goals as well as the possibility of unplanned and unwanted secondary consequences.

(3) Shortage Plagued Economy: Will it Ever End?

One of the more pressing problems of the national and international economy is the continuation of serious material and resource shortages which have caused the price of all goods and services to rise to historical highs. The question before us must be: is there any incentive for this to change? If we accept the arguments of an earlier discussion that profit is the single most important evaluator of performance of an industry, then there is little incentive for the corporate body to increase the supply of a material resource, an act which will reduce the price of that material.

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[8] Guazardi, op.cit., p.105.

competition, or in the case of so-called natural monopolies, to regulate the performance of the monopoly so that the classical fears about monopolies do not occur.

Hence, many of the new product safety requirements and occupational safety requirements (as well as truth in lending legislation, accurate labeling laws, etc.) are stimulated by the need for the buyer to be increasingly informed as the complexity and sophistication of products increases. Hence, the government intervention is aimed at trying to increase the amount of market information.

The notion that a single firm is not so large as to be able to influence the selling price of a good or service is unheard of in this country in all but the most disaggregated industries such as consumer' services (laundries, dry cleaning, television repair, etc.). Price leadership in the steel industry is notorious and one of the best examples of this distortion. Yet in those same areas where market activity would substantially lower the price, business and industrial interests have been effective in persuading the government to intervene in the market place and arbitrarily support higher prices than the market would otherwise award. This can be seen in the agricultural industry, telephone industry, the airlines and a host of other commodities.

The question, then, is not over the rôle or existence of government intervention in the market place; the proper question should be whether such intervention helps or retards achievement of national socio-economic goals. It is clear that many regulatory activities hamper industrial efficiency, contribute to higher consumer costs and have a general negative impact on the economy. It is equally clear that other government interventions (say

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