ENVIRONMENT AND SOCIETY IN TRANSITION:
WORLD P Priorities

Edited by
Boris Pregel, Harold D. Lasswell, and John McHale

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FOREWORD

Boris Pregel, Harold D. Lasswell, and John McHale

The Second International Conference on Society and Environment in Transition under the auspices of the American Division of the World Academy of Art and Science (WAAS) and The New York Academy of Sciences was held on the premises of The New York Academy of Sciences May 6-11, 1974. The theme of the Conference is stated in the subtitle "World Priorities."

The First International Conference laid a broad foundation for subsequent activities by examining scientific, educational, social consequences and policy implications (Annals of the New York Academy of Sciences, Vol. 184, published June 7, 1971). Significant recent trends and impending developments were conscientiously reviewed by outstanding contributors to the physical, biological, and cultural realms of knowledge. These developments were weighed in terms of their current and prospective impact on society and environment. Preliminary efforts were made to clarify the policy implications of new knowledge.

Recognizing the fundamental importance of continuity and definiteness the Second Conference recommended the appointment of a Continuation Commission. The Working Groups into which the First Conference had divided itself were successful in formulating preliminary policy papers that dealt with preferred goals and strategies of public policy. Taking off from these documents the Continuation Commission obtained the cooperation of twenty panels who prepared brief reviews and appraisals of public policy in reference to "earth and space," "life," and "culture." These reports were published and distributed on request among official and private persons and organizations who were involved in environmental policy (Annals of the New York Academy of Sciences, Vol. 216, published May 18, 1973).

The Second International Conference on Society and Environment in Transition is a further step toward closing the gap between knowledge and policy. Public policy requires continual re-examination of priorities. We have characterized priorities as judgments of importance and urgency among and within various fields of choice. Policy priorities therefore are recommissioned allocations of capabilities in time and place.

A word must be said about the mode of operation of the First and Second International Conferences. The participants took multiple responsibilities. (1) as writers of papers, they presented a summary of their contribution and participated in the discussion of all papers; and (2) as members of a working group at the Conference they engaged in the preparation of policy recommendations and joined in the discussion of all recommendations to the plenum. The 1970 Conference emphasized the working groups, and the Second Conference went even farther in this direction. The result in both cases was to create a much more active and demanding environment than is traditional at scientific meetings where reading of papers is the norm.
INAGURATION OF THE CONFERENCE

Boris Pregel
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World Academy of Art and Science
American Geographical Society

My dear colleagues, I welcome you to the second conference on Environment and Society in Transition held under the joint auspices of the American Division of the World Academy of Art and Science and the New York Academy of Sciences. The outstanding features of this conference are as follows. There are a very limited number of participants and a limited number of paper sessions. Most of the discussions will be taking place in special committees where participants will work together to prepare memoranda. In these memoranda, criteria for public policies in key sectors of life will be recommended and guidelines for establishing priorities in the world environment will be included.

The conference structure, therefore, takes the shape of four working committees, rather than considerations of papers in plenary sessions. By way of orientation, a world survey of opinion regarding various sets of priorities has been circulated to the participants and also to a number of scientific and other organizations throughout the world. John McHale will discuss the implications of more than a thousand replies that were received to this survey, and, in this regard, I should like to register appreciation for the assistance that was granted in this endeavor by the Union of International Associations, Brussels, and by the International Council of Scientific Unions in Paris.

The second conference on Environment and Society in Transition is taking place in very troubled times. Different crises, some imagined, some artificial, and some real are plaguing our society. During the last few months, we have witnessed a transition from one era to another with consequences that can totally change our life style. It looks as though the world cannot control its destiny. It has become clear that the existing circumstances, the control of our economic and monetary conditions in the western world, may become dependent upon the shift of the tremendous amounts of wealth to the semideveloped oil producing countries. Not only are these countries economically underdeveloped, but also they are unprepared to handle this situation.

History lessons are readily forgotten. It is not the first time that underdeveloped countries are threatening the western world; this has occurred from time to time beginning with the fall of Rome.

The richness of the western world, its lack of cooperation, and its social and political structure are responsible for the present situation. The professionals who register current events, of whatever nature, have to go further
than simply search for parochial solutions of a temporal nature, they have to study the underlying reasons for the pressing world difficulties. They will have to recommend ways and means for solving the problems and to order the priorities. These are the aims of our conference and let us hope that we will be able to accomplish them at least in part.

PART I: CONFERENCE PAPERS
A. An Overview

SURVEY ON WORLD PRIORITIES (FIRST ROUND)

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In reporting the results of our survey, it is important that we give a brief explanation of its development. This was an exploratory questionnaire to establish a provisional framework for discussion of the various sectors of public policy. It was also understood that "impressionistic judgment of priorities would be appropriate at this stage." One might add here that this interim report on the survey is of the same order—both provisional and impressionistic.

Our original intention, for this first round, was to elicit a rough profile of fields of interest and priority rankings from participants in the Conference only, i.e., less than one hundred persons. The rather oversimplified one-page questionnaire form was designed, therefore, merely for internal use—to give the various working committees some overall sense of the ways in which priorities were ranked by their colleagues in terms of their different fields. From this process we hoped to develop a more sophisticated survey instrument.

The interest generated by the survey, however, led us to extend this first round to a much wider audience. Through the collaboration of the International Union of Associations in Brussels and the International Council of Scientific Unions in Paris, we were able to circulate the questionnaire to a large number of institutions and organizations around the world.

Although the survey instrument was hardly suited to this larger purpose, it has resulted in a significant profile of responses from many different kinds of organizations—ranging from voluntary and professional associations of various kinds to specialized centers for scientific research.

To date, we have had over 1000 responses from a sample audience of approximately 3000. Returns are still coming in at a steady rate. For the immediate purpose of this report we have processed approximately 700 returns from 73 countries.

To our knowledge, both the survey topic and the worldwide response are relatively unique. We feel that we have taken an important initiative which should be sustained and expanded as part of the consuming work of this series of international joint undertakings.

Many of the replies also expressed interest in the Conference and asked if they could be apprized of its work. One signal contribution of the survey, therefore, to the Conference is that it underlines the critical nature of the "World Priorities" theme in itself and should convey to its participants a
strong sense of the larger audience for this discussion and the wider global
context within which this discussion is being conducted.

The survey itself consisted of two sets of questions. The first listed 25
fields of interest in alphabetical order, from anthropology to space sciences,
and asked respondents to check their principal field of interest. In addition,
the second question, ranked on a 1 to 3 scale, of policy priorities, considered in
world perspective, of some 25 priority topics—
ranging from atmosphere and noise, the clarification of values norms to
utilitarian and water supply. Respondents could also add three other topics
as desired and were asked to give additional speculative comments on the
reverse side of the page.

These fields of interest were expanded by respondents to 32 and were
ranked as follows:

1. Sociology
2. Economics
3. Medicine
4. Biology
5. Political science
6. Technology
7. History
8. Earth sciences
9. Engineering
10. Philosophy
11. Law
12. Arts
13. Biochemistry
14. Anthropology
15. Literature
16. Biophysics
17. Chemistry
18. Oceanography
19. Physics
20. Linguistics
21. Atmospheric sciences
22. Cybernetics
23. Space sciences
24. Mathematics
25. Ecology—Environment
26. Education
27. Agriculture
28. Astronomy
29. Communications
30. Planning and Development
31. Management
32. Demography

* These were not listed fields but added in "other" category.

This tabular profile may be regrouped in percentages of field interests:

- Behavioral/Social Sciences 37%
- Biological/Health Sciences 19%
- Arts/Humanities 17%
- Earth Sciences 12%
- Physical Sciences 11%

As the 708 respondents could check more than one field of interest,
Figure 1 may be helpful in showing the aggregate profiles of choices for
various fields.
The overall distribution of fields of interest matches closely that of the actual conference participants. Although the latter may contain a higher proportion of physical scientists, many of these, by virtue of their wider interest in the social consequences and policy implications of scientific development, would also indicate various fields in the social and behavioral sciences. Also, as we shall underline below, many of the international associations who responded were specifically concerned with the social, cultural and behavioral aspects of various world situations, even though their memberships might also include other specialized disciplines.

**Priority Indications**

In addition to the 25 priority topics given, 196 others were added by respondents. The majority of these, i.e., 119 in number were within the category of environment and ecology.

The tabular ranking below is given in order of prior importance allocated—with education, energy, and food as the highest categories—and outer space exploration and volcanism allowed lowest priorities.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Education</td>
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<tr>
<td>2.</td>
<td>Energy development and use</td>
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<tr>
<td>3.</td>
<td>Food supply and distribution</td>
</tr>
<tr>
<td>4.</td>
<td>Health and medical care</td>
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<tr>
<td>5.</td>
<td>Population numbers and distribution</td>
</tr>
<tr>
<td>6.</td>
<td>Mobilization of public participation and support in decision processes</td>
</tr>
<tr>
<td>7.</td>
<td>Income distribution and consumption (including income)</td>
</tr>
<tr>
<td>8.</td>
<td>Water supply and distribution</td>
</tr>
<tr>
<td>9.</td>
<td>Public communication and information</td>
</tr>
<tr>
<td>10.</td>
<td>Social discrimination and non-discrimination</td>
</tr>
<tr>
<td>11.</td>
<td>Control of violent and non-violent coercion</td>
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<tr>
<td>12.</td>
<td>Education and training</td>
</tr>
<tr>
<td>13.</td>
<td>Freedom and political rights</td>
</tr>
<tr>
<td>14.</td>
<td>Peace and security and relations</td>
</tr>
<tr>
<td>15.</td>
<td>Planning and appraisal functions</td>
</tr>
<tr>
<td>16.</td>
<td>Social and community development</td>
</tr>
<tr>
<td>17.</td>
<td>Economics and development</td>
</tr>
<tr>
<td>18.</td>
<td>Energy use and development</td>
</tr>
<tr>
<td>19.</td>
<td>Forests</td>
</tr>
<tr>
<td>20.</td>
<td>Metals and minerals</td>
</tr>
<tr>
<td>21.</td>
<td>Outer space exploration and utilization</td>
</tr>
<tr>
<td>22.</td>
<td>/Tectonic activity (including volcanism)</td>
</tr>
</tbody>
</table>

It may be noted, of course, that the regrouping of the priorities, although useful in suggesting the strong emphasis on socioeconomic and political policy questions as the single “most critical” group, does conceal the actual ranking of priorities as given in the tabular list.

This may be viewed more clearly in Figure 2, which is based on the number of check rankings given to the different topics, bearing in mind that respondents could rank up to six priorities.

**Correlation of Fields of Interest with Priorities**

Although little systematic correlation could be carried out, due to the variability of response resident in the questionnaire design, the following observations may be made (Figure 3).

1. At this stage, there seemed to be no generalized priority dependence on field of interest. Although the major priority grouping in the social, economic, and political sectors corresponds to the major field clustering in the behavioral and social sciences this aggregation conceals a much more variable response. For example, as noted above, many physical scientists also accorded highest priorities in the social, economic, and political sectors.

2. In specific correlations, the highest was that of medicine and medical care: occupational health and medical care practice. One hundred thirty-two out of 180 respondents ranked medicine as major field that chose health and medical care as their highest ranking world priority.

3. One particular geographic correlation emerged. The majority of those responding from countries in arid zones indicated water supply and distribution as a key priority. This cut across almost all of their more specialized fields of interest.

4. On the other hand, the lowest priority overall was assigned to volcanism (including earthquakes) even among those respondents living in earthquake prone areas such as Japan and Central and South America.
This priority was ranked very low even by those in earth sciences, e.g., of 95 in this field category only 4 accorded vulcanism as requiring policy priority.  

5. The second lowest priority indicated overall was in outer space exploration and utilization. This may be due in part to the deficiencies of the survey instrument, as certain subdivisions of outer space exploration such as earth resources satellite scanning might have been linked to the high priorities given to energy development and food supply. There was no opportunity for respondents to make these specific kinds of interrelations.

6. Comparison of Conference participant profiles with external respondents showed no major variance in fields or indicated priorities. This is of specific interest, perhaps, as conference participants were carefully chosen as to specialized knowledge and interest in world problems whereas other responses came mainly from institutional and organizational representatives. We might presume, from this, some generalized agreement on world priorities which is widely shared and relatively independent of specialized field concern.
As noted earlier, the 706 returns processed were from 72 countries. Since the “cut off” date for preparing this interim report, the overall response has grown to 1000; the number of countries represented is between 75 and 80. As returns are still coming in, this distribution pattern may become wider.

The present breakdown by countries and regions is given below:

A. Major country responses

<table>
<thead>
<tr>
<th>Country</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>101</td>
</tr>
<tr>
<td>Switzerland</td>
<td>51</td>
</tr>
<tr>
<td>USA</td>
<td>108</td>
</tr>
<tr>
<td>Netherlands</td>
<td>49</td>
</tr>
<tr>
<td>France</td>
<td>86</td>
</tr>
<tr>
<td>Germany</td>
<td>22</td>
</tr>
<tr>
<td>Belgium</td>
<td>66</td>
</tr>
<tr>
<td>Italy</td>
<td>22</td>
</tr>
<tr>
<td>Canada</td>
<td>15</td>
</tr>
</tbody>
</table>

B. Regionally grouped responses

<table>
<thead>
<tr>
<th>Region</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latin America (including South and Central America and West Indies)</td>
<td>48</td>
</tr>
<tr>
<td>Scandinavian group</td>
<td>41</td>
</tr>
<tr>
<td>Europe (additional to (A) but including Eastern Europe and USSR)</td>
<td>37</td>
</tr>
<tr>
<td>Asia (including India, Pakistan, Japan, Thailand, etc.)</td>
<td>30</td>
</tr>
<tr>
<td>Africa (South of the Sahara)</td>
<td>19</td>
</tr>
<tr>
<td>Middle East (including North African countries and Israel)</td>
<td>11</td>
</tr>
<tr>
<td>Southwest Pacific (including Singapore, Philippines etc.)</td>
<td>10</td>
</tr>
</tbody>
</table>

Organization aspects of sample audience

Apart from the conference participants and a small group of international lawyers suggested by one of our colleagues, the range of respondent organizations is very diverse.

A few examples may convey this more clearly:

Scientific Organizations
- International Hydrographic Organization
- International Service of Cooametric Indices
- Inter-American Statistical Institute
- International Union of Radio Science
- East African Leprosy Research Center

Professional Associations
- Asian Environmental Society
- International Psycho-Analytical Association
- Commonwealth Association of Architects
- Society for Long Range Planning
- Hungarian Chemical, Oil and Allied Workers

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Nongovernmental Organizations
- International Committee for Television
- Asian Productivity Organization
- International Council of Monuments and Sites
- The Red Cross Organization
- World Wildlife Fund

Some of these respondents underlined that their replies were indicative of their institutional goals; others that they replied as individuals only and that an organizational response would require that they pull their membership, e.g., where this may represent, “several million members in sixty countries of varied races, religion and politics.”

A few organizations said only that their interests were purely technical so they could not reply on such broad questions, or in the case of religious organizations, such as the World Fellowship of Buddhists, that their central purposes were transcendental to the given priorities.

A considerable number were extremely interested both in the conference itself and in the survey—and asked if it might be possible to extend the latter to their membership.

Written comments were extensive and extremely interesting. Many were addressed to the substantive content of the survey and clustered around the following points: that (1) obviously, the given priority topics were highly interdependent and interactive, hence difficult to rank in linear fashion; (2) priority allocation should include indicated actions; (3) broad priority areas such as ocean “potentials” should be linked to field research priorities in their appropriate disciplines of chemistry, biology, engineering, climatology, etc.; (4) the perception of priorities as given may only reflect current and changing views, and may also vary considerably according to socioeconomic position, education, and geographic location.

These few selected points do not adequately convey the care and attention which was given to the questions and which was particularly evident in the range of diverse comments.

The overall responses of so many organizations, in their functional diversity and their common patterns of interest, do reflect the growing transnational web of institutions and associations now operating at the world level. They also communicate, most forcibly, those increasingly shared perceptions of world priorities which begin to transcend both specialized field interests and local national preoccupations.

Concluding Remarks

However, we may gauge the substantive value of this survey and its contribution to the deliberations of this present conference, we feel that it was a most useful activity in its own right.

Although the relatively crude “first round” instrument was hardly ade-
One purpose may be simply its questioning and alerting function as addressed to those sets of broad constituencies around the world in ways which adjust, reinforce, or augment their common perceptions of world priorities.

The second purpose is providing feedback regarding these perceptions between individuals and organizations which may help in promoting more coordinate policies and actions in the various priority sectors.

The third, and larger purpose, may lie in contributing, in some small measure, to the development of what Vickers has called "the appreciative system" in society—those functions of continuous appraisal, review, and assessment which provide for a longer range and more qualitative orientation of human activities which we so urgently require at the global level.

QUALITY OF LIFE: SOCIAL INDICATORS
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I arrived in New York City at eight o'clock last night and was informed that I was to speak to you in the morning in place of Professor Sasaki who, unfortunately, is ill. Of course, such a sudden change was somewhat surprising to me, having travelled a long way from Tokyo, but there are two reasons why I could not decline. The first is the fact that I have been a student of Professor Harold Laswell. Although I have not been his student in the formal sense, I have nevertheless been privileged to meet and talk with him. I have learned much from Professor Laswell. Of course, if anything I say this morning does not make sense, it is not because of Professor Laswell, but because of the quality of the student, himself.

The second reason I could not decline is that I am now in the field of journalism, where I must nearly always make deadlines. I had been a university professor for years, and one of the fondest aspects of being a professor is that he knows what time his lecture will begin on what day of the week. Imagine the case of a journalist—he never knows when he might be expected to speak! On my way from Tokyo to New York, I came by way of the West and had the opportunity of meeting Sir Eric Ashby of the United Kingdom. He told me that the university today has become like a religious institution with so many "priests" that some sort of "religious reformation" is needed. In that sense, he congratulated me for leaving the university for the time being to remain myself.

In the West, of course, all sorts of studies have been made of what are called social indicators. Following the western nations, we Japanese decided that we too must study these indicators so we began to organize a commission in 1971, before the Ministry of Environment was established. This new commission, of which I am a member, belongs to the Economic Planning Bureau of the Japanese government. We have been working since 1971 and are now publishing our findings this summer; it is hoped that they will be translated into English by the end of this year. This report is quite lengthy and because some areas of it are also very dense, I have been struggling since last night to find a way to tell you briefly what is in it.

The first questions we asked were: What are the major social indicators that we should be studying and what programs should we advocate that could improve Japanese life? We decided that there are three major areas of concern. The first comes out of economic growth, and economic growth in the case of Japan, as in many countries, sometimes brings about unfortunate consequences, not only to the environment, but also to the economic system itself, such as the inflation that nearly all of us around the world are now experiencing.

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The second is the question of how to spend the time that has been freed because of the success of economic growth. The people of Japan now enjoy a higher income than before and they also have more time to enjoy it. However, this new leisure time is not quite so enjoyable because often people do not know how to spend it.

Lord Keynes wrote many years ago that although he could help to design a new economic system, one of the things he could not foresee was how to build up fruitful use of nonworking time, because this is against the tradition not only of the West, but of the East too, where people have had to work diligently for many centuries. So, except for men like Socrates or Confucius, it has been rather difficult for people to spend leisure time profitably.

The third area encompasses the various kinds of dissatisfaction and grievances that exist in society. This question of grievances, which is often raised in socialist philosophies, includes such things as inequality. However, other kinds of grievances are becoming increasingly apparent, such as the fact that the people of our society have no longer enjoy nature as they once did. And even though all employees receive a fairly good income, the value of money is decreasing rapidly in proportion to the increase of income, creating another source of dissatisfaction.

These are the three major problem areas that we decided we must study. Our assignment in the commission was to determine which social indicators would show any improvement or deterioration with reference to these three areas mentioned. After some months of study, we decided to choose seven major areas for further study. (Eventually we had to discontinue study of one of those areas—the quality of community life—which was too difficult to measure.)

We began to study such areas as health, examining the output rather than the input, that is, whether or not people in Japan have a longer life span than they used to, whether or not medical service is provided regardless of a person's locality, and whether or not medical security is provided by the government for the general population.

The definition of output is quite difficult and depends upon the area. For example, in the case of education, we can say that the number of people who go on to higher education in Japan is almost up to United States' standards. About 32 percent of high-school graduates in Japan go on to some institution of higher education, but the actual quality of the higher education that they receive there is very difficult to assess. Therefore, when we say output, we are cognizant of the fact that this part of our report is only tentative.

We also decided to look at changes in a time dimension. So we picked three different points of time that we used for comparison: for example, in the case of education (facilities for primary, secondary, and lifelong education as well as other cultural opportunities in society) our first point was 1960, which was used as base one hundred. Then we reported five years later, in 1965, and ten years later, in 1970, on the changes that had occurred.

We have studied, as I already mentioned, the areas of health and education. Other areas studied were: ways of spending leisure time; the pattern of em-
of ten years, in the 1960s, horizontal mobility (i.e., movement from rural to city areas) and vertical mobility (i.e., occupational mobility from farm worker to manual worker to white collar worker) have been increasing. In fact, there is slightly greater social mobility in Japan at present than there is in the United States.

Their findings indicate, then, that we need not take an unduly pessimistic attitude toward the social changes that occur so rapidly. However, we do have to be careful to take a more analytical approach to certain other areas.

The two areas that seem to be most critical in Japan, and which are known to the rest of the world, are the material environment and criminal behavior and violence. First to me tell you about the environment. Housing conditions in Japan, of course, have been bad, but some efforts have been made in the last ten years to correct this situation. There has been slight improvement. We discovered that space has become a little larger for every individual, but not very much.

The second in which there has been drastic decay is the trend of harmful materials such as gasoline, by-product pollutants that have multiplied thanks to the prosperity of Toyota and Nissan and some other companies in Japan.

The success of the Japanese chemical industry has also brought about harmful effects, not only to human beings, but also to animals, fish, and the natural environment. Harmful effects result from accidents caused by the automobile. The preservation of national parks and other natural environments is another area that has suffered.

Then there is the question of violence and criminal behavior. Our study shows that during the first five years since 1960 there was an increase in violence, but that in the second half of the 1960s there has been a decrease. We cannot explain this change. Homicides are fewer in Japan today than they were five years ago. Crimes such as rape have also been decreasing. However, in the first half of the 1960s, there was an increase in that kind of criminal behavior.

This is a rough summary of what we have studied in our report on social indicators in Japanese national life. Our proposals for policy priorities of Japanese life are based on this report. I cannot tell you about world policy priorities—I am afraid that all I can describe are some piecemeal policies for our small nation of Japan.

We must change the type of industry that is affected by the supply of energy. For example, for all we are dependent on imports from other nations of the world: 99.4 percent of the oil consumed in Japan is imported; only 0.6 percent is produced in Japan. We are aware of the fact that oil is important for all countries, especially for those nations where there should be greater economic growth for more people. Given these circumstances, it will be necessary for the Japanese to save oil, to bring about a better quality of life not only for the Japanese, but, it is hoped, for other parts of the world. Such a policy, of course, is somewhat optimistic and is not always easy to implement because politicians are part of democracies and, on the
ALTERNATIVE FUTURES: EXPECTATIONS

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I wish to confine my remarks to some of the problems that arise in the formation of expectations and the way we go about generating the alternative futures that provide the scenarios for the study of the assignment of "world priorities." I believe that it is extremely hard to completely separate the study of the generation of alternative futures from the study of the assignment of world priorities. The ways in which the scenarios are generated and priorities selected are highly interlinked.

In the last 20 or 30 years there has been a considerable development in a set of new disciplines broadly described as the decision sciences. We live in the brave new world of the computer, and I doubt that we could live in a way that most of us would like to without the computer and the new communications technology. However, it is interesting to note that in spite of the computer and all of the promises by the big model builders, the decision-making methodologists, the management scientists, and the operations researchers, the aid to decision making rendered by the computer is greatly overestimated. The proliferation of alternative futures is just too large. Even if we restrict ourselves to a single mathematical problem, such as chess, the number of alternative strategies or plans available is astronomical. Lloyd Shapley of the Rand Corporation and I tried to estimate the number of alternative strategies available to a chess player. It came out to be around 10 to the 20,000th.

Such simple calculations lead me to suspect that we are not going to have large-scale computer runs search exhaustively through the alternative scenarios for playing a game as simple as chess. Exhaustive enumeration or search is not the way alternative futures are generated and priorities assigned. The full combinational analysis of alternative futures requires computations of unbelievable size. Blind, exhaustive computation of even four or five moves in a game as simple as chess, without the use of some sort of perceptual filter or method of evaluation, guarantees that the computer will bury itself in computation. The problem of alternative-futures planning is one in which the processes of perception, and value formation have to act as controlling devices on the overall program of search and computation.

It is easy to generate scenarios of the future out of thin air, but such an occupation would not be particularly fruitful for this conference. Instead, I suggest that before we look at any specific plans we impress upon ourselves the fact that future planning is a present occupation and has as its major product process and not plans. Future planning generates plans, and plans frequently serve as a good measuring device for the effectiveness of future planning. They are, however, only a small part of the process.

key questions to be asked when reviewing a planning activity are: Who plans? Who listens? Who cares? Who gains? And who does anything about it? These cannot be answered meaningfully by looking at published documents.

When I consider the list of questions noted above, I find that it is not by coincidence that for many years I have enjoyed my acquaintance with Professor Lawell. He might phrase these questions in a slightly different way, but the questions would still remain.

Extreme faith, a large computer, and a futures-planning group provide only a fraction of the resources needed for the design of a functional planning process. Without the other resources, at best, technological planning groups are expensive toys.

I wish to make a few more specific comments on the topic of prime technical interest to me: economics. My comments are more specifically on expectations and are directed partly to microeconomics and partly to macroeconomics. For many years microeconomic theory has been primarily static. It has been concerned with equilibrium conditions. Much of its stress has been on the functioning of a price system and the concept of economic efficiency. There have been several interesting facets of that work. First, the development of the theory has called for the use of extremely elegant mathematics, and it is comforting to many to see elegance and an aura of mathematical certitude appear in what is frequently regarded as a soft science. Unfortunately, closer scrutiny shows that the mathematical sophistication underlying microeconomic theory was purchased as the price of either a completely static view of the world or a jocular argument concerning the nature of expectations and futures planned. Without going into technical detail, it is possible to indicate the nature of the trick used by economic theorists to develop an elegant theory of an efficient price system. The future-prediction problem is avoided by assuming that all economic agents have self-fulfilling prophecies. The future-planning problem is disposed with by a mathematical trick that amounts to showing that there will be some set of prices which, if predicted by all, will provide the appropriate information for self-fulfilling prophecies.

This result was a deep and valuable tout de force in the development of economic theory. Unfortunately, although an intellectual basis was provided to show the importance of prices in efficient planning, the fundamental difficulties faced by most planners lie in the generation of expectations and not in the generation of prices.

In contrast with the development of microeconomics, the macroeconomic tradition has been heavily ad hoc. There has been a heavy stress on the role of expectations, yet unfortunately, no completely satisfactory theory of the formation of expectations has been developed by either micro- or macroeconomists.

Having noted the problem of prediction of expectations in economics, I wish to comment on a "new game" that has recently come to town. This is known as the futurist business. It scarcely existed 20 years ago except for a few honest astrolgers and palmists, and a group of less bonnet
who hang around the staff headquarters waiting to take care of those who sell plans to the five-star generals without first taking care of the central staff? The distance between a model and its implementation is enormous.

The world that I perceive is a world in which, if you do not take care of the central staff and the middle bureaucracy, no matter how beautiful the flip charts look and how lovely the computer programs appear to be, planning models will be at best cosmetic rather than operational and will fail to be integrated into a planning process.

Among the other questions of interest in judging the work of futurists are: Where is the funding coming from and what are the conditions usually attached to that funding? Some years ago, with a young colleague, I made a study of the proceeds of a model that had been done in the United States. We found that there seems to be something almost like an inverse fourth-power law between visibility and propaganda effect on the one hand and the amount of money spent on a simulation.

For example, a political-military exercise using ambassadors and high State Department officials can be run for a few $100,000. In doing so, it is easy to attract every camera man and every newspaperman and his brother to whatever it is being held. The propaganda value of this sort of exercise can be enormous. At the same time that these exercises were popular, other simulations, costing on the order of $10,000,000, were being run quietly in the depth of the middle bureaucracy, where they were used as part of a complex sociopolitical process of decision-making. In my estimation, these simulations were probably often used to give an aura of scientific reasoning to a decision that had already been made.

There is a very simple rule of which most historians should be aware, and that is, given enough degrees of freedom in a system, one can prove virtually anything. This being the case, it is possible for a decision-maker to say to a futures-planner or simulator, "This is the way I want the future to look." If the model builder is given a sufficient number of degrees of freedom he can make the future look that way and still be consistent with virtually any given set of empirical information. The large-scale simulation, if used without care, can open up new dimensions for "rationalizing man."

I personally believe that futures-planning is of extreme importance and that the correct size for a serious work in future-planning is about the size of the space program. The design of fruitful planning processes calls for considerable managerial innovation and coordination in information-gathering and communication control.

I firmly believe that the generation of actual plans or specific scenario writing is far less important than the design and integration of planning organizations. Furthermore, even in the design of planning organizations there is an extremely important paradox that has not been adequately recognized.

In the design of forecasting systems there are at least two types of prophecy that need to be considered carefully. One is the prophecy that already
underlies a lot of microeconomic theory, i.e., the self-fulfilling prophecy. The other is the self-defeating prophecy, which should be of key importance in the design of planning systems with an adequate feedback.

In many aspects of economic life, the self-fulfilling prophecy can have a high individual payoff to the prophet, even if it has a low payoff to the society in which the prophet dwells. For example, if an individual could successfully predict the failure of various financial institutions and enough people believe him, he might cause a run on the banks and calls at the brokers' houses. By being sufficiently successful as a prophet of doom, he might generate a serious financial disaster and cash in on his own account as the economy changes.

In contrast, the futures-planner may best serve his society as a generator of self-defeating prophesies. His prediction that we are on a collision course should be sufficient to enable us to change course and avoid collision. It is my belief that we do not yet possess either the technical ability or the organizational structure to evaluate good self-defeating prophecy and to reward those who are willing to engage in this thankless task.

There are two last points I wish to make. Meetings such as this can be extremely valuable, providing that we can define and understand our own role. Lordly suggestions as to what some undefined group of decision-makers should do are in general a waste of time. Instead we could regard ourselves as part of the perceptual and neural control mechanisms of our society. In this role, I believe we have a key part to play.

My last point is that if we are willing to take a rather dull view of ourselves, many of the major advances in the planning process may be looked at in terms of the invention, construction, and use of new accounting systems. These new accounting systems, however, have two properties. Numbers are critical provided that stress is always placed not merely on what the numbers are, but what the numbers mean. The interpretation of what the numbers mean is part of the key perceptual and intellectual problem to be faced in evaluating information in the context of the purposes at hand.

ASSIGNING WORLD PRIORITIES: THEORY AND APPLICATION

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Given the brief time available for the plenary sessions, I thought it was wise to skip part of my subject, especially the theoretical part that we could better discuss, I think, in the working group. There are two parts of my paper available: the summary and a brief supplementary note with tables. (paper available: the summary and a brief supplementary note with tables.)

As I said, I propose to skip the theoretical part, and jump at once to what I feel is the main application, which I have become convinced is worth a long discussion. Let me say briefly that I have been responsible with others for trying to get the main points of the development of developing countries for financing. I have done this in the second development, which was accepted by the governments in the session of 24 October 1970. We have been confronted with the unhappy development that this strategy was not taken seriously by any government and in the meantime, indeed, another problem complex had come up which may be among the reasons why no new strategy was taken up.

This second complex of problems might well be indicated by brevity's sake, the problems raised by the Council of Rome and by the report of the Mehran report. Even though I am not aware of the fact that there are many possible things to criticise in the Mehran report, I think that, nevertheless, it has had the great virtue of bringing us to a number of problems that before that time certainly were known to you and to a conference of this type but not to the larger public. Ever since then groups have mushroomed who try now to supplement or amend this report which I think has been, as a whole, a very fruitful activity.

The way I would like to formulate the task that I see for all of us in this respect is to find out whether a reorientation is possible between these two big units of force, the development strategy and the environment strategy. In the meantime, by the way, it is interesting to note that the second complex has now a sort of United Nations commotion in Mr. Shubik's U.N.E.P. agency. Therefore, it has officially also become a necessity for all governments that are members of the United Nations, and for United Nations organizations themselves, to look after this possible reorientation.

If I were to take over some of the terminology that Mr. Shubik gave in his admirable expose this morning, I would say that in presenting what I feel about this problem, I would have to give a self-defeating forecast. For my forecast, which is a sort of down-to-earth opinion, is that probably we will not make it, and that rather bad things will happen, but this is not a very productive sort of scientific activity, because having said this, you can sit down and see what happens.

So, I take the other possibility. I want to try to formulate something that I would hope would be self-fulfilling, but then it cannot be a forecast any-
more. I think it would have to be some sort of an inclusive plan and would really inspire a number of politicians toward action, in contradiction to what we have seen so far with regard to development strategy.

I think the first statement that has to be made is that we simply do not have the knowledge to solve the problem at the moment. I think this should always be said first, because it means that an enormous problem of research is before us and has to be carried out. Priorities have to be set which are quite different than they would have been about 10 or 20 years ago.

When I am going to talk about briefly is typically set a scientific point of view because we simply lack the knowledge. I call it, in an optimistic mood, the prescientific view but you could just as well, of course, give it less flattering names, such as just an opinion of one citizen of the world. Thinking over these various problems, it has occurred to me, as I think it must have to most of you, that depending on the phase one is in with one's thinking, one passes through different ideas about what the main bottleneck is. I have started working with, and am having great use for Dr. McElrath's studies. My initial preoccupation was with the exhaustion of minerals. At that time I already had the feeling that pollution could be overcome up to a point, if we are willing to spend about 4 percent per annum of our national product on it. But the possibility of exhaustion of minerals seemed to me to be quite real. However, after some extremes, my impression was that this faded away somewhat as a preoccupation. I became less afraid of it although I still certainly do not deny it to be a problem.

Increasingly, I became impressed with what a number of ecologists, in particular, sometimes also called ecologists, had to tell us. Fortunately, I could pursue this within the family which was easy. I must say that my impression is now that the main bottleneck is to be found in food production and that it is mainly lack of communication that has existed for quite some time, between, on the one hand, agronomists, economists, technologists, sociologists, and geologists up to a point, and on the other hand, the ecologists. The main difference of opinion seems to be whether it is at all conceivable that agricultural production will increase 3 or 4 times between now and the year 2010.

For a number of years, well-known agronomists including, I think, most of the FAO experts, were rather optimistic about what could be done, thanks to the breakthroughs of the green revolution. This feeling has been strengthened for some time, but consistently the small group that I indicate of ecologists and ecologists had its doubts. The amazing thing is that two so typically neighboring fields as agronomy and ecology evidently had a communication gap. How else was it possible that when we drafted the development strategy, some people could still assure us that 4 percent average increase in food production would be possible, and that fitted nicely into the strategy, so there seemed to be no great problem. But during the last year or two, I think the economists have become much more concerned. The difficulty over integrating the preoccupations of the ecologists into some set of figures—and we need figures if we want to see—is that the sort of problem that they see is very complicated. The current state of their research is not yet far enough advanced to give anything like world estimates strokes; for instance, which parts of arable land should be untouched in order to

1. Tinbergen: Assigning World Priorities

research is not yet far enough advanced to give anything like world estimates strokes; for instance, which parts of arable land should be untouched in order to
be given a sense if a social welfare function for the world at large can be established. Needs showing the highest marginal welfare or utility then have the highest priority and should be satisfied first; if part of the total resources available are left, second highest marginal utility needs can be satisfied, and so on. Needs exist for each single person and can be "ordered" in this way: the marginal need satisfied for persons A should be equally pressing as the one satisfied for persons B living simultaneously and for persons C belonging to generations living later.

The possibility of measuring welfare and of comparing it with other people's welfare is assumed by the present author and supported by a limited number of fellow economists. Governments, in isolation or in cooperation, try intuitively to determine priorities. They tend to underestimate the welfare of people living for away or in the future. Welfare depends on the quantity and quality of consumption in the future and on the satisfaction or dissatisfaction of efforts needed to make that consumption available, taken per person.

**APPLICATION**

In the present context human needs are by far stronger for the poor masses than for the few well-off. Severe limits are set in a continuing expansion of population and production by the stock of exhaustible natural resources (minerals, pure water and air, arable land, and the stock of sufficiently diversified genes). Some (unknown) limit may be hoped for because of our expanding research and inventions.

With many strategic data on these matters still lacking, only a prescientific (intuitive) judgement can be given. For the time being, the author ventured to suggest that:

(a) around 2010 the developed countries' population should be equal to today's, whereas

(b) developing countries should decelerate their rate of population growth from the present 2.6 percent to zero over that period, further that

(c) the rate of growth of income per capita should average—for the period and the LDC's—5 percent per annum,

(d) the rate of growth of material production of the developed world should reach zero around 2010, and

(e) income inequality within the most advanced countries should be halved.

**SUMMARY**

Assigning priorities is identical with drawing up an optimal (perhaps only indicative) plan of how to allocate available resources. Optimality can only
Table 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Population in Millions</th>
<th>Per Capita Income in $1950 (OECU)</th>
<th>Total Income in $1950</th>
<th>Per Capita Income in $1970 (OECU)</th>
<th>Total Income in $1970</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940</td>
<td>3000</td>
<td>2500</td>
<td>7500</td>
<td>3000</td>
<td>9000</td>
</tr>
<tr>
<td>2012</td>
<td>7000</td>
<td>5000</td>
<td>3500</td>
<td>7000</td>
<td>3500</td>
</tr>
</tbody>
</table>

and the 10 percent poorest (same measure), the incomes per capita are shown in Table 2.

Some recent research suggests two further corrections. Tobin and Nordhaus have presented an alternative measure of national income for the United States, omitting duplications as a consequence of the "cost of development" (increased pollution, traffic accidents and so on) and find a rise between 1929 and 1957 of this new income concept which is a quarter less than the traditional figures suggest. Assuming that in 1929 in the United States and in present in the developing countries these duplications could be neglected, we may use their figures to argue that in Table 2 the figure for the richest countries has to be reduced by one-quarter.

Kravis has completed but not yet published (according to information I received from Mrs. East Bercamp, member of the United Nations Development Planning Committee) a more sophisticated attempt at comparing real incomes in richer and poorer countries, resulting in a real income of $300 for countries with an "official" (World Bank atlas) of $100, where official means converted with the aid of official exchange rates.

Using these two further corrections we get Table 2A.

These figures show a ratio between richest and poorest countries still well above the corresponding figures for well-integrated present nations, such as the United States, France, and Germany (F.R.G.), where these ratios (between the richest and the poorest middle) amount to 1.8, 1.7, and 1.5, respectively. For a less stable community such as Italy I find 2.1 and for the six 1960 EEC 3.2 (Deciles refer to regions, not 10 percent.)

My demographic assumptions imply, according to some information provided to me by the Netherlands Interuniversity Demographic Institute, that in the Netherlands an immediate switching to 1.6 children for the first generation born after a 1964 should materialize. For a number of reasons the switch will probably be less dramatic.

The implications for agriculture are that world agricultural production would have to grow by 3 percent per annum as compared with almost 4 percent between 1965 and 1985 according to the World Indicative Plan of FAO and 2.6 percent over the decade 1961 to 1970.

My figures are in an attempt at reconciliation of the following challenges:

1. take seriously the need to arrive at more equitable world social and political tensions between rich and poor countries;
2. take seriously the threats of pollution, especially of the oceans, by a combined growth of chemical industries, in particular fertilizer,
3. take seriously the threat of the exhaustion of some mineral resources,
4. take seriously the desire for a more equitable income distribution within countries and the minimum of further development needed for this purpose.

The main intent of my paper is to invoke alternatives.

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The general analysis and the main conclusions I presented at our first conference, 4 years ago, on the energy needs and supplies of mankind until the end of the century, are still essentially valid. But the recent energy crisis, initiated by the very large increase of the price of crude oil produced in the Arab states, associated with a general limitation of their production and restrictions of deliveries decided by these states, have changed the scale of time for the problems connected with the final exhaustion of world reserves of petroleum and natural gas and show how different these problems are, in the near future at least, for the main industrialised countries according to the importance of their national resource and reserve in fossil fuel. The priorities should be modified taking into account the most urgent needs of these countries or group of countries, essentially North America, Western Europe and Japan, the Soviet Union being practically unaffected by the energy crisis. The sharp increase in the price of crude oil will also probably slow down the development of the poor countries of the third world, such as India, thus creating a serious situation for mankind.

During the past few years a number of excellent analyses of the world energy situation, present and future, have been published, most of them with recommendations on what should be done to face the energy shortage which may appear before the end of the century. But there is not a general agreement between these conclusions, emphasis being put on the continuation of the annual increase of the energy consumption, considered as desirable or unavoidable, or on the protection of the environment. Moreover, the priorities between the different actions on which an agreement appears have been changed by the new policy of the oil-exporting countries.

Throughout the industrialised "western world" the most urgent priority is to try to become, as soon as possible, independent of, or at least less dependent on, the oil-producing Arab states, essentially those bordering the Persian Gulf, where the largest reserves exist. This can be done only by using known technologies and developing the production in already known important deposits of fossil fuel. These actions involving very large investments and the development of new sources of primary energy cannot have more than a second priority, although they may be of great importance in some cases before the end of the century.

In Western Europe, particularly in France, Italy, Switzerland, Belgium, and Spain, there are two alternatives: either a serious expansion of energy at all its forms (electricity, gas, gasoline, fuel oil) or the launching of a large program of construction of nuclear power plants. However, any effective rationalising of energy would be extremely unpopular and would stop completely any further industrial and economic growth; it would thus lead to a considerable social unrest or even to a popular uprising. It would be very naive to try such rationalising and unrealistic to believe in its success. In these conditions of Western Europe there is indeed no choice, and many large electronuclear power plants will be constructed during the next decade; the same is true for Japan too. For instance, in France the decision has already been made to multiply by three the 1-year-old program of construction of nuclear plants. Each year, during the next 5 years, the construction of six nuclear power units, each of about 1000 MW electrical output will be started; the first six of the Weslhington P.W.R. type have already been ordered by Electricité de France from a French company by a single contract, one of the largest ever signed in the world. Because such units require about 5 years for construction, this decision implies that in 1985 the fraction of electrical energy of nuclear origin produced in France will have grown from a little less than 10 percent, which it is now, to more than 60 percent of a total production of electricity multiplied by 2. Similar nuclear programs are considered in the other European countries, and to avoid a practically complete dependence on the United States for the supply of enriched uranium to feed their new electronuclear plants, five of these countries have decided, under the leadership of France, to build a large diffusion plant, which will cost about 1.3 billion dollars and should start producing the enriched uranium in 1978.

In the United States the situation is different because of the existence of very large reserves of oil easily workable and of a reserve of oil in shale, which is much larger than all the Arab oil reserves but is still untapped because of the cost of extracting the crude oil from these shales was too high in comparison to the price paid a year ago on the world market. With the recent considerable increase of the world price of crude oil, the extraction of oil from the shales that can be worked by open-air mining has become very advantageous even if the cost of the crude oil thus produced is increased by an obligation of reclaiming and reclaiming the extended areas had waste by the open-air mining of shales done on a large scale. Increasing the production of coal and developing the extraction of oil from shales will necessitate very large investments, within the next 5 or 6 years, but might avoid large importations of crude oil from the Persian Gulf and the corresponding very heavy payments to the Arab states. Coal should be more extensively used for electrical power production and for district central heating, preferably coupled with a production of electricity by back pressure turbines. To avoid increased general pollution of the atmosphere by sulfur oxides, all new plants burning coal or heavy fuel oil should be equipped with rather expensive devices for denitrogenization of the smoke.

In the United States there is thus no urgent necessity, as there is in Europe, to speed up the construction of electronuclear plants. Nevertheless, in addition to the 40 such plants already in operation which produce about 6 percent of the United States electricity, more than 50 others are under construction and 100 are planned. In spite of the clamorous opposition of
from now. But the operation of such breeders raises new safety problems, essentially because of the very large amount of concentrated plutonium involved in their fuel cycle, and there is strong opposition, principally in the United States, against their development. I do not think that this opposition to the construction of large breeders is well founded, but it may succeed, and the development of other types of reactors, using uranium more efficiently than the present ones, should be envisaged and prepared. There are already in operation some experimental high-temperature gas-cooled reactors which, because of their higher thermodynamic efficiency, use about 30 percent less uranium to produce 1 unit of electrical energy than the P or BWR reactors; this is not a great progress but the high-temperature reactors may become important in the field of high-temperature chemistry. The best substitutes for the breeder reactors are the Canadian heavy water moderated reactors whose industrial success is now well established. These reactors utilize uranium two times better than the P or BWR reactors and have the considerable advantage over all other types of nuclear reactors to operate economically without any reprocessing of their spent fuel, which means that the production of concentrated plutonium can be avoided; the possibility of a criminal diversion of plutonium for a clandestine manufacture of simple atomic weapons is thus eliminated. Considering all these advantages I think and strongly recommend that heavy water reactors of the Canadian type should be constructed throughout the world for the production of electricity, at least on an equal footing with the American type reactor.

Nevertheless, the fast increasing number of nuclear plants requires the reprocessing of spent fuel will lead to the accumulation of very large amounts of long-lived radioactive wastes. Presently these wastes are stored, as concentrated water solutions in underground double shell stainless steel tanks. This is very safe under normal conditions, but may appear too vulnerable in case of a conventional war or in case of a powerful sabotage attempt by terrorists. An important improvement would result from the solidification of the radioactive wastes by incorporating them in a special glass; this would prevent any possible dissemination of an intense radioactivity in the environment and would make easy a very safe underground storage, for instance, in worked out salt mines. Adopting this solution, the French government has just decided to construct a first large plant for the vitrification of radioactive wastes. In spite of such progress, a great priority should be given to research aimed at improving the safety of storage of long-lived radioactive wastes.

To slow down the increase of consumption of fuel oil for the production of electricity one should not resort only to more and more nuclear energy. In addition to the development of new sources of primary energy, which will be discussed later, it appears possible to increase notably the efficiency of conventional power plants by coupling a high-temperature cycle to the ordinary steam cycle. For instance, the research and development effort on the direct conversion of the kinetic energy of a high-temperature limited
gas jet into electricity by magnetodynamics should be intensified, now that the high price of fuel oil would justify the estimated supplementary invest-
ment.

It should not be forgotten that, also during the next 10 years, rather large funds should be applied, notably in North America and in France, to the equipment of many possible sites for hydroelectric plants, which have been left unexploited because they could not compete with cheap fuel oil.

Other important savings of fuel oil could result from the extension of storage facilities for electric energy, making it possible to store the peak hour demand from electricity produced during the night by base load plants, which will be operating more and more with nuclear fuel. The storage of electric energy on a large scale is only possible now by pumping water from a lower reservoir to an upper one; this can be done only in hilly or moun-
tainous regions and requires rather large areas. The storage of energy in large special flywheels has been proposed recently and appears very promising considering the fact that flywheels made of fiber-composite materials, instead of even the best steel, can store up to 5 times more energy per unit of mass. Such a flywheel weighing 100 tons, coupled with a variable speed motor-generator, could store some 10^-3 kwh with a total efficiency of more than 90 percent, which would be much cheaper than the equivalent pumping installation, and could be situated anywhere. An important effort of research and development on these modern flywheels should be done in the near future, not only in view of their use on electric networks, but also because smaller units might become, by far, the best solution for electric driving of automobiles or buses. The energy stored in a flywheel, weighing less than 100 kg, would be sufficient to propel a medium size car over a distance of 500 miles at a speed of 60 mph, and the reloading time might take only 5 min. The industrial development, on a large scale, of such electric automobiles, which might take 15 to 20 years, would save much gasoline and would elimi-
nate the largest cause of air pollution in cities.

Another important industrial problem that might be solved within a few years, if a sufficient effort is made, is the gasification of coal, eventually directly underground. This would make cheaper the production of synthetic gasoline from coal and thus alleviate the oil situation. A special mention should also be made of the possibility, already in view, of producing large quantities of hydrogen by catalytic thermal dissociation of water at tempera-
tures below 1000°C. This may become the best way to store, to transport (by pipelines), and to distribute the energy produced in large high tempera-
ture nuclear reactors. The storage of hydrogen by absorption, under moder-
ate pressure, on special porous materials may even lead to the possibility of using it as motor fuel, thus avoiding most of the pollution due to exhaust gases.

GEOTHERMAL ENERGY

The possibility of using the internal energy of the earth, corresponding to the increasing temperature of its crust with depth, depends on the existence,

SOLAR ENERGY

In spite of the enormous amount of energy received by the earths from the sun (approximately, at ground level, 1 kw/2 m on a surface perpendicular to the sun rays), it is very difficult to use it for the production of electricity on a large scale. Covering large surfaces with solar cells, like those used on space crafts, would represent an enormous investment if such equipment was to replace a modern power plant delivering energy on a large distribution network and is not likely to be done, even with much improved photovoltaics, before a distant future. Nevertheless, research on solar photoelectrics should be increased because the conversion of sunlight into elec-

tricity by medium size units, delivering up to 100 kw, coupled with the storage of energy by modern flywheels described earlier, might become economical to provide electrical light in isolated villages in very sunny regions, like the moor part of India.

The direct use of solar energy is the form of heat would be possible quite rapidly. The quantity of solar energy received on the average by the walls and roofs of an individual home is approximately equal to the consumption of industrial energy by its inhabitants. Solar heat is already used to provide hot water for domestic consumption in many warm countries, and experi-

ments have shown that up to one-third of the fuel oil burned for heating a house in winter could be spared, even in the temperate north belt, by special coverings of its walls and roof. It is not the rather simple technology in-
volving which will slow down the spreading of solar homes, but rather the fact that the installations required for a good utilization of solar heat must be integrated in the house structure at the time of its construction, and that housing, in most countries, is replaced at a rate of only 3 percent yearly.
CONTROLLED FUSION

A completely new source of energy for mankind would result from the success of the now nearly 20-year-old effort to control the nuclear fusion of light atoms which provide the explosive energy of the thermonuclear hydrogen bomb. The easiest and most energetic fusion reaction is between atoms of deuterium and tritium, the two heavy isotopes of hydrogen. Practically unlimited reserves of deuterium, in the form of heavy water, exist in ordinary natural water; the tritium, artificially prepared, can be quantitatively regenerated by the absorption in lithium of the fast neutrons emitted by the fusion reaction, and lithium is a rather common element, existing in an appreciable proportion in all granites. However, it is not these unlimited reserves of the raw materials used which make attractive the production of energy by thermonuclear fusion reactors; it is the fact that such reactors might operate without producing either long-lived radioactive wastes or such unstable but many elements like plutonium.

The conditions necessary to achieve controlled fusion are extremely difficult to fulfill. The most onerous problem is the confinement, away from any wall, of an extremely hot (more than 50 million degree) gaseous mixture of hydrogen isotopes. To solve it, two different approaches have been followed: magnetic confinement and laser compression. Considerable research has been devoted to magnetic confinement; it is now mostly based on the "tokomak" device, first proposed by the Russian physicist Aristovitch. The next generation of large experimental facilities of this type, which are now in the final design stages in America, Western Europe, and the Soviet Union, may bring the proof, within 5 or 6 years, of the physical feasibility of controlled fusion. A similar success appears to be possible also with the second approach, the sudden compression and heating by very powerful laser beams of pellets made of a frozen mixture of deuterium and tritium. This method, proposed on theoretical grounds after the development of powerful lasers, is now the basis of an impressive research program in the United States.

But even if a first demonstration of controlled fusion is effectively achieved in the near future by either of these methods it may be expected that the central part of the very expensive experimental set-up involved will be destroyed by radiation damage after only a few seconds of actual operation. Tremendous technical problems will have to be solved after such a demonstration of the physical feasibility of controlled fusion, before it becomes possible to design and build a powerful nuclear fusion boiler able to work. Let us say, just a few months. This may require the creation of essentially new materials and may take some 20 years. The cost of these first fusion boilers will probably be prohibitive, and many more years will elapse before controlled fusion becomes competitive with any fusion boiler or even with a conventional boiler burning very expensive fossil fuels.

I consider that it would be wishful thinking to hope that by increasing sufficiently the effort of research in the field of controlled fusion, it would be possible to avoid a considerable worldwide development of nuclear fusion plants of an efficient type, which means fast breeders or at least heavy water moderated reactors, during the next 40 or 50 years. This does not mean that research in this field should be slowed down. The peaceful use of thermonuclear fusion energy is a great challenge to man and, for long-term planning, it is important to know much in advance if and when it will be possible to derive from this most satisfactory form of nuclear energy a significant fraction of the very large amount of energy that will be required by mankind in a distant future.

LONG-TERM FORECAST OF ENERGY CONSUMPTION IN THE WORLD

It is usually considered, at least as a desirable and possible objective, that in the not too distant future all the inhabitants of the earth should enjoy a similar standard of living implying an equal annual energy consumption per capita. This is completely unrealistic; in any more or less predictable future there will remain considerable differences between the consumption of energy per capita in the different economic regions of the world; it is even out of the question that within two or three generations the consumption of energy per capita in the presently less developed countries might attain a value comparable to that existing 20 years ago in the United States.

Nowadays, the consumption per capita of energy of industrial origin is in Western Europe about one-third of what it is in North America, and in the poor underdeveloped nations, it is about one-tenth of what it is in Western Europe. Even if the economic growth is slowed down in North America, as much as possible without disrupting the production system and the social order, and if on the contrary this growth is maintained in the underdeveloped countries, there will remain near the end of the century a very large gap in the energy consumption per capita (and of raw materials) between the United States and, let us say, India. On such assumptions, by the year 2000 the energy consumption per capita may have increased by at least as 20 percent in the United States, but will now be more than one-half in Western Europe and one-sixth in the underdeveloped nations which it is now in North America.

It seems to me most likely that the energy consumption per capita will everywhere tend toward a constant value, but earlier or later and at very different levels in the varied regions of the world, the different nations forming the present economic group, a society similar to the present society of citizens in a free democratic nation. This will probably happen in the middle of the next century when the total world population is stabilized around 12 to 15 billions of inhabitants.

The large disparity between the average energy consumption in different countries may appear unjust, but it is not more unjust than the disparity between individual incomes in any country, and if the smallest average energy consumption is not too low, this disparity between nations would not imply that life should be much more pleasant in the nations where the consumption of energy is the highest.

GENERAL CONCLUSION

The very large investments necessary in the immediate future to face the oil crisis leave little money available for research and development during
the next 10 years. During this period priority should be given to that research which may lead within 10 to 15 years to important energy savings, to the development of new sources of energy, or to the protection of the environment against pollution.

In the field of nuclear energy, which will be more and more extensively used, an important effort should be made to increase the safety of operation of nuclear reactors and the safety of long-term storage of radioactive wastes. The substitution of more efficient reactors for those now most extensively used in nuclear power plants should be prepared. Fast breeders should be developed with the aim of making possible a large use of them 10 to 15 years from now. But in the meantime that the safety of operation of such breeders, including their fuel cycle, could not be convincingly demonstrated in face of a hostile public opinion, the use on a large scale of heavy water moderated reactors of the Canadian type should be prepared as an alternative solution.

For oil savings, the most important development to be intensified is the gasification of coal, eventually underground. Important oil savings may also result from the storage of electrical energy in flywheels made of new fiber materials which appears as one of the most promising technical proposals, and its development should be intensely pursued.

Geothermal energy may become of great importance for the production of electricity in some special regions of the world, and its use for direct heating of houses and buildings should be possible in many more regions, especially if more efficient and cheap heat pumps can be developed. A great effort of prospecting by geophysical methods and by drilling should thus be devoted to this source of primary energy, very little used until now.

It is only for direct heating of individual homes and the production of hot water that it appears possible to use solar energy on a large scale before the end of the century. The rather simple corresponding devices, including good thermal insulation, should be incorporated in the structure of new houses during their construction, in all the regions where winter heating is necessary, but this does not require a very important research program. The direct production of electricity by solar light in large power plants in highly industrialized countries is probably only a very distant possibility; nevertheless, the research effort for the improvement of solar photovoltaics should be increased because they could be useful, if they are sufficiently improved, in medium sized installations which might be very useful for isolated villages in undeveloped countries endowed with a sunny climate.

Finally and contrary to several authoritative opinions, I consider that the research effort on controlled nuclear fusion should not be intensified, because I do not see any hope of an industrial and commercial success in this field before at least 50 years.

THE SCOPE OF THE CONFERENCE: POSTCONFERENCE OBJECTIVES

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INTRODUCTION

Before the conference separated into committees it may be opportune to glance at the past of The American Division of the World Academy of Art and Science and to look forward to the post-conference impacts that our activities will hopefully produce.

The current conference is in the tradition of the American Division and of the World Academy as a whole. When the late Hugo Boyko and his colleagues inaugurated the Academy in the years immediately following World War II they wanted to assist in clarifying and realizing the common interests of the World Community.

From the beginning the Academy has been interdisciplinary in deference to the contributions of knowledgeable persons who specialize in any branch of the physical, biological, and cultural arts and sciences. The Academy is policy oriented and examines the implications of knowledge for public policy.

In the early years the Academy established a record in Europe. Conferences were held in Rome, Paris, Brussels, Stockholm, and elsewhere, and symposium volumes were published on world population, resources, and other problem areas.

Toward the end of the sixties the American Division began to accelerate its program. In 1970 The International Joint Conference of The American Geographical Society and The American Division was held on the premises of the New York Academy of Sciences. This was the first Conference on Environment and Society in Transition: Scientific Developments, Social Consequences, Policy Implications.

A theme that ran through the deliberations of the Conference and received emphasis throughout was the importance of maintaining continuity in the relations between the scientific and professional community on the one side and the public policy process. Much more is implied than the idea that close connections are made with government officials and agencies. The Conference recognized the importance of reaching beyond officialdom and establishing ties of mutual interest and confidence with individuals and associations throughout the body politic.

In the United States, for instance, relations are episodic. Interest is stimulated by public awareness of an "energy emergency" or by alarm among scientists and educators when their appropriations are under attack. If the concern of scientists with the public interest is to be credible the evidence of involvement must be continuous.
method that were discussed this morning may deserve more extended or independent treatment. The committees should feel free to prepare or to arrange for the preparation of special reports. Perhaps an example & the theory of specifying the quality or style of life, including the choice of social indicators. Other possibilities are the projection of futures, and the technique of conducting surveys of world priority estimates.

Committees are free to adopt any procedure that promises to expedite their work. They may decide to establish subcommittees of one, two, or more members. Perhaps they will take advantage of the presence of lawyers and other professional-investigating reports for the plenums of the Conference and in the preparation of the final version of documents to guide post-Conference activities. Assistance may be obtained by private arrangement with members of the Conference who are not on a particular committee that desires their participation.

Most committees are expected to consider a large sector of substantive problems and to carry on the work begun at the First Conference. Our discussion has already demonstrated the importance of refining judgments of specific policy goals to explicit assumptions about the context in which these goals are expected to reach a stated level of attainment. If we are to deal realistically with objectives expressed in terms of quality of life, infrastructure, and the like, we must be clear about the size of the population. Does one assume zero growth or a specific level of acceleration or stabilization?

Further, a given level of population is assumed, what resource levels and technologies are necessary to sustain the preferred quality of life and life style? For instance, how drastically must the capabilities of present technologies be changed?

If we postulate a preferred quality of life at a given level of population, resource use, and technology, what changes in organization and in legal structure will be required to manage and stabilize the transition?

Understanding the same set of assumptions what strategies will be effective in mobilizing the public support necessary to achieve and maintain the preferred public order?

Each committee is responsible for outlining the implications for their topic of adopting various goals and assumptions. It will be noticed that the list of committees does not cover the entire range of world policy questions. The intention is to concentrate on sectors of special importance and to invite the committees to examine priority questions within the sectors. The inter-disciplinary character of each group will speed up effective communication among committees, regardless of their separate starting points. The committee on world energy, for example, will necessarily deal with levels of resource and technology. It will judge the probable impacts of organizational and legal structures, and also of public perspectives and behavior. A corresponding range of issues will challenge the attention of the committees on food and population.

The committee whose take-off point is world structures of government and law will work closely with the substantive groups. The committee's
task is to design priorities for adapting the decision-making and executing agencies of world public order to the several phases of decision:

- The formulation of prescriptions;
- The provisional invocation of prescription in concrete circumstances;
- The final application of prescriptions;
- The termination of prescriptions and the compensation of claims;
- The approval of policy structures and actions to date;
- The gathering, processing and supplying of intelligence to decision makers; and
- The promotion of public action.

The organization on world perspectives will be directly concerned with strategies for the mobilization of public support on behalf of appropriately timed action. This will necessarily involve analyzing the strength of pre-existing predispositions that either stand in the way of perceiving common interests or of identifying with the history and prospects of the world community.

Closely connected with these problems is the committee on knowledge, which covers research, instruction, and public information.

The committee on regions will explore the policy priorities by which regional changes can both express and strengthen fundamental transformations on a global scale.

On the basis of our experience thus far, it is evident that documents are most valuable when they are brought to the focus of attention of active or potentially active participants in world public and civic order. The Academy will bring the documents that emerge from this conference to the attention of scientific academies, societies, universities, and other organizations that possess sufficient autonomy (in fact) to sponsor or to initiate reviews and appreciations of public policy toward use or even sectors of the cultural, biological, or physical environment. The overall aim is to strengthen both public (official) and civic (private) order in furthering the common interests of man.

A second post-conference initiative is closely related to the first. The documents will provide guidance to those who are in a position to direct the focus of attention of the general public, as well as of official agencies. It is clear that perspectives are most immediately affected by what comes to the focus of attention. If the world community is to acquire a more coherent picture of the past, present, and future of man, and also to perceive the alternatives open for common action, coherent images must be made available at the focus of world attention. The proposed strategy is to approach potential sponsors with the idea of initiating or adopting conceptions such as a social perception of the cultivation of world perspectives.

AFFECTING WORLD POLICY: STRENGTHENING CIVIC INITIATIVE, REVIEW, AND APPRAISAL

We first consider the objective of affecting public policy by strengthening civic initiative, review, and appraisal, particularly by private scientific and professional associations. Experience demonstrates the danger of allowing the levelling of power to swallow society, or, conversely, of permitting

private monopolists or anarchistic forces to paralyze public order. Menacing imbalances between governance and society are not invariably associated with either socialist or liberal-capitalistic structures. Socialist states can be democratic or oligarchic, and liberal commonwealths vary from democracy through monopolistic oligarchy to temporary anarchy. The Academy's purpose is to cultivate continuing self-appraisal and correction throughout the world community. A self-correcting process is more likely to succeed when it proceeds in two relatively independent parallel channels. The probability that a public order can stay "normal" is improved when the civic order is well-informed and active. Therefore, the major aim of the Academy is to encourage scientific and professional associations to contribute to the world decision process by performing the civic function of reviewing and appraising the adequacy of public order as it affects environment and society.

In an informed and comprehensive civic order, scientific and professional associations would regularly issue reports on public policy in specific sectors. These reviews would not be "one-shot" performances. On the contrary, they would become fixtures on the calendar of these associations. In the reviews would develop attentive constituencies among government agencies, media of communication, political parties and pressure groups, and other private groups and individuals.

The World Academy plans to multiply Fellows who are interested in initiatives of the kind implied by the appraisal program. In every jurisdiction a first step is to survey the current state of planning and appraisal, with special reference to the role of scientific and professional associations.

A glance at the topical organization of the 1970 Conference (somewhat modified) provides an abbreviated map of the potential scope of appraisal. Our concern is with the impact of public policy on the physical, biological, and cultural environment.

1. Earth and Space
   - Space
   - Air
   - Climate and weather
   - Water
   - Seabed
   - Earthquakes
   - Fossil energy
   - Nuclear and solar energy
   - Minerals and metals

2. Life
   - Marine life
   - Food plants
   - Forests and timber processing
   - Land animals
   - Special regions (polar, deserts, marshes and estuaries, rain forests)
III. Man and Culture

Population
Human genetics
Family
Health
Education
Communication
Wealth
Arts
Sciences
Religion
Government, law, politics
Morals
Ecology

Even a cursory examination of the world community shows how various are the institutions and the circumstances of the scientific and professional groups.

In some countries the scientific and professional societies are so tightly interwoven with the policy processes of governmental organizations that they are not sufficiently detached to sponsor reports of the kind we are discussing. Elsewhere the ties are less with official organizations than with private nonpolitical structures. In any case the “free professions” are not, in fact, independent enough to engage in genuine acts of appraisal.

Sometimes the scientists and professionals are polarized into “establishment” and “antiestablishment” camps, so that no tradition has evolved of effective independence on the part of at least some specialists. In some nations current circumstances may be favorable to the emergence of a more independent civic order in which scientists and professionals play a dynamic role.

We are well acquainted with some policies whose private and semiprivate academies and societies have a record of occasional and sporadic recommendations and who are willing to recognize the opportunities and dangers of the time and to mobilize their efforts in these directions.

In countries where the scientific and professional establishment is short sighted and is heavily engaged in official nation-building activities, it may seem premature (even dangerous) for initiatives of the kind outlined here to be taken. Perhaps it is more useful to develop informal institutions designed to encourage unofficial and official discussion of basic aims and achievements. In the Southeast Asian country, for example, a university professor who is also a key official in the national planning agency sponsors a regular private gathering once a month that provides a unique forum of this kind. Eventually the institutional evolution of the country may justify more elaborate arrangements.

In recent years we have witnessed the rapid growth of official and private agencies that give prominence to one or another feature of the decision process. “Futuro” societies are a case in point. The “projection” of varying developments is one of the five problem-solving tasks mentioned above (for others: goals, trends, conditions, alternatives). The Academy’s initiative may very well induce some of these organizations to broaden their scope to include more features of the policy process.

Another contemporary trend toward an institutional and research institutions is to reach beyond traditional limits by giving systematic encouragement to “policy analysis” or “the policy sciences.” This is especially apparent in scientific and professional training. One manifestation of change is the widening scope of management programs in schools of public administration, public health, business, law, engineering, architecture, planning, education (and so on). No doubt the Academy’s initiative will stimulate and help to justify these programs.

Concern with public policy is also evidenced by new centers intended to assist the formation of professionally competent persons in “policy analysis” or “policy sciences.” The emerging field goes beyond training in particular managerial skills to include critical examination of the factors in the context of policy that affect success or failure.

These developments once more raise the question when a skill group judiciously achieves recognition as a profession. The capacity to serve clients is not the test, whether we look at the old professions, such as medicine and law, or think of more recent creations. It is necessary to add capability in manipulating an aggregate process and in the clarification of common interests. Physicians are expected to concern themselves with community as well as individual health, and lawyers are expected to consider the community level of justice in addition to the interests of particular clients. This criterion applies to all knowledgeable groups in the several realms of the physical, biological, and cultural environment.

It is helpful to provide initial guidelines for reviewers and sponsors of public policy. Appraisals differ in several ways from a standard summary of a precisely defined field. Reviews often deal with sectors of the environment toward which public policies are incompletely formalized. Goals and principles may be somewhat elusive, contradictory or confused, and legal prescriptions and procedures may be missing or incoherent. Organizational structures may be in flux; technologies may be underdeveloped, nonexistent, or in debate; public support may be incoherently mobilized. Inclusive and satisfactorily tested information may be unavailable.

In a word, while a great deal of information is at hand, the links between knowledge and action are somewhat tenuous. The urgency of uncertainty is yet another scientist is accustomed to, and in such circumstances he may feel uncomfortable about using his judgment. Nevertheless, it is because a disciplined judgment can assist in the formation of working programs and in estimating success or failure, that the knowledgeable citizen is under a moral obligation to contribute what he can—based on his special knowledge—to coping with the common problems of the community.

Policy planning or appraisal faces an individual or a committee with complex intellectual tasks. The following questions have been used to illustrate the work of some panels. Suggested improvements are invited.
and leaders. In countries where popular institutions are well-rooted, it is important to maintain the strength of the total system of public and civic order by involving professionals with their neighbors in community action.

Mobilizing World Attention: The Social Planeterium and Other Techniques

We mentioned a broad strategy of Academy action in the rest of the conference period. It is intended to reach those who have access to the focus of attention of large audiences in the world community.

The spectacular expansion of all media of communication has accelerated the tempo and direction of world history. To assert that history has accelerated is to imply that what would have happened later has happened sooner, and that changes in timing influence substantive developments. World attention must outstrip other zones, notably those of travel, trade, and technology, and also of opinion, sentiment, and organization.

The communications revolution was expected to contribute to the rapid proliferation of world public order. Growth has been much less rapid than predicted. Fragmentation has counterbalanced unification. National and anticolonial identities have multiplied. The universal aspirations of the Marxist world have been moderated by proliferating national socialism. Radical calls across a potential identification with man. Even the media of mass communications are absorbed by parochial news and commentary.

From its inception the Academy has emphasized the importance of disseminating a sufficiently common map of society and environment to foster the continuing discovery of common interests. The innovation of institutions designed to realize these interests, and the cultivation of self-correction policies of change.

We affirm that it is possible for scientific and professional organizations to strengthen the forces that work against fragmentation on behalf of coherent presentations at the focus of attention. Specialists on communication are hopeful, if not confident, that comparatively new methods can be used to correct the fragmented impact of the mass media without turning to global dictatorship.

Among corrective devices is the planetarium technique. In the last century the planetarium was introduced as a means of popular education in astronomy. It provides a self-orienting experience, an exposure by means of which the individual ego can be brought to perceive himself in the context of the whole. The presentations display the past of the heavens and the Earth and preview the future, including in recent years such policy goals and alternatives as the arrangements of artificial satellites and the control of pollution.

The social planetarium does not require a machine. It calls for a technique that creates a coherent experience of society that is equivalent to the experience of nature. The Academy’s proposal will be directed to colleagues in academies and professional associations. The suggestion is that each organization take the initiatives necessary to apply the social planetarium procedure at all terri
toral levels and among all pluralistic groups. Whether the technique is
adapted to an ephemeral broadcast or a permanent exhibition the purpose
remains the same: to provide a comprehensive, realistic, vital, and policy-
oriented image of the whole.

Selectivity is the key. The challenge is to sustain a conceptual sense de-
spite the avalanche of detail involved in an inclusive pantheon of man’s past,
present, and future. Each committee of this Conference is invited to offer
propositional guidelines to those who will assume eventual responsibility
for outlining in detail the presentations appropriate to each geographical
setting, historical period, social sector, and problem complex. Some initial
questions:

Goals. What conception of life quality and style can be presented in
ways that will be meaningful to world audiences who are in situations that
range from global broadcast to relatively permanent local exhibits? Such
documents as the Universal Declaration of Human Rights can be given
tentative, not dogmatic interpretations. They refer to every value-institu-
tion sector of human life (to the shaping and sharing of power, enlighten-
ment, wealth, well-being, skill, affection, respect, rectitude).

Trends. What are the most available indicators of the key changes that
have occurred in the globe as a whole and its various regions? We are con-
cerned with government, law, and politics; the communications revolution;
the technologies of producing and distributing wealth; the transformations
in safety, health and comfort; the variety of professional, occupational, and
artistic skills and expressions; the range of institutions for the guidance of
love and loyalty, and other manifestations of affection; the arrangements for
recognition (respect), including social class and caste; the norms and levels of
responsible conduct (rectitude).

Conditions. Many explanations are offered to account for the changing
directions and intensities of world trends. Given the presence of scientific
and political differences in the world community the problem is to aid
communication and inquiry by presenting the most important versions.

Projections. What future time periods are the most relevant? (Note the
symbolism of A.D. 2000 and of 20-year generation rhythms.) What range of
“catastrophic” or more mundane scenarios should be chosen? What are
the recommended sensors and indicators?

Alternatives. In the light of assumptions about priorities what policy
problem should be proposed for universal presentation? How can the cate-
gories employed at the Conference be extended to the purpose (e.g., assump-
tions about quality and style of life, population, resources and technology,
organizational and legal structures, mobilization of support)?

It is to be taken for granted that parental constraints will modify social
planetarium content in many situations. Nevertheless it is probable that
tough convergence of view has already occurred to warrant the claim that
such can be done to achieve a widened and deeper map of common
interests and identities in the world community.

The social planetarium program can be launched on a modest scale by
academies, professional societies, universities, or other knowledgeable

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bodies. Under the guidance of local panels (who, among other sources,
evaluate suggestions and materials from elsewhere) exhibits can present a
complete version of the whole.

The social planetarium concept can also be applied on a huge and
highly differentiated scale, redesigning available museums, galleries, libraries,
archives, gardens, and parks. By giving prominence to current trends, future
projections, and action priorities we can add a dynamic dimension to “the
future of exhibition.” It will be feasible to take more effective advantage of
occasional fairs and exhibits and so make sure that they are planned in ways
that permanently enrich the community.

It is important to realize that the social planetarium technique can be
applied at inter-village levels, as well as at great national, metropolitan,
and regional centers. World either are in possession of sophisticated resources.
But the planetarium conception challenges everyone in every locality to
guide his future behavior with an enlightened and updated image of the
whole.

The original planetarium was an achievement of scientists, engineers,
and educators. It will continue to attract and challenge the most knowledgeable
components of human society. In addition, everyone can, in principle, be
entitled to participate in planning the future. (“Hawaii 2000” is a precursor of
the involvement of young and old, rich and poor, professional and
amateur.)

A world of knowledge does not need to be a world of passivity. It can be
a world of cooperation in expanding, interpreting, and acting on the basis of
knowledge and judgment.

OTHER ACADEMY PROGRAMS

The two post-Conference programs do not exhaust Academy activities.
We have emphasized Appraisals and the Social Planetarium because they
seem particularly timely.

It is appropriate to comment upon our relationship to the World Uni-
versity movement. For many years the World Academy (WAAS) has been
involved in plans for a World University and has engaged in exploratory
initiatives to this end. We encouraged the United Nations to act affirmati-
vely and communicatively many specific suggestions to UNITAR and other
responsible agencies. On various occasions WAAS prepared publications
in which the objectives and operations of world universities were examined
in some detail. For example, memoranda and booklets were distributed at
the Stockholm Conference of the Nobel Foundation on “Values and Facts in
the Modern World.” There are grounds for believing that these activities
had some influence on the evolution of the plans recently announced by
UNESCO and others.

The Academy has always conceived of the world university movement as
not comprehensive to be confined to a single structure. It welcomes initia-
tives under official, semi-official, or private auspices and looks forward to
collaborative projects and arrangements among them.

Another feature of the Academy’s approach to the creation of world
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position toward the institution itself. Nor does it presuppose awareness
of the connection between many specific situations and the overall network
of war-supporting institutions. It may be that work in a particular laboratory
is not perceived by the staff as intimately involved with weapons.
The analysis provides a guide to the explanation of two phenomena which
bear directly on our topic: the failure to abolish war (a) by establishing a
universal system of public order by conquest, or (b) by introducing at least
a minimum system of effective public order by consent.

If we think of world developments in terms of innovation, diffusion, and
restriction, the inference is that innovations designed either to conquer or
to bring about peace by consent have hitherto been blocked by the restrictive
forces. We recall the two German initiatives (of 1914 and 1939); or the
carrier Initiative of France (1789). We think, too, of the initiatives at the
end of World War I and World War II on behalf of the League of Nations
and the United Nations. Both types of innovation have failed on a suf-
ciently grand scale to transform the fundamental perspectives and operating
techniques of world public order.

Ellis Trapped in the Political Process

As far as we know, the top figures in China, the Soviet Union, the United
States, France, West Germany, Italy, and Japan are disciplined, experienced,
realistic men. They may be "peculiar," but they are not sick in the clinical
sense of Stalin in his later years. I have no doubt that no matter how meager
or extensive their training may have been in science or technology, these
leaders are convinced of the catastrophic potential of nuclear weapons in
an anarchic world system. I suggest that, even if they wanted to agree with
their opposite numbers to establish a new system of effective public order,
they would hold back from taking crucial steps for fear of opposition in
the arena of internal politics. After all, a power relation is a two-way affair.
To "have" power is to be unpowered. Any rumor that the top leaders are
planning to put the country in a position where it can be subordinated to a
coalition of foreign powers on questions of "security" or "basic policy"
continues to stir personal, factional, party, and governmental bruises to
resist. Is it any wonder that a statesman may decide that political suicide
contributes nothing to his career nor to the fundamental reconstruction to
which he may be personally devoted?

The political rivals of the globe are trapped by the internal and external
proverb of power balancing which is fundamental politics.

Scientists and Professionals Trapped by Proximity Preference

Many eminent figures in science, as in scholarship and the arts, have
echoed the many cultural and religious leaders who have identified
with mankind and urged everyone to recognize the common interests of all.
We think of Einstein, Kant, and galaxies of outstanding persons. None the
less it continues to be possible to ask: Why are all scientists and professionals
not part of a single corporate body that works for man?

Many factors work against universality. A principle appears to be that
universality of claim and use is frustrated by the paradoxical locus of innovation.
Many philosophical, juridical, and theological doctrines involve universal symbols of justification. The point of initiation of a doctrine is, of course, circumscribed in time and place. In consequence the acceptance of one universal claim may be restricted by invoking another universal. (For instance, a scientific generalization is not necessarily without resistance from the scientific community, nor is the spread of a technological device a foregone conclusion.)

So long as specialized scientists and scholars depend for economic support, respect, and other value indulgences on national states, it can be predicted that career expediency, at least, will put the fruits of knowledge at the disposal of national societies and honor of national states. Those scientists who cross the boundaries of one power or power coalition with which they are identified will continue to be tacitly isolated by the middle range and the rank and file, who are overwhelmingly dependent on the pecuniary indulgences offered them by national settings. Nor further that for scientists who decide to play political roles national popularity and success will presumably be at the cost of some international interests or affiliations.

The inference is that although the world politics of our epoch can be plausibly characterized as marking the emergence of "the permanent revolution of the modernizing intellectual"—including natural and social scientists—the aggregate advantages perceived by competing intellectuals maintain the aggregate structure of world division.

World Identity and the Self-Reference Mechanism

The attentive observer continues to be impressed by the revolutions that have transferred the technology of communication. The revolutions have diminished the intensity of devotion to local identities. The beneficiaries have usually been the more inclusive units of national identity. These images have, however, stopped short of universality. Communication has not, as yet, generated a deep sense of identity with mankind and with institutions that explore and express common interests.

To some extent this is to be attributed to a pattern of response that is not at first premeditated but which is quickly exploited in a divided world. The "self-reference mechanism" is the most economical means by which an individual familiarizes himself with a new environment and enlarges the scope of his own identity. Witness how visitors to a new town or country inherently compare it with their home town or native land. The role of the self-reference effect is heightened in the world arena by the deliberate strategies of official and unofficial controllers of education and mass media. Huge states that are well advanced in voluntary modernization (e.g., Great Britain, France, Western Germany, and the United States), although cultivating many foreign contacts, are largely self-absorbed, internal news references multiply more rapidly than references to foreign matters, and especially to foreign perspectives. Giant states that engage in forced modernization (e.g., the Soviet Union and Red China) are especially nationalistic and local and anti-international.

The significance of the self-reference effect and the monopoly of attention paid to national events is underscored if we think of the negative responses that appear when proposals are made for the purpose of weakening its impact. For instance: give a world communications commission access to all citizens of the globe for at least an hour a day of news and comments (and make small receiving sets available to all); put in the hands of a world board of education at least a day of school time during elementary common and secondary years; arrange for each child to spend at least a year abroad (preferably in the territory of a political rival); before adolescence, provide each young person between adolescence and young adulthood at least another year abroad; break up the national power monopolies by dividing the giant powers into small powers and consolidating an international organization strong enough to maintain at least minimum public order and to allow the movement of persons and goods.

Parochial Ideology: Partial Rejection and Partial Incorporation

Closely to the preservation of the divided and militant structure of world afflicts are provided by mechanisms that may also rise to the level of strategies. One is partial incorporation of an ideological innovation. The other is partial rejection of a new pattern. The symbolic system in the name of which power was seized in revolutionary France included "liberty, equality, and the pursuit of happiness." These themes were rejected in whole or in part by ruling elites in and outside of Europe. Concurrently some elites were able to maintain or to win new support at home by incorporating some of these doctrines into an established ideology. A parallel process was exemplified in the response of outside elites to the challenge of the new symbol structure in the name of which the Russian Revolution of 1917 was conducted. Partial incorporation is synonymous with a deliberate strategy, as in the case of the Nazis in Germany who were self-proclaimed party of "workers" and "socialists." By emphasizing the "national" identity opposition was mobilized among acknowledging the primacy of the Russian Center of self-styled "world revolution." The "racism" theme was a political innovation that helped to differentiate the Nazis from the Marxists. Similarly the Marxists emphasis on "economic" categories played a role in functionally differentiating Marxist movements from the "socialism" and "egalitarian" of French-intended political ideologies.

Up to the present various world revolutionary movements have fallen short of universality as a partial consequence of the mechanisms that fostered rejection of the political demands of the innovating center, while facilitating the spread of support mobilizing features of the new ideology. Symbolic manipulation serves as a means of testing the direction and intensity of the predispositions current in the world community as a whole or in any component part, by a divided and militant world arena polarization is a consequence. Universalizing and parochializing tendencies are in fluctuating balance and imbalance, whether one is examining the territorial or the pluralistic deployment of individual and collective actors. Ruling elites are trapped in a divided world arena in part as a consequence of the factors that play into the hands of internal opponents who are able to
utilize the predispositions available as expressions of the self-reference effect and of the mechanisms of partial incorporation and rejection. The mechanisms referred to are not limited to the ideological features of a particulate pattern. Every other element may become a target of partial incorporation or rejection. The operational practices of “liberalism” were much further than words and attitudes; and they, too, were selectively responded to by the political environment.

These symbolic processes interpose barriers to the completion of an inclusive world public order by consent. The tendencies toward universalizing the practice of participation in the shaping and sharing of values are being held in check.

Although great centers and subcenters have arisen outside Western Europe, the core of modern values and institutions is geographically unbalanced and promises to remain so, owing in part to the cumulative advantage of established centers. We note, too, that the established elites of a traditional society tend to retard the tempo of innovation and diffusion by introducing self-modification. Hence the strategy of exclusion by partial incorporation plays a conspicuous role in perpetuating the substance and the diversities that aid in maintaining a divided and militants world.

Simultaneity and Non-Simultaneity: Future Prospects

Implicit in the foregoing analysis is the significance of non-simultaneity in retarding the spread of innovations that comprise or expedite world public order. Often originating at one single center, there is time for all who are identified with established values and institutions to isolate the domain of the new center by combining against it and to weaken its distinctive asset by partial incorporation of its most value-enhancing features. The growth of innovative subcenters outside Western Europe has failed to bring about diffusion and unity, partly because competing patterns are “asynchronous” rivals.

It is possible to imagine contingencies in which unity could be achieved by a process predominantly of consent rather than conquest.

For example, conceive of simultaneous access to power in many nation states by publicly supported political movements committed to a universal public order, whose leaders would immediately establish or invoke an inclusive organization to take over the command of armed forces and to preserve the peace, and to exercise the taxation and fiscal authority necessary to support key common activities.

Such simultaneous action could conceivably follow rejection of the war system by the creased youth (and other groups) and their concurrent withdrawal of support from independent, separatist, nation-centered institutions. Sudden collective squares have occurred on a large scale in the past, such as the Crusades. In the contemporary world, with its vast networks of instantaneous communication, quick travel, and rapid transport, it is possible that the anxieties generated by the arms race, coupled with a gradually widened self-reference function, may lead to simultaneous rejection of the institutions of war and division, and the prompt diffusion of an authorita-

tive and controlling system of optimum public order. Such a development would provide the support necessary to permit power elites to expect more advantages from anterior rather than continuing the war system.

We do not forget that a unified system of world public order is not necessarily a participatory public order. Two contrasting scenarios indicate why it is important to provide for continuing supranational and planning of changes in the world community context:

1. The Oligarchic Model. The power centers of the world are those who develop policies at home and abroad that depend on high levels of investment in resource-harvesting technologies, in this way heightening commitments to wealth and power. In such states that emphasize the values of material wealth and power, the revolution of rising frustrations continues to generate pressure, “from below,” and from “out there” for the wider sharing of wealth and power. Provoked by parallel challenges “from below” the oligarchic elites (governmental, industrial, political) come to expect that it is cheaper and less hazardous to evolve toward a unified transnational oligarchy (Washington, Moscow, Peking, Tokyo, for example). It is striving to consolidate an oligarchic world public order the instruments of communication are used to indoctrinate and distract. Chemical and biological and other coercive means are employed to test or correct failures of indoctrination.

2. The Participatory Model. The demand for selective development increases the pressure for investment in intermediate, resource-paramount technologies that minimally disrupt the distribution of population and intensifies demand for the pluralization of values. Excessive concern with that culminates in expressive acts that are parasitic on material requirements. Levels of frustration are held in check; oligarchies are deprived of support; the decision process is responsive to persuasive alignments of skill and other pluralistic groups; mass media provide attention opportunities that generate and re-define common maps of man’s past, present, and future and strengthen a universal and differentiated sense of identity and common interest.

It is not necessary at present to predict whether the oligarchic or the participatory model will most closely harmonize with future events. The main function of such a model of the future is to test forestall or to expedite their occurrence.

The “developmental consensus” of the past and future has underlined the importance of communication in providing the most rapid and comprehensive means of guiding collective action by providing relevant and vivid messages at the focus of attention of all who participate in the public and civic order of the World Community. The Academy is an institution primarily in the civic order that already possesses a partial network of communication with other individual and organized actors in the world community of knowledge. The question is how can we utilize these connections most effectively to strengthen civic order and especially to mobilize coherent conceptions of common interest and identity throughout the world community.
THE WORKING CRITERIA FOR POLICY SELECTION

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I have been asked to prepare a note on the working criteria for policy selection. I start from a view of the policy-making process which is different from that implied in our conference prospectus, so I must first explain this view.

I cannot attach reality to "policy making" except in relation to some "political" human system in which policy making is going on. The countries represented at this conference are regulated today by complex sets of "policies." Each of them depends on or is characterized by a host of internal and external relations, and in each of them governing bodies at national and local levels are monitoring some of these relations and trying to maintain them at levels which are as acceptable as it is deemed consistent with other demands and with total resources. The standards which define these levels of acceptability are the operative standards which express the current policy selection.

Some of these relations are conditions of the society's survival or of its growth. Externally, for example, its balance of payments reflects the relation between what it is drawing from beyond its frontiers and what the world outside is accepting from it. Internally its budget surplus or deficit reflects the relation between what it is trying to do and the resources available for the job. Cows and candle flares, no less than nation states, preserve a form more enduring than their substance only by drawing on the milk and disseminating into it. Their total physical capacity is limited by what they can thus metabolize, and they perish when their balance collapses. A great deal of policy making is directed simply to preserving the integrity and continuance of the system. I will call the relevant criteria "metabolic criteria."

Add to these criteria of growth. These suspiciously cancerous criteria have long dominated business and are influential in national government (less so in local government). They are currently being qualified even in business but they remain important, if only because increased resources are supposed to increase the scope for initiative and sometimes really do so. Irresistible as any human system acknowledges any purpose other than to survive and to grow, new fields of policy making emerge, regulated by what I will call "political criteria. All our countries anxious monitor the level of unemployment, poverty, health, education, crime, and a host of other indices, observing how fast these are changing and in what direction and comparing the state of these relations with the operative standards which define what they "ought to be." To a much lesser (although interesting) extent they concern themselves with similar indices in other countries and for the world as a whole, partly because external disasters may have unneutral effects and partly through a dawning sense of global solidarity.

These surveys of the "state of the system" reveal areas of promise and threat. In areas of promise the achievement of present standards may invite us to raise them. The more frequent threats of threat show current standards unstandable or current attainment threatened by changes in circumstances and call for different or more intense effort. Since the total demand implicit in all these new premises and threats, as in the earlier ones, is bound to be more than we can meet, choices are still needed to define the most acceptable new mix of standards which it seems realistic to set.

On any redefinition of policy the changed set of operative standards will be related to the old. It will have some continuity, partly because of the momentum and vested interests (in a good as well as a bad sense) generated by every ongoing policy, partly because even in revolutionary times these standards of the acceptable (which structure the minds of individuals as well as the policies of governments) do not change completely overnight. The changed set of operative standards will also have some discontinuity because it is generated by a dialectical process. More attention will probably be paid to areas which current policies neglected or handled unsatisfactorily. Less attention may be paid to areas which current policies have handled so successfully as to abate their urgency. Furthermore, external events, like the current threat to oil supplies and the worsening trend of trade, may change the relative importance of different fields merely by requiring a rationalization of resources to all of them. Thus, the working criteria for policy selection are a function of the ongoing state of a specific historical situation. This situation has several aspects. For Western States today, for example, these include the present state of the world's physical resources and equally the present state and policy of other national systems, its own internal state as expressed in economic and other statistics and equally the present attitude of its citizens towards the values expressed in its policies, and to a host of other values which may not be so expressed but which profoundly influence them.

I realize that our conference is designed to focus on world problems. But I do not think that our countries can effectively contribute to these problems except by the internal and external policies which they adopt. These can only be considered in the context of the country concerned. Moreover, the impact which they are having now, for good and ill, on the rest of the world is the fruit of their current policies and invites appraisal in that light. We start from a highly specific—and highly exotic—historical situation. If this be a valid summary of the policy-making process, three key questions arise: How do human systems define the situations which invite control by policy and changes of policy? How do they generate the standards which define what is unacceptable? And how do they cut down the rival claims of inconsistent standards, so as to contain them all within the limits?
of available resources? Recent developments have thrown more light on the first of these questions than on the second or third.

The pattern of promise and threat which attracts attention may be general, as when a British parliamentary party prepares an election manifesto or an American president prepares a "State of the Union" message, or it may be specific as when a specific promise or, more usually, threat demands attention in its own right. However wide or narrow the initial concern, the first step is—or ought to be—to analyze and resolve the situation which gives rise to it. This usually shows that both the factual situation and the policy issues involved are wider than they at first appeared.

The clearest example known to me arose out of a very limited, specific threat. In 1961 a British minister of transport set up a departmental working party of architects and engineers to study the problem of vehicular congestion in towns. In its report in 1965 the working party observed in effect that congested traffic in towns is not a problem but a symptom of the wider problem that modern towns generate more vehicular traffic than their ancient layout can contain. Towns could be so designed that they could accommodate more vehicular traffic than they do now. Equally, their activities could be so regulated that they generated less vehicular traffic. But towns and their activities, not roads and traffic, are the minimal variables which need to be considered, rather than the problem.

Similarly, success in solving the problem cannot be measured simply in the abatement of vehicular traffic congestion. Any change made to improve the state of this variable will affect others that no planner can afford to ignore, notably pedestrian access, safety, parking, amenity, and "visual squallor." Different combinations of these, all imperfect, are to be had at different prices, but none of the alternatives can be judged simply by its effect on vehicular traffic.

The lessons for policy makers to be drawn from the Buchanan report can, I think, be summarized as follows:

1. Identify the minimum number of variables so interrelated that they must all be considered in order to understand the problem and to estimate the probable result of any action or inaction (in other words, identify the simplest relevant system).
2. Identify the constraints which limit the policy makers' powers of intervention, including:
   - constraints imposed by the limitation of the resources at his disposal;
   - constraints imposed by the need to preserve the stability of the system so identified; and
   - constraints imposed by the demands of consistency with other current policies.
3. Identify points of diminishing or increasing return in pursuit of alternatives possible policies.
4. Identify elements of risk and uncertainty, their possible range and relative importance, and their relation to various time horizons.
INTRODUCTION

Let me first reassure you. I do not intend to bore or puzzle you with an abstract discussion of the esoteric issues involved in international monetary negotiations. I am not afraid of saying a few words first about the substance of these discussions, but the bulk of my remarks will center on an attempted exposition of the utter failure of these negotiations, at the present juncture, and of my conviction that this will prove to be only a temporary phase in an irresistible evolution toward a more rational world monetary order.

My reasons for choosing this topic are two:

1. It is the only one with which I am personally familiar, through 28 years of direct involvement in proposed reforms, both at the world level and at the regional level, in Europe, Latin America, Asia, and Africa.

2. It is a field which illuminates the extreme oppositions of progress toward international agreements and institutions, unparalleled in any other field of international relations, on the one hand, and, on the other, of utter failure and chaos at this very moment.

PROGRESS

I shall outline briefly such examples of progress in two areas: worldwide monetary reform and regional monetary integration.

Worldwide Monetary Reform

The creation of the International Monetary Fund, in 1945, was, of course, the first and most crucial step ever taken in world history toward the establishment of an agreed world monetary order. Confiding myself to the more recent past, however, I would like to point out the truly revolutionary—and hopefully geopolitical—reform adopted in 1969, under the aegis of the Fund, i.e., the creation of a new international monetary instrument, barbarychically designated “Special Drawing Rights” (or SDR’s for short), but permitting in effect the international community to issue a kind of world money designed to supplement, at first, and later to replace gold and the United States dollar as a means of international payment and reserve accumulation by the national authorities in charge of more than 100 national monetary systems.

This was widely hailed as the first step toward a more rational monetary order in which the creation of international money would be consciously planned and implemented by international agreements rather than aban-

The IMF would adjust the creation of this new money to the requirements of non-inflationary growth of the world economy.

Finally, the IMF would encourage the lending policies derived by it from world reserve growth to help finance collectively agreed objectives, such as the offsetting of disruptive movements of private capital, the acceleration of economic development of the so-called Third World, etc.

Regional Monetary Integration

Equally constructive and revolutionary steps were also agreed, and partly implemented, toward ambitious plans for the merging of obsolete national monetary sovereignties on a regional scale, particularly in Western Europe.

Summit Conferences of Heads of State or Governments had repeatedly commended the countries of an enlarging European Community to full economic and monetary union by the end of the present decade. A European Fund for Monetary Cooperation had been set up to organize a system of
multilateral consultations, payments, and credits, aiming to preserve, in the short run, agreed exchange-rate relationships between member currencies, until irrecoverable exchange-rate stability within the Community could be reasonably guaranteed and would make possible the ultimate plunge into a full merger of national currencies into a single Community currency.

Slower, but significant, progress toward regional monetary integration was also under negotiation in other parts of the world, particularly the COMECON, Central and South America, and even Asia and the Far East. This might lead in time to a better structured and more decentered IMF, enabling it to discharge more efficiently and realistically its enormous tasks placed upon it by the modernization and rationalization of the world monetary order.

Failure or Setback?

The negotiation and implementation of these ambitious and revolutionary reforms remained, however, an intricately difficult and time-consuming process. It was thrown into utter confusion, both at the worldwide and at the regional levels, by the utter collapse of the Bretton Woods system.

The unavoidable and long predicted suspension of the dollar convertibility, on August 15, 1971, removed the keystone of the whole structure, i.e., the gold-convertible dollar on which it rested, before anything else had been agreed upon to take its place. We are facing today a total collapse of the international monetary order and of the legal infrastructure on which it rested. This is, in part at least, the result of negotiating techniques and habits which tear, by their very nature, to minimize rather than maximize the chance of reaching agreement. Let me comment briefly on these three points.

The International Monetary Chaos

The exchange rates among all major currencies are now fluctuating wildly—not to say "wildly"—from day to day without any agreed limits or margins on such fluctuations. The main exception to this generalization is the preservation of the so-called "snakes" limiting the maximum range of fluctuation of seven European currencies (the German mark, the Dutch guilder, the Belgian and the Luxemburg franc, the Danish and the Norwegian kroner, and the Swedish krona) vis-à-vis one another, but not vis-à-vis other currencies, and particularly the dollar.

This total reversal of the previously agreed framework of fixed, even though adjustable, exchange rates is applauded today by a number of officials and academicians dogmatically devoted either to free market forces or to national sovereignty, or, more broadly and contradictory, to both. Exchange rates should, in their view, be left free to float without any governmental interventions or interference with market forces or in accordance with whatever interventions or restrictions are "sovereignty" decided by each national government, in the light of its current—and often ephemeral—perception of the country's national interests.

Both of these views are practically untenable, for different reasons.

Triffin: Negotiating a World Monetary Order

Freely floating exchange rates would make sense indeed if their fluctuations on the market merely reflected and offset basic changes in the international pattern of comparative prices and costs. In practice, however, these changes are often dwarfed by the impact of huge capital movements prompted by a different evolution of monetary and credit expansion, interest rates and fiscal policy in the countries concerned or even of bullish or bearish speculation on anticipated changes in exchange rates. Private firms will object strongly and legitimate in such cases, to an appreciation of their currency that would subject them to unbearable handicaps in their competition, in foreign markets as well as at home, with the firms whose currency is depreciating in relation to their own. Governments will be forced to intervene and would anyway be unwilling themselves to abandon to market forces and private speculators a policy instrument crucial to their basic employment and price stability objectives.

This diagnosis is fully confirmed by the way in which floating rates have functioned in practice over the last 2 or 3 years. Government interventions are universal, irrespective of the fact market do not loudly, but methodically, proclaimed by some leaders. Central banks buy and sell foreign exchange in the market to influence exchange rates in whatever direction they see fit, and/or adopt, intensify, or relax all kinds of exchange restrictions in order to discourage or, on the contrary, to elect larger international inflows, or outflows, of capital, depending on the circumstances of the moment.

This free-for-all exercise of "sovereign sovereignty" is bound, of course, to be mutually defeating. More than 100 nationally sovereign countries—or even any two of them—cannot possibly succeed simultaneously in forcing their exchange rates in the desired direction vis-à-vis one another. Some may be more successful than others, but all are likely to suffer, as they did in the 1930's, when the pursuit of incompatible objectives engulfed them all in beggar-my-neighbor policies of competitive devaluations and trade or exchange restrictions.

An internationally agreed framework is as indispensable to permit an orderly functioning of free market forces between residents of different countries as a nationally agreed framework is recognized everywhere as indispensable to their functioning within a country's own borders. The detection of a country as important as the United States from the previously agreed Bretton Woods framework has spelled the utter collapse of the system and a universal repudiation of the legal commitments embodied in the Articles of Agreement of the International Monetary Fund.

The Legal Breakdown

National breaches of these Articles of Agreement by other countries had occurred in the past and multiplied dangerously in the late 1960's, partly as a result of the protracted inability of members to negotiate the long overdue reform of the dangerously unstable and ultimately univisible gold-exchange system centered, since the second World War, on the national currency of the United States. Unavoidable as it had become by then, the unilateral suspension of ex-
variability by the United States was not only illegal. It deprived the international monetary system of the keystones—the gold-convertible dollar—in which the Bretton Woods commitments were defined and implemented in practice by all participating countries.

A forbidden attempt was made, in December 1971, to salvage something from the wreckage through the definition of "central rates," as an alternative to "par values." The central rates would be defined with reference to an inconvertible paper-dollar, divorced from gold, and exchange rates would be allowed to fluctuate up to 4.5 percent around these central rates, rather than the 2 percent prescribed by the Articles of Agreement. These two fundamental modifications of the Agreement should normally have required the approval of three-fifths of the Fund's members, having four-fifths of the total voting power. They were decided, in fact, by 10 members out of about 120 and promptly promulgated—the same day—by the Executive Directors. The Fund, moreover, accepted successively two changes in the "par value" of the dollar itself, with respect to gold and SDR's, while closing its eyes to the fact that the dollar would remain inconvertible into either. Nearly all major countries have now "informed" the Fund that they no longer intervene in the exchange market to maintain fluctuations within any agreed margin around "par values" or "central rates," no matter whether defined in terms of gold, the dollar, or the SDR.

The Negotiating Impasse

The marathon negotiations of international monetary reforms, launched 10 years ago, are totally stalled, and prospects for any comprehensive agreement postponed for several years, at least, in spite of the urgency repeatedly proclaimed by the negotiations themselves.

Unavoidable defects of national interests account only in part for this dismal record of unceasing delays. As, or more, important, are the inherent defects of negotiating techniques and habits that make it unnecessary difficult to reach concrete agreements, even on points that have called for large-scale concessions among all the parties concerned. A keen awareness of these shortcomings, and possible remedies, might well prove as essential in this case as the success of future negotiations—in the field and in substance—of the intellectual exploration of the issues under debate.

The following remarks summarize a few of the lessons that I would derive from the 28 years' involvement in worldwide and regional monetary reform.

First and foremost, it is the fact that continued failure to agree may be far more damaging to the national interest of every participating country than the partial compromise needed to reach agreement.

I was reading recently a brilliant paper by a former student of mine, now Associate Professor at the University of Chicago, designed to explore whether the United States national interest would be served by participating in reform, and particularly to determine which types of reform we should propose or support. One of the key considerations in this respect would require us to "decide whether the United States is more likely to be pay-
the IMF solution to the CRU solution. These various flip-flops delayed until 1967 an agreement that might otherwise have been reached much earlier.

Another example of the ephemeral interpretation—or "misinterpretation"—of national interests in the negotiation of international monetary reform is our former commitment to "stable" exchange rates and to the inapplicability of the SDR an ounce gold price, which have both been reversed in our recent advocacy of two successive increases in the gold price and of prompt readjustments, or even full flexibility, of exchange rates.

In brief, the very possibility of reaching agreements among still legally "sovereign countries" demands that emphasis be placed, first and foremost, on the convergent long-term interests of all participants in a workable system, fair and acceptable to all of them, rather than on ephemeral interpretations—or misinterpretations—of inevitably conflicting short-term national positions and interests. The failure to reach agreement in time has triggered all too often, and particularly in the last 4 years, a cumulative process escaping uncontrolled, as well as international, control, and far more detrimental to each and every participating country than the concessions it might have had to accept in order to make agreement possible.

2. A second general observation derived from my experience with the IMF, the Organization for European Economic Cooperation (OEEC), European Payments Union (EPU), the United Nations Economic Commissions for Europe (ECE), Latin America (ECLA or CEPAL) and Asia and the Far East (ECAFE), and with the European Communities (E.C.) relates to the respective role of national and international civil servants in the negotiating process.

A strong Secretariat of international civil servants is, of course, eminently useful and necessary for the conduct of basic research and the performance of various ancillary services: meeting rooms, interpretations and translation, distribution of documents, etc. In the end, however, political decisions have to be made by national politicians, highly dependent on the advice they receive from the national civil servants closest to, and trusted by, them.

The OEEC had developed, in this respect, a technique of operations that functioned with amazing success over a long period of years. Each country maintained in Paris a delegation of national civil servants, to daily contact with one another and with the OEEC Secretariat. They met in various technical committees to deliberate on issues on which joint action was proposed, reported to their principals at home, made recommendations to and received instructions from them on the positions they would advocate in their countries. The Ministers themselves would meet in Paris, in frequent intervals, to adopt formally the decisions on which agreement had been reached and to iron out the necessary compromises on the issues on which the technical committees had been unable to reach agreement.

The responsibility of the national civil servants stationed in Paris was not only to carry out faithfully the instructions received from their home office, but also to argue with it to have such instructions modified in time, when necessary, to save their Ministers the embarrassment of finding himself in a minority in these Ministerial debates. Continuous personal contacts in Paris fostered a gradual interpretation of the national civil services with one another and with the international Secretariat of the OEEC, rather than a rivalry between the former and the latter. It also contributed immensely to the improvement of the statistical and analytical expertise and output of the national bureaucracies, through a process of mutual learning. The production of a yearly report, subject to unanimous approval by the Ministers, and carrying adequate and comparable documentation from all member countries, was particularly useful in this respect. The compromises involved in obtaining such unanimous approval made it a far more rigid document for the readers than the concurrent annual report produced by the Economic Commission for Europe under the sole responsibility of its General Secretary. What was important, however, was the educational process imposed upon the national bureaucracies by the production of such a report, rather than its academic quality for the outside reader.

Current negotiations on international monetary reform in the IMF and the Committee of XX are now contemplating administrative reforms of the IMF structures aiming at a similar interpretation of national policy decisions, at the highest as well as at the intermediate levels, as contrasted in the more modest role that can be realistically assigned at this stage to the international staff of the Fund.

1. One of the major handicaps to be surmounted in the excessive secrecy that usually surrounds the national decision-making process itself until final agreement has been reached among all the national agencies involved in this process. Once made, the decision becomes very difficult to reverse, or modify, as it often must be to reach international agreement.

A hopeful start was made, in the early days of the Kennedy Administration, to discuss in the OEEC, in the early days of this process, issues still under debate in the United States Administration itself, so as to maximize the international information needed to reach intelligent decisions, acceptable to all countries. A similar technique had already been used, most successfully, by the Managing Board of the European Payments Union. It was not unusual for a member of the Board to invite his colleagues to express more bluntly and forcefully their rejections to a proposed national position still under debate, so as to be able to report to his own Government the unfavorable reaction—and damming qualification—which it might elicit from other countries if their views were not taken into account.

This could be extremely effective, as, contrary to a naive, but wide-spread misconception, so-called "national positions" are by no means monolithic. They often entail as bitter inner fighting and compromises between various Ministries and vested interest groups within each country, as the open clashes of proclaimed "national interests" that emerge in international negotiations. The process of national decision-making is by no means immune from the difficulties which international decision-making has to confront. The basic similarities between the two processes are worth stressing, particularly since the first and most advanced one (the national) may be of some predictive value for the latter (the international). The main difference
between the two is that the latter is usually based on ad hoc discussions, subordinating decisions to the agreement of all participating countries, while the former sets up “authorities,” with specific procedural, voting rules, and in which an individual, or a Cabinet of Ministers, or, as a last resort, a national election, can theoretically arbitrate in the end-obscure controversies between subordinate authorities. In practice, however, every effort is made to reach an acceptable consensus without having to invoke the arbitration of an overwrought President, a Cabinet crisis, or a national election whose outcome may often, in any case, remain ambiguous. The adamant opposition of minority groups may, in fact, paralyze action in the national level as effectively as a lack of unanimity may paralyze it at the international level.

The European Communities are still in the process of switching gradually from the international to the supranational method of policy-making decisions, but they have been very wary of making full use of the voting procedures authorized by the Rome Treaty to impose a majority decision upon a member country obstinately opposed to it. The same has long been true of the IMF Executive Board. Effective progress toward a merger of national sovereignties into the acceptance of supranational decisions becomes possible only as the national leaders, bureaucrats, and public opinion of the participating countries have learned from previous ad hoc negotiations that the advantages of joint action far outweigh the disadvantages that are at all likely to be imposed upon them in practice by their partners.

What I have dubbed above the gradual “interpenetration” of national administrations in the collective decision-making process is as essential in this respect as the setting up of a rival “supranational” body of international civil servants.

4. My fourth observation is that independent experts may play, at times, in explaining issues that official negotiators are unable to raise and debate as candidly and objectively, because of their official responsibilities and of the presumed “national interests” of the countries they represent.

The hearings of various Committees of the United States Congress, particularly the Joint Economic Committee, have provided many of them, foreigners as well as citizens, a most valuable forum in this respect. Committees of so-called “wise men,” of recognized international prestige, have also been appointed at times to help clarify major policy issues facing some international institution or negotiation.

Conferences and round tables of governmental, academic, and business experts have multiplied in recent years to debate the problem of international monetary reform. Many of them have helped bring out new insights and stimulate communication among a growing number of interested people. Only a few have been specifically aimed at disentangling from the welter of individual views those on which a consensus could be reached between the participants and have, therefore, a better chance of influencing

*Note, however, that weighted voting is largely the rule, already, in some international organizations, such as the IMF and the European Community.

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The officials and negotiators. I wish that such an objective could be pursued more often in the future by the organizers of such conferences.

5. My last observation will be directed at my fellow economists, especially those in academic, rather than governmental or business life. They exercise, in the long run, a considerable influence on public opinion and on the officials whose decisions, or re-election, depends upon it. All too often, however, they tend to become good forecasters— or even prophets—rather than good advisors. They center their advice on what they guess the politicians will accept and like as their premise that policies is the “art of the possible.” A disastrous example of this tendency, at the present juncture, is the resignation of many to the inevitability of huge and permanent rates of inflation and the recommendation that we learn to live with them through various systems of indexation and so-called “monetary corrections.” In Brazil, Politics is not only the “art of the possible.” It is also the art of making possible tomorrow, through better public education and leadership, what is still impossible today. Economists elucidate their true profession when they make their “first best” advice as relevant and useful today and resign themselves to offering only their second or third-best advice as the only one likely to be promptly followed in practice.

Conclusion

Two pervasive trends have characterized the post-evolution of the international monetary system and will continue to dominate it in the future. The first is only a special aspect of the much broader and pervasive trend that marks the evolution of mankind: the constant striving of man to control his physical environment, rather than be controlled by it. In the monetary field, this trend expresses itself in the gradual displacement of commodity moneys (such as gold and silver) by man-made and man controlled money (paper currency and bank deposits). Completed long ago in the national field, the same process is already far advanced in the international field, in which the bulk of international monetary reserves is no longer gold, but paper reserves—primarily United States dollars—since the end of the war.

The most promising path for the future is the one summarized under “Progress” above, and on which a large consensus has already emerged after 10 years of protracted debates and negotiations. The international monetary system should be anchored on a truly international reserve asset, rather than on gold or any national currency, be it the once mighty dollar.

The second characteristic of all previous national as well as international monetary reform, however, is that they have only rarely been the result of conscious planning by any national, or international authorities. Changes are initiated spontaneously, and largely one-sidedly, by the activities of individual traders, business firms, banks, etc., and are for a long time unsuspected by government officials and even academic writers. Official interventions in this evolutionary process come only belatedly, and most often only under the irresistible pressure of large storming crises. And the actual
results of such interventions are, on many occasions, totally different from their aims and intentions.

To quote only one example, the official debate on international monetary reform was launched, in 1963, with repeated assertions that two basic features of the past system were unanimously agreed on: the "foundation for present and future arrangements." They were "fixed exchange rates" and the established value of gold, i.e., $35 per ounce. The two major changes that have effectively turned the present system upside down, of course, are the opposite of these official forecasts and prescriptions: the daily floating of exchange rates and the variations of gold prices, vastly unglued to any of the "official" prices of $38, $34, and $32.22 successively proclaimed since then, but at which nobody is willing to sell, and therefore nobody is able to buy gold today.

Let me conclude, however, on a less somber note. The present crisis will not reverse forever the irresistible trend of world history toward a more rational international monetary order designed and managed to serve the needs of the world economy rather than to finance gold production or the unfathomable deficits of any "reserve-center" country or countries. What is most needed at this stage is an urgent reappraisal and reorientation of the negotiating techniques that have led us to the present impasse. The stress should be placed on modest but urgent steps on which concrete agreements can be reached and implemented quickly, rather than on comprehensive and ideal blueprints whose negotiation and implementation would still drag on for many months or years.

This is precisely the line of action now advocated by the new Managing Director of the IMF, Dr. Wittchen, and endorsed at the last Ministers meeting of the Committee of XX in Rome. It offers, at least, a slight hope that we may soon resume our search forward, rather than backward, on the long road of international monetary reconstruction. The intellectual consensus already reached on the direction to be followed should be sufficient to rally agreement on the first steps to be taken, rather than wait until its further meanderings have been fully charted.

References

conference have drawn on his eloquent image and used it, for example, to suggest that just as a spaceship is equipped with finite amounts of food and energy before being launched, so too the Earth has been provided with finite quantities of the natural resources on which modern industry depends and with limited means of capturing other resources from, for example, the energy of the sun. Although there is no doubt that the metaphor must at some level be valid, it is my contention that it has no bearing on contemporary problems of how best to manage economic growth.

Some simple illustrations show what I mean. Especially in the past few months, people have been saying that the world's reserves of petroleum are finite and that we must learn to adjust to that fact of geology, with or without prompting from the OPEC countries. Nobody denies that of the carbon-based fossil fuels, conventional petroleum is the least plentiful. By the same token, however, it must be acknowledged that the proved reserves of petroleum at any time are in practical terms determined by the market price or, more accurately in this complicated industry, by the price that oil companies are prepared to pay to extract it from the ground. Long before the OPEC countries put up the price of oil, it had become clear that the conventional petroleum industry in the United States could not last much longer unless the price of oil were increased. Now that the OPEC countries have made the cheap oil from the Middle East vanish almost overnight, however, it becomes feasible to strictly commercial terms to think of extracting oil from previously uneconomic reservoirs, to drill offshore beyond the 200 meter isobath, to extract liquid fuel from oil shale, or even to make synthetic oil from coal. And if petroleum were in some sense or other an indispensable ingredient of industrialized society (which it is not), it would now be possible to look forward to a supply of liquid petroleum lasting not for a few decades but for several centuries.

The failure to appreciate that the size of a resource is mathematically a function of the price which it commands is at the root of many recent statements about the implications of the finiteness of the real world for the development of our societies. In part, I should acknowledge that the latest visions of the Meadows study do include assumptions about the relationship between the proportion of one of the Earth's resources that has been consumed and the price that may have to be paid for that material, but nowhere does the MIT computer model relax the assumption that such resources are unalterably fixed in advance. For the life of me I cannot understand why this oversimplified view was built into the computer model and never changed when so many other variations of the assumptions were undertaken.

We know from experience that with many natural resources, copper, for example, the past few decades have seen such rapid technical progress that the concept of finiteness is entirely irrelevant. Before the Second World War, it was not feasible to use copper ore containing less than 2 percent of metal. Now it is commonplace that copper ore containing one-twentieth as much copper can be processed, and—this is a bonus—the technology of mining and extraction has simultaneously improved so that the production costs of copper (as distinct from its price on the London Metal Exchange) has not significantly increased. This is one of many dramatic examples which show that the past few decades have brought an increased awareness that many of the resources of the Earth that we need most are not finite.

The use of the land is another illustrative case of how the arithmetic concept of finiteness does not apply. Estimates of how much land might be cultivated differ, chiefly because of uncertainty about the potential usefulness of tropical regions, but land is still by far the largest single resource remaining. Food production, for example, is becoming more and more prominent than in the United States, has shown that the productivity of land can be enormously increased by modern techniques—not merely doubled but multiplied by 10. To be sure, intensive agriculture requires the use of fertilizers, capital equipment such as tractors and irrigation works, and constant vigilance against crop diseases. Some argue that these accomplishments of modern agriculture are unattainable in themselves; they declare a backward social changes in countries such as India or the risks of the scale's use of pesticides, and raise room is for argument on these points.

For what it is worth, I consider that there may be an element of improbability in this argument and that in any case it is not available with whom I take the present. The essential point is that the finite supply of land is not a limitation to food production. If a society such as India has failed to control its birth rate, it may find itself short of wheat. But the former conclusion.

There is, I recognize, a danger in what I have said about the way in which the finiteness of the real world is modified by continuing technological change which can be counted on to solve all the problems of scarcity that arise in the future. But my case is no more than logical. First of all, the technological, developments that have been carried out in the past half century are already a sufficient guarantee that problems of shortage can be overcome in the foreseeable future. By which I suppose I mean a couple of generations, say half a century. On a similar time scale, problems of global pollution can, it seems to me, be dealt with by means of techniques already available or within practically. Indeed, I know of no threat to human survival except radioactive fallout from nuclear weapons that is to be regarded as an immediate threat which is not of course to say that these questions should not be studied.

This leaves, I know, the question of what happens in the long run, but I still return to it after taking up the question of what constitutes economic growth, another misused concept in the argument of the past few years. First, I know of nobody who seriously contends that Gross National Product...
Product (GNP) is an accurate measure of human happiness. Indeed, it is easy to see that an increase of GNP can easily be compatible with an all-inclusive transfer of economic resources from the poor to the rich in some communities. At the same time, there are some reasons for believing that the statistical increase of a nation's GNP does bring about desirable social improvements—more food for the poor, a better distribution of resources between rich and poor, and greater social benefits. This is why it is an accident that in Western industrial societies, industrialists and workers all agree that economic growth is likely to be beneficial. I acknowledge that there are widespread regrets about the ways these extra resources are spent, and it is an essential part of the political process in liberal societies that different groups in the community should differ in their views of how increased economic resources should be spent. Some want more education or health care, others more automobiles and television sets. But one does not have to believe in the rationality of the consumer market to acknowledge, in the context of Western society, expenditures that people think they desire are desirable, at least in the sense that they are desirable.

One fallacy common to compact models is that those who assume that economic growth is inherently desirable is the assumption that economic growth can take place without qualitative change. The compact models and their followers implicitly assume that if an economy grows, its consumption of raw materials such as steel and copper will grow proportionately or by some other arithmetical rule, that the number of vehicles on the roads will similarly be increased and that the unaltered consequences of economic activity, pollution and the like, will increase by one rule or another. Similarly, the workers and industrialists who work for economic growth suppose that the activities in which they are engaged will be in some sense or other made larger but otherwise be unchanged.

In reality, however, except over the shortest intervals of time, economic growth brings profound changes both in the pattern of industry and the structure of society. You can tell this from the experience of Victorian England. The agricultural labor force shrank to a quarter of what it had been while the population of the country doubled. In the textile industry, the source of most of the innovations of the early industrial revolution, cotton industry was replaced by factories. Elsewhere, economic growth took the form of entirely new industries: railways, chemicals, road transport, flight, and since the Industrial Revolution computer, computers. As far as the consumption of natural resources is concerned, these qualitative changes in the pattern of industry are often accompanied by marked reductions in the demands made on the consumable surface of the Earth.

Socially, the changes brought about by economic growth can be equally dramatic. Daniel Bell has written enough about the "post-industrial society" to show the kinds of things he has in mind. It seems to me that one must acknowledge that there is a wide range of social opportunities to be won from economic growth; education, health care, prisons, and the equipment of large standing armies must all compete for whatever economic resources are available. There is no simple rule for deciding between them.

Maddox: Economic Growth in a Finite World

So how should public policies be determined with these qualifications of what is customarily meant by economic growth and finite world? First, it seems to me important to acknowledge that one cannot build utopias overnight. We are where we are now, in 1974, and our chance of improving the condition of society, by whatever criteria are decided upon, by 1975 must necessarily depend on our success in choosing a concerted array of policies which may be very different in kind. For example, it may be held desirable that everybody should have access to decent health care but that, for the 12 months immediately ahead, expenditure on public transport is more necessary. It might be held that the desirable objective of keeping Colorado unspoiled by major mining operations should be compromised in the public interest by a few experiments to discover whether it is possible to mine shale oil profitably. It seems to me impossible that the political process should throw up entirely different arrays of policies like these, for the management of society is bound to be an empirical process.

However, it is a proper question to ask whether the finiteness of the world, or the illusion that the world is finite, has implications for the way in which governments should set about their job and whether there is anything to be said about the more distant future. So far as the short-range objectives are concerned, there are several things to say, most of them political. First, it seems to me that if governments were prudent to manage the natural resources at their command, they must use economic forces exert their full influence. To say this is not to imply a blind faith in the mechanisms of the market, which plainly is an inefficient way of distributing resources where land development is concerned, but it is a way of achieving the same result by a method and practice to which we are already accustomed. That may governments at any time are concerned with shielding various sections of the community from the full effects of the economic costs of different, frequently alternative, resources; The United States Government is the chief offender: the price of natural gas has been kept too low since 1938, petroleum producers have been protected from competition by Middle East oil for a quarter of a century, cheap food imports (when they used to be available) have been kept out, and the American people in the past few years have been allowed to think that they could have the benefits of an ambitious environmental protection program (and a price-free Alaska) as well without substantial cost. These practices are wasteful, partly because they encourage the use of relatively scarce sources (natural gas, for example), partly because they discriminate the use that might be made of plentiful materials to everybody's disadvantage, but with harmful consequences for the trade as well, and partly because they help to cultivate that frame of mind in which politicians and voters are drawn, which in the belief that they can have their cake and eat it too.

As a part of the greater economic realism for which I have been asking, governments should, to take one practical example, make those who cause public nuisances by pollution or other means pay the full social cost incurred. I know that it is frequently hard to determine what penalty should be imposed on the owner of a factory for the pollution that he causes, but harder still to tell what should happen if a second steel producer should...
open up in the neighborhood. There are also problems that arise when one part of a community may disagree with another over some development in the neighborhood—witness the difficulty in finding deep water ports for tankers in the northeastern states of America. It should not, however, be beyond the wit of well-endowed people and the flexibility of the democratic system to allow compromises to be struck in such circumstances.

The argument for greater economic realism is frequently mistaken for an argument in favor of the economic system as it is, so I want to emphasize that I am making a narrower case. Traditional economic calculations of costs, and traditional methods of minimizing those costs are an effective way of making sure that societies make the best use of the resources of industry and agriculture, which are in the last resort not material or natural resources but human resources, labor. If a manufacturer finds that costs are reduced when he replaces a labor-intensive process by a capital-intensive process to accomplish the same objective, he has implicitly discovered a way of economizing in labor. I would agree with those who complain that our communities are much less willing about the proportions of skill that should be devoted to different sectors of the economy and that the public services are too often starved of the human resources they need, but that is a case for political decision which does, admittedly, entail a trade-off between the rate of economic growth and public welfare. It is not an argument against economic realism in the coating of goods and services. It does not restrict the freedom of governments to nationalize industries or to regulate the profits of the corporations in whatever way they choose.

Our important point, which follows from what I have been saying and which is partly a consequence of the increasing difficulty of managing natural resources and partly a consequence of decisions that have been or should be taken about the balance between public services and the provision of goods and services by corporations, is that the capital needs of industry and agriculture are bound to continue to increase in the years ahead. Extracting copper from low grade ore may not be significantly more expensive than working the rich deposits of the past, but it needs more capital. Our governments are not sufficiently aware of the problems this trend may create. How is it possible to reconcile the now widespread wish that profits should in some sense or other be secured, the hope that inflation may go away, and the reluctance of governments to be involved in large-scale investment with the need substantially to increase the rate of investment in industry and agriculture? In essence, these are political questions. They need more conscious and deliberate attention than they have so far been given.

Internationally, the quasi-fininess of the world has created more daunting problems, among which are conspicuous the poverty of many developing nations and their rapid population growth. This set of problems seems to me again a social and political issue in which finiteness plays only an accidental part. In India, as in similar countries, the question is to determine which comes first, poverty or population growth. In my judgment there is now enough evidence of what is happening in India to suggest that the population might be stabilized, much as it was in Western Europe in the the early part of the nineteenth century, if only the impoverished majority were better off and able to look forward hopefully to a world in which housing, food, and jobs were not as hard to come by as they are at present. To pretend that Indians differ from us in that they do not care about the future is simply a polite way of the West to wash its hands of its responsibilities. In other words, the pressure of the population on the resources of India, and our fears that the resources may be inadequate, are probably a function of the poverty of India. So far, however, the scale of foreign aid has been grossly inadequate compared with the need in India. For the advanced communities of the West, it is a proper question to ask whether they can allow themselves to wring their hands about the problems of economic growth in a finite world when what they have in mind are countries like India and when they have obviously neglected to do what they might have done to help.

There remains the question of what happens in all countries, developed and developing, in the long run. I said earlier that I am not ascertaining that technology can be counted on to solve all problems, and it would in any case be rash to think of such a way. Nobody respects Mr. Menzies. But, there is a pattern to the industrial and social history of the past few centuries which does, I think, provide a robust foundation for hope, if not optimism. First, there has been no break in the continued increase of people's technological competence, and it is hard to see why one should now arise unless governments are recklessly neglectful of research and development. Certainly it is wrong to make projections into the future that assume that present trends of material consumption will continue without at least allowing something for the continuing process of technological change. But I agree, of course, that this is a difficult task. And to principle there is always a possibility that the technological improvements that have made our world what it is may at some stage in the future be much harder to accomplish. But I do think the long lead-times that characterize modern technology provide at least this assurance: that we or our children would have warning that technological development was at an end as far in advance as some of the recent warnings of global disaster stemming from the supposed finiteness of the world.

Underlying this improbability is the question of how our society should determine its attitude towards poverty. This, it will be recalled, is not a new issue. St. Augustine had a lot to say on the subject, much of which accords with what psychoanalysts now say. The forces that keep society coherent—parents' love for their children, people's love for other people—see as it were the microscopic basis for society's regard for posterity. At the other end of the scale were the Utilitarians—look after the present, and let the future look after itself. The question has recently assumed fresh importance chiefly because of specific fears that if we, now, consume too much petroleum, there will be none left for future generations. The point, however, is this. Future generations will value not merely whatever natural resources are still left in the ground but the social institutions which they inherit. We know from our experience that it is harder to create beneficial institutions than to manufacture energy or to extract copper, and this imbalance is
likely to persist. So we may actually deprive future generations of benefits they would value if we fail to heed resources and thereby deprive ourselves of the economic resources with which robust institutions may be developed. To be sure, it is hard enough to know what we need and impossible to tell what kind of educational or judicial systems will be needed in the future. But we have at least some evidence for believing that social institutions have been steadily if slowly improved. Certainly there are now many obvious ways in which further improvements could be brought about. So custody of the interests of future generations does not condemn the hoarding of material resources but self-interested improvement of the fabric of our society in the Augustinian sense. If you want another literary analogy, there is the parable of the talents.

THE PROTECTION OF THE ENVIRONMENT AND WORLD PUBLIC ORDER

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Man is both creator and custodian of his environment, which gives him physical sustenance and affords him the opportunity for intellectual, social, and spiritual growth. In the long and tortuous evolution of the human race on this planet it stage has been reached when, through the rapid acceleration of science and technology, man has acquired the power to transform his environment in countless ways and on an unprecedented scale. Both aspects of man's environment, the natural and the manmade, are essential to his well-being and to the enjoyment of basic human rights—such the right to life itself.


INTRODUCTION

The Globe as an Ecological Unit

It is today widely recognized that the globe—or, more precisely, the entire earth-space environment—is an ecological unity both in a basic scientific sense and in the interdependences of the social process by which man uses it. The plants, animals (including Homo sapiens), and microorganisms that inhabit the planet are united with each other and with their nonliving surroundings by a network of complex and interdependent natural and cultural components known as the planetary "ecosystem." Within this comprehensive ecosystem, man alone has a dual role: both as natural symbiotic component and as conscious disrupter.

It is the more specific codendritic units or interdependences—physical, engineering, and utilization—of this comprehensive ecosystem which make our whole earth-space environment a single sharable, and necessarily shared, resource. What is true about the shareability of the oceans, the atmosphere, the air space and unfolding outer space, and land masses when considered separately, is no less true of the indivisible whole which they comprise. The appropriate perspective has been aptly stated by Barbara Ward and Rene Dubos:

There is a profound paradox in the fact that four centuries of intense scientific work, focused on the dissection of the "strictly" web of existence and resulting in extensive increase in knowledge has led to a new and unexpected view of the unity, cohesiveness, and interdependence of the entire cosmos.

The same perspective is expressed in other words by Harold and Margaret Sprout.

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The ecological way of seeing and comprehending enviromental policies as system of relationships among interdependent, earth-related communities that share with one another an increasingly crowded planet that offers finite and valuable quantities of basic ecomomics of human well-being and existence.

The most urgent need confronting us today is that of securing new and more precise scientific knowledge about the different units and interdependencies of our most comprehensive environment. With an increase in such knowledge, we might be able to devise more effective remedial measures that will better conserve and develop the environment for future use and better to secure the basic values of human dignity for which we maintain our different community processes.

Rising Demands for Better Protection of the Environment

Fortunately, demands are rising all about the globe for improved knowledge and more appropriate measures for environmental protection. These rising demands were dramatically illustrated in the environmental benchmark of "Stockholm '72." Three separate conferences on human environment took place in that city in that year: the Dai Dong Independent Conference (its name being derived from an ancient Chinese concept, "For a world in which not only a man's family is his family, not only his children are his children, but all the world is his family and all children are hers") was sponsored by the International Fellowship of Reconciliation (IFRG) and met from June 1-6. The official United Nations Conference on the Human Environment, with 1200 delegates from 113 countries, was the most publicized of the three, and it met for 2 weeks from June 5-17. Finally, the official United States Conference was paralleled by an unofficial meeting organized by various citizens' groups and private individuals known as the Environment Forum. Although the substantive developments at both the official and unofficial gatherings disappointed many participants and observers, what happened at Stockholm is most significant in indicating that both as elite and mass levels, environmental demands on the world decision process are becoming more comprehensive and more fully perceptible.

Unfortunately, however, these demands are not as yet either sufficiently comprehensive or sufficiently perspective. It is, in specification, still not widely recognized that there are environmental dimensions, just as there are human rights dimensions, to all the authoritative decisions taken in all our communities from local to global, and that the rational making of those decisions requires that a comprehensive intelligence about the environment be brought to bear upon them. Similarly, it is not always recognized that beyond the mere inflating of relevant intelligence about the environment into the traditional flow of decisions, positive and dynamic programs for the better protection and more advantageous use of the whole earth space environment in all its features—biota, oceans, air space, land masses, and so on—are required if common interests in survival and optimum order is to be served.

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The full specification of an appropriate program in demand and response would require, much beyond our compass here, performance of a sequence of distinct, but interrelated, intellectual tasks, including:

1. The detailed specifications, in their contexts of causes and consequences, of the more important problems arising from man's contemporary interactions with and exploitation of his environment;
2. The clarification in detail, from the perspective of an observer identifying with the whole of mankind, of basic general community policies in relation to each of these particular problems;
3. A survey of past experience, of prior trends in decision, at all levels of government, from local to global, in terms of approximation to clarified policies;
4. An investigation of the factors that have affected past decisions on particular problems;
5. The projection of probable future decisions and conditioning factors in relation to particular problems; and
6. The recommendation of new alternatives in constitutive process and public order prescriptions for the better securing of clarified policies.

The Inherited Global Cosmocentric Process of Authoritative Decision

The process of authoritative decision maintained by the larger general community for the resolution of controversies about the environment, as for other matters, is that of traditional international law, now built about the framework of the United Nations and the specialized agencies and regional organizations. This global decision process has lately begun active response to demands for the better protection of the environment, as the very conviction and outcomes of the United Nations Conference on the Human Environment illustrate. The Conference adopted an Action Plan for the Human Environment which contained more than 300 specific recommendations for future international activities. It also passed a Resolution on Institutional and Financial Arrangements, which formed the basis for creation by the United Nations General Assembly of the United Nations Environment Programme (conspired of a Governing Council for Environment Programmes, a small Secretariat with an Executive Director, the Environment Fund, and an Environment Co-ordination Board). Supportive efforts are also being undertaken by a whole host of international organizations—governmental and nongovernmental, specialized and non-specialized, general and regional.

There remain, nevertheless, certain special difficulties characteristic of the past operation of the larger community process. Planning and development activities at the international level, although among the most stressed, have been inadequate in both reach and detail. In consequence, and perhaps also as cause, the promotion or active advocacy of environmental polices alternatives before authoritative decision-makers has also been weak. Most importantly, there has been a relative absence of the centralized performance of the presenting and applying functions in relation to international un-
environmental law. It is small wonder that overall public order of the environment has suffered.

The Continuation of Problems

The problems we observe are, in sum, the continuing destructive impact upon and spoliation of the environment and continuing unplanned exhaustion of resources, with loss of potential gain. The world's population increases at an alarmingly accelerating rate, with cumulative new demands upon resources. Technological advances multiply the potentialities of destructive impact. Perceptions of policy alternatives and programs for ameliorative action remain inadequate, and the time is short for meaningful reorientation of the world decision process.

Clarification of Basic Community Policies

Our Commitment and Environmental Goals

The observational standpoint we recommend is that of the scholarly observer or decision-maker who identifies, not merely with some single parochial community, but rather with the whole of man's many different often concurrent, and always interpenetrating—communities. The enlightenment we seek is that relevant to clarifying and implementing the common interests of all and to defending and extending the domain of institutions compatible with the fundamental concepts of human dignity.

The most general goal we recommend for environmental, as for other problems, is that of protecting common and reporting special interests. By common interests we refer to shared demands for values whose achievement is affected by conditions of interdependence or interdetermination. By special interests we refer to demands which are destructive of common interests in that they cannot be shared even in equivalences and their achievement is divisive of the conditions of interdependence, imposing unnecessary harm upon others.

Within common interests, as contrasted to special, a distinction must be taken between inclusive interests and exclusive interests. By inclusive we refer to interests in activities that have significant unanomalous effects, that is, which importantly affect more than one territorial community. By exclusive we refer to interests in activities which affect predominantly only one territorial community. The distinction may be put in tabular form:

| Inclusive public order interests: |
| Demands for values plus supporting expectations about conditions of achievement, the expectations involving high degrees of collective impact upon the relationships referred to by the goals of the world community; community-wide participation in decision, or a lesser degree of participation by more than one component community of the world arena. |

| Exclusive public order interests: |
| Demands for values plus supporting expectations, the expectations involving high degrees of particular impact, compatible with the goal values of the world community, and unaccompanied by higher levels of collective impact. |

The inclusive interests of peoples in the enjoyment of the environment, like those in any other necessarily shared resource such as the component parts, atmosphere, and air and outer space, relate to both minimum order and optimum order. By minimum order we refer to the conduct of activities by the processes of persuasion and agreement, with a minimum of unauthorised coercion and destruction. By optimum order we refer to cooperative activity in the utmost production and distribution of all demanded values in a world society. It may require emphasis that the inclusive interests of peoples in the protection of the environment extend beyond the mere sum of their interests in all the component sharable resources, to the healthy functioning of the earth-space environment as a whole, even including the land masses.

The exclusive interests of particular communities in the protection of the environment may be described similarly in terms of both minimum and optimum order. Every state has an interest in protecting its own internal order from external coercion and destruction. Every state has, further, an interest in promoting the healthy functioning of its own internal optimum order or social process. It is clear that both transgressions of ecological interdependencies and implementation of sound environmental policies have selective impacts upon different communities. The preoccupation of less-industrialised countries with ensuring that environmental measures are not inaugurated at the expense of their basic economic and social development is a contemporary reflection of exclusive interest.

In more detailed specification and accommodation of inclusive and exclusive interests, certain more specific goals of environmental protection will require clarification. These are inextricably interrelated at multiple junctures with other cherished objectives of individual and group behavior. Even the negative goal of minimizing damage to the environment has a whole range of subgoals. These more particular subgoals include: prevention (long-term efforts to minimize the occasions for injury), deterrence (precluding injury immediately threatened), restoration (putting an end to injuries already in process), rehabilitation (short-term binding up of wounds), and reconstruction (long-term redesign of the situation to preclude further injury.) Detailed recommendations with respect to each of these subgoals must vary enormously with context.

Beyond the basic goal of minimization of environmental injury, there are the positive motivations of optimum order. These include preserving the environment and securing its most constructive use for the benefit of present and future generations. For proponents of human dignity, such an approach requires the detailed clarification of programs for optimisation of the shaping and sharing of all values: power, respect, enlightenment, wealth, well-being (including health), skill, rectitude, and affection.

Recent Community Statements of Goals

Most recent international statements about goals and attempts at clarification have substantially, although not always explicitly, approximated our
recommendations. The first Principle of the United Nations Declaration on the Human Environment summarizes the common conviction that:

Man has the fundamental right to freedom, equality, and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being, and he bears a solemn responsibility to protect and improve the environment for present and future generations.

Similarly, the United Nations General Assembly, in its resolution providing for the institutional and financial arrangements of UNEP, declared itself

Convinced of the need for prompt and effective implementation by Governments and the international community of measures designed to safeguard and enhance the human environment for the benefit of present and future generations of Man.

If we can believe the explanations, the task of creating in the peoples of the world the perspectives necessary both to their more realistic understanding of their common interests in relation to the environment and to their invention, acceptance, and initiation of some of the many measures required for the fulfillment of these common interests is well begun. The real question is to what degree the goals and related advisory recommendations will actually be made effective in decision outcomes.

TRENDS IN DECISION AND CONDITIONING FACTORS

Claims in Relation to the Process of Use

The potentials afforded by world constitutive process and inherent public order, for assisting movement toward improved environmental protection may be comprehensively and economically indicated in terms of the trends in decision in relation to certain basic personal problems.

Allocation of Resources

It is a function of the global constitutive process to allocate resources between the inclusive and exclusive use and competences of the different territorial communities. The resources traditionally held open for inclusive enjoyment and decision-making include the oceans, the airspace above the oceans and the ocean floor, the void of space and the celestial bodies, international rivers, the polar regions, and some flow and store resources within these areas. Left subject to exclusive appropriation are the land masses of the world and their immediately proximate waters (in particular, internal waters and the territorial sea), their subsoil and airspace, and the genetic, aesthetic, and cultural resources within those areas. It is readily apparent that this basic pattern of allocation has greatly emphasized geographic factors in its determinations of inclusivity and exclusivity.

Claims to limited assertions of exclusive competence have in the past been made and honored in connection with some specific interests or uses of basically shared resources. Thus, continuous zones and other special zones

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(e.g., fisheries zones in the oceans and air defense zones over the high seas) have been allowed, building upon the principle of “impact territoriality” which establishes the competence of a state with respect to external events which have impacts upon its territorial base. These zones are unlike territorial seas in that coastal states do not possess over them the whole bundle of competences known as “sovereignty,” but rather are accorded a limited competence for certain specific functional purposes.10

Most recently, the outstanding trend has been toward vast demands for shifts from inclusive to exclusive competences and from geographic factors to functional criteria in justification. In the area of oceans management, many states are claiming “exclusive economic zones” or “patrimonial seas,” in which they assert the right to exercise exclusive competence over natural resources exploitation, with varying degrees of control over transportation, communication, military uses, and scientific inquiry.11 In addition, the United States has proposed that coastal state competence be extended to cover the entire migratory routes of anadromous fish (e.g., salmon) and not just their spawning areas.12 Either or both of these types of claims will result in broad areas of the oceans coming under some exclusive competence, while remaining an inclusively enjoyed resource for other purposes. Finally, with particular reference to environmental considerations, Canada and some other states favor recognition of a residual competence of coastal states to establish environmental standards until and unless the international community reaches agreement on a suitable regime. Canada has already passed legislation, the highly controversial Arctic Waters Pollution Prevention Act,13 establishing “environmental protection zones” out to 100 nautical miles from its Arctic coastline.

As far as the atmosphere is concerned, similar emerging—but not as yet carefully delineated—problems with respect to weather and climate modification are beginning to demand attention.14 As an inadvertent by-product of industrial processes, man is already having profound effects on weather and climate, and the technology is or will soon be available to make purposive alterations.15 There is no escape, therefore, from questions of whether or not the atmosphere is open for such use by any and all states and of who has decision-making competence—with all its attendant rights and responsibilities—over the activities involved. The fundamental question is whether weather and climate are to be regarded as inclusive resources under inclusive competence or are to be subjected to exclusive appropriation.

Regulation of Enjoyment

The general community seeks to minimize the environmental losses, interferes or disturbs, that inevitably attend transnational interactions. It seeks also to effect the productive and harmonious use of the earth-space environment by present and future generations. In order to accomplish this dual objective, the most comprehensive constitutive process maintains a regime for regulating the enjoyment of resources.
Controlling Injunuous Use

Resources inclusively enjoyed. With regard to resources inclusively enjoyed, many international agreements have been reached on means for controlling their injunuous use and fixing liability and compensation for damage which nevertheless results. In the area of the law of the sea, several conventions seek to prevent pollution. Articles 24 and 25 of the 1973 Geneva Convention on the High Seas provide that "Jefferies shall shall draw up regulations to prevent pollution of the sea" from discharge of oil and dumping of radioactive waste, respectively. The 1954 International Convention for the Prevention of Pollution of the Sea by Oil (as amended in 1960 and 1969) prohibits the international discharge of oil and oily mixtures into the sea, while the 1957 International Convention relating to the Limitation of the Liability of Owners of Seagoing Ships and the 1962 Convention on the Liability of Operators of Nuclear Ships deal with and limit the liability of shipowners for damage caused by (test vessels).

More recent treaties speak in similar terms. The Intergovernmental Maritime Consultative Organization (IMCO) International Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (the "Public Law" Convention) and International Convention on Civil Liability for Oil Pollution Damage ("Private Law" Convention) were both set up at Brussels in 1969, but neither is yet in force. The former acknowledged the right of a coastal state to take necessary and proportionate measures on the high seas to protect its coastline or related interests from pollution of the sea by oil. The latter would impose strict liability on the owner of any oil tanker from which oil escaped after an incident at sea and who's caused damage in the territory or territorial waters of a contracting state. It was supplemented by the 1971 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, also yet to enter into force, which would relieve ship owners from the "additional financial burden" imposed by the 1969 "Private Law" Convention and provide supplementary compensation for oil pollution victims up to a limit of $10 million.

Very recently, the 1972 Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft established an absolute prohibition against the dumping of certain highly toxic substances and regulated the dumping of all other substances in the region of the North Sea and North Atlantic Ocean, and the subsequent 1972 London Convention on the Dumping of Wastes at Sea made similar black and grey lists applicable to all marine waters other than internal waters of states. The 1972 International Convention for the Prevention of Pollution from Ships extended the 1954 Pollution of the Sea by Oil Convention with the intention of achieving the complete elimination of pollution of the sea by oil and other noxious substances and the minimization of accidental spills. Finally, the Oslo Convention states (joined by three landlocked neighbors) have just expanded their 1972 agreement into a comprehensive regime for that region of the sea by complementing it with a 1974 Convention for the Prevention of Marine Pollution from Land-Based Sources.

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The list of relevant conventions is long, and efforts at meaningful agreement are not limited to the oceans. The 1963 Treaty Between Nuclear Weapons States in the Atmosphere in Outer Space and Under Water (the "Outer Bar Treaty") and the 1970 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (the "Outer Space Treaty") provide that a state launching an object into space shall be internationally liable for damage to another state's property in the Outer Space Treaty or, in the event of any natural persons by such object, and the new 1972 Convention on Environmental Liability for Damage Caused by Space Objects provides that a launching state shall be absolutely liable to pay compensation for damage caused by its object on the surface of the earth or to aircraft in flight.

Resources exclusively enjoyed. With respect on the other hand, to exclusive enjoyment of resources, the conferences at Stockholm made clear that such rights of states must be limited or balanced by responsibilities to ensure that their exercise does not result in damage to others. Principle 21 of the United Nations Declaration on the Human Environment contains the crucial balance:

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction.

While the principle of responsibility of one state for damage caused in another is generally recognized, there have been only a few relevant international decisions on the subject. Most cited is the Fruit Smelter arbitration, in which an international tribunal found Canada liable for damages emanating from a smelter located in British Columbia and doing damage in the state of Washington. The Curfey Cattle case, in which the International Court of Justice held the Netherlands responsible under international law for damage to British ships from mine explosions in Belgian territorial waters, is another example. The third international judgment usually cited for its environmental implications is the Lai Lomoua arbitration, where an international tribunal said France would not be strictly liable if, due to its hydroelectric utilization of a French lake, damage resulted to waters draining into Spain.

Similar policies are expressed in the more general protocols of states. Traditional international law doctrines of "self-help" (including those of "self-defense," "self-preservation," and "security," as well as the somewhat less defined principle of "good neighborliness," allow a state confronted with a major threat to an exclusive resource interests to assert the necessary and proportional force to avert the danger or to secure its effects. In addition, in their various contiguous zones, states exercise limited control over inclusive resources to prevent injury to particular exclusive in-
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Resources exclusively enjoyed. With respect to their exclusive resources, many states have gone further than existing international norms in instituting positive programs of action. The United States Clean Air Act, 1967 Air Quality Act, and Clean Air Amendments of 1970, to which together aspire to set up a comprehensive system of air quality control, afford an impressive example in just one area. Not only are national governments declaring their environmental aspirations, but they are also creating the infrastructure essential to achieve these goals. Just a few years ago "conservation" was a relatively minor interest associated primarily with birdwatchers and occasional whale enthusiasts, but now most of the major industrialized nations of the world have set up national departments of the environment. In this country, the Council on Environmental Quality (CEQ) has a highly significant advisory role and the Environmental Protection Agency (EPA) undertakes major operational functions. States collectively as well as individually are increasingly making efforts to conserve and preserve exclusive resources. Under the recent 1973 UNESCO Convention for the Protection of the World Cultural and Natural Heritage, states have reciprocally recognized their duty of "ensuring the identification, protection, conservation, presentation, and transmission to future generations" of the world's heritage, and they have bound themselves to take "effective and active measures" toward these ends. Similarly, the new 1973 Endangered Species Convention, by which states agree to refrain from trade in species of wild flora and fauna in danger of extinction, represents such a collective conservation attempt covering some resources within the exclusive competence of nation-states. Finally, international aid and technical assistance for environmental management projects, if it is forthcoming, would also come under this category.

Planning and Development Functions in Relation to Resources

Resources exclusively enjoyed. Many of the most important resource use problems are associated with regional development and urbanization. Community planners have been advocating more effective planning of the physical environment and services of communities and subsequent development of resources in accordance with these plans. Many of these local considerations themselves have international implications (e.g., amount of and devoted to food production, land activities which pollute the oceans and atmosphere, water modification), and certainly the aggregate problem of planning and development of the resources of the shared earth-space environment is a matter of utmost international concern. Until quite recently, nevertheless, these functions have been given little attention by the world community, and only initial projects have been undertaken. These have in the past been attempts at shared river basins planning and development. The 1969 Boundary Waters Treaty between the United States and Canada set up the International Joint Commission (IJC) to make recommendations for the effective use of these waters and since then the Rhine and Danube Commissions have been set up for analogous purposes. On a broader scale, the comprehensive efforts by many international
agency) of the United Nations Family to alleviate the drastic conditions caused by the drought in the Subsaharan region in Africa and to improve the future prospects for the area is an unprecedented international coalition. Yet, as far as overall inclusive international coalition and development of the resources of the altered earth-space environment is concerned, the record is woefully deficient.

Resources exclusively enjoyed, with respect to exclusive resources, all nations plan, some with more formal term projections and explicitly state goals than others. The individual governmental ways and means are diverse. A helpful collective initiative in terms of international cooperation for the planning and development of national or exclusive resources might, however, be noted. In the preparations for the 1975 Vancouver Conference: Exploitations on Human Settlements, countries with similar environmental problems in areas such as city planning, urban and rural services, low-cost housing, accommodation of migrants, etc., are pooling their expertise for new joint and separate benefit.

Managing the Access of Peoples to Resources

The issue of managing the access of peoples to resources involves reconsideration of criteria for membership in national communities (nationality), freedom of movement between communities (transnational migration), and control of numbers of people (population).

Nationality. Nationality is the vehicle by which an individual can advance claims to richer participation both in the exclusive resources of his particular national community and in the inclusive resources of wider communities. States have historically been permitted to prescribe and apply highly restrictive policies in the granting or denial of nationality. This regime has frequently resulted in "stateless persons," who are politically impotent both in the national territory in which they had themselves and in international arenas. More generally, it dishonors the principle of individual voluntarism and the maximization of human rights and human dignity.

Fortunately, however, some amalgamation of historic attitudes toward nationality can be seen in the contemporary human rights program. The Universal Declaration of Human Rights provides that, as a minimum, "everyone has the right to a nationality" and that "no one shall be arbitrarily deprived of his nationality nor denied the right to change his nationality." Furthermore, the same condition is implicit in the broader proclamation in the U. N. Human Rights Declaration that "man has the fundamental right to freedom, equality, and adequate conditions of life ...."

Movement of peoples. The right to a nationality, if it is to be a meaningful vehicle of individual freedom and self-expression, must be accompanied by certain concomitant international rights: the right to return, the right to leave, and the right to stay in a country. Problems of emigration between and among national communities are required for their efficiency.

Traditionally states have imposed severe limitations on international freedom of migration: in terms of immigration quotas, travel, and visa reside...
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how the various types of decision are performed transnationally in relation to environmental problems.

Particular Functions

We describe the varying phases of the world constitutive process in terms of seven basic functions or culminating outcomes in decision: intelligence, promotion, prescription, invocation, application, termination, and appraisal.

Intelligence. Intelligence is the obtaining, processing, and dissemination of information (including planning).

The intelligence function is given great emphasis in the United Nations Environment Programme. The Action Plan adopted at Stockholm provided for a comprehensive global assessment program to be called “Earthwatch.” Earthwatch included functions divided into four categories: evaluation and review, research, monitoring, and information exchange. Of the 69 recommendations adopted by the Conference, Recommendations 25, 40, 23, and 72 had provisions pertinent to these four respective areas.

As subsequent sessions of the UNEP Governing Council, a large number of representatives have expressed the view that high priority should be given to the Earthwatch program and that a beginning should be made with the monitoring component of the program. The establishment of a “Global Environment Monitoring System” (GEMS).

Several important transnational environmental groups carry out environmental information gathering and dissemination activities. Some highly prominent examples are the Study of Critical Environmental Problems (SCEP), the Scientific Committee on Problems of the Environment (SCOPE), and the Study of Man’s Impact on Climate (SMIC) of the International Council of Scientific Unions (ICSU), the Marine Environmental Protection Committee (MEPC) of the Intergovernmental Maritime Consultative Organization (IMCO), the Committee on the Challenges of Modern Society (CCMS) of the North Atlantic Treaty Organization (NATO), and International Union for the Conservation of Nature and Natural Resources (IUCN) of the Council of Europe. On a bilateral level, the recent United States-Soviet treaty on the exchange of environmental information underlines the importance of this function as a prerequisite to other forms of environmental cooperation.

Many subnational groups, of course, also perform vital environmental information activities. The requirement of environmental “impact statements” under Section 102(2) (C) of the United States National Environmental Policy Act of 1969 was designed to ensure that such activities are carried out by federal agencies before they undertake major federal actions with significant environmental effects. Finally, countless research and analysis efforts by private individuals and institutions contribute to the overall global fund of environmental intelligence.

With all the recent proliferation of international environmental intelli-
genus programs, the system is still somewhat incomplete. There has been only qualified recognition of the duty of states to warn and consult with other states concerning activities which risk significant adverse environmental effects on the other states. As one writer has expressed it, we lack an international analog for national "impact statements." 24 This duty to provide proper warning was proposed by the Working Group of the Preparatory Committee for the Stockholm Conference for inclusion in the Environment Declaration; the so-called "Principle 30" would have read:

Relevant information must be supplied by States on activities or developments within their jurisdiction or under their control whenever they believe, or have reasons to believe, that such information is needed to avoid the risk of significant adverse effects on the environment in areas beyond their national jurisdiction.25

Unfortunately, due largely to an environmental dispute between Brazil and Argentina, this principle failed to win acceptance at the Conference. It was instead forwarded to the United Nations General Assembly, which incorporated only a modified version in a separate resolution calling for "cooperation and good neighborliness" in the field of environment.26

Our need for new and more precise environmental information in general and in specific situations is enormous. It is matched only by the need for better arrangements for processing and exchanging present knowledge. Promotion of promotion (or recommendation) is the advocacy of general policy. It involves the formulation and propagation of demands and the mobilization of support for new enforcements.

This function has been rather inadequately performed in the transitional level in relation to environmental affairs. The Whole United Nations Environment Programme (UNEP)—with its Governing Council, Secretariat, Fund and Co-ordinating Board—was, however, set up basically to see that there are improved and better-coordinated international environment initiatives in the future.27 In particular, the Environment Secretariat and its Executive Director have been mandated by the General Assembly to act as "a focal point for environmental action and co-ordination within the United Nations system."28

Many other organizations are becoming quite actively involved in environmental promotion activities. The numerous nongovernmental organizations represented at the Stockholm Conference got together and promulgated their own "NGOs Declaration,"29 and they made recommendations on policy and action in regard to the Conference agenda and, inter alia, separately to "mobilize support for the Stockholm decisions" and to "mobilize joint pressure for environmental change."30

The Club of Rome, with its now famous study on The Limits to Growth,31 is an example of an international organization which has developed high potential for international environmental promotion activities. The International Council of Scientific Unions, largely through the SCEP, SCOPE, and SMIC studies,32 has had similar effects. The International Institute for Environmental Affairs was specifically established in 1971 to serve as a clearing house and catalyst for action.33 Finally, certain domestically based public interest groups are performing international environmental promotion functions.34 The Sierra Club has developed transnational concerns and an international organizational network to sustain them, and the Center for Law and Social Policy is active in foreign policy and international relations advocacy for inclusive environmental interests.

The initial thrust of all these promotion activities is to change the perspective of effective discourses to incorporate broader recognition of ecological imperatives. Their ultimate objective is to formulate and propagate environmental demands and to mobilize support for the enactment and application of new authoritative prescriptions at all levels of community participation. Promotion is the formulation and projection of policy as authoritative community expectation. Historically, the making of transnational law has gone forward by way of articulated multilateral agreement and of unarticulated, habitual, cooperative behavior from which expectations about authority and control are derived. Five different types of international arenas house activity toward this end: diplomatic, parliamentary-diplomatic, parliamentary, adjudicative, and executive. In the field of international law, the trend is markedly toward the delegation of law making functions to the executive arena, since it features specialized agencies with certain hierarchies which can deal continuously with decision functions.

Recent achievements in the prescription of international environmental law are impressive. Within the area of the ocean environment alone, several examples have been mentioned, and there are many others: the 1958 Geneva Conventions on the Law of the Sea,35 the International Convention for the Prevention of Pollution of the Seas by Oil (1954-1971),36 the International Convention relating to Intervention on the High Seas in cases of Oil Pollution Casualties (1969),37 the International Convention on Civil Liability for Oil Pollution Damage (1969),38 the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (1971),39 the Basic Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil (1969),40 the General Principles on Marine Pollution41 and the Statutory Declaration on the same subject (1972),42 the Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (1972),43 the International Convention on the Prevention of Pollution from Ships (1973),44 and the Convention for the Prevention of Marine Pollution from Land-Based Sources (1974).45 All these conventions show an increasing awareness of the problems of the marine environment. They—especially the last-mentioned—also show growing recognition of the complexity of the ecological interdependencies which are the most important conditioning factors of the policy-making process. Finally, there is a subsidiary trend toward increasing acknowledgment that, in the context of marine pollution, coastal states have a particular interest in the management of area resources.46

Recent outcomes in prescription are, of course, not restricted to pollution and not restricted to the resources of the oceans. The "Test Ban" Treaty
Even if these deficiencies are cured and all participants provided with a right to have their own claims heard, however, there would still remain the problem of how to secure protection of wider inclusive interests. This is the question of "who can speak for the commons?" In the Nuclear Tests Case, Australia and New Zealand are currently claiming that states should be allowed to sue not only on the basis of specification of injury to their own exclusive interests, but also as representatives of inclusive international environmental interests. This vital matter is, therefore, now directly before the ICJ.

Application. Application is the final characterization of concrete circumstances in accordance with community prescription. Historically, the great bulk of the applications designed to protect general community prescriptions into controlling effect in particular circumstances have been made in interactions between foreign office and foreign office. The fact that some participants have had to be, alternatively, both claimants and applicants has not been so much a source of bias as a guarantee of aggregate decision in terms of common interest.

In recognition of this traditional mode of application of international law and of the fact that the international system has developed very few mechanisms for supranational application, the relevant conventions rely on national policing systems. In the past, through the 1960 and 1971 IMCO Conventions, the reliance has been placed solely on enforcement by flag states in maritime law and by the state of registry in space law. The 1972 London "Ocean Dumping" Convention, however, departed from past practice in recognizing complementary roles of flag and coastal states: the convention is enforceable by a contracting state not only against its flag and registry vessels, but also against vessels and fixed or floating platforms "under its jurisdiction and believed to be engaged in dumping." Full and prompt application of environmental prescriptions may, nevertheless, require more radical solutions—at least until adequate international cooperation is possible. The highly controversial Canadian Arctic "anti-pollution zone" is described as an example of such unilateral action in furtherance of multilateral objectives. Within that zone, Canada has forbidden the deposit of wastes and other forms of pollution, imposed absolute civil liability and penalties for violations, and authorized "pollution prevention officers" to carry out extensive inspections and other regulatory measures. Canada asserts that such action is based, first, on the uniqueness and fragility of Arctic ecology, and secondly, on an emerging international law concept of pollution prevention and control authority of coastal states beyond their territorial waters. The underlying rationale invoked, in other words, is again the principle of impact territoriality: until and unless the international community takes appropriate action to support its prescriptions for environmental protection and preservation, coastal states assert the right to protect their own interests.

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Unilateral assertions can, of course, be directly contrary to the policies of
transnational community expectation. When meant to insulate arbitrary and narrowly self-interested national actions from inclusive review (instead of simply providing an alternative arena for policy interpretation and other application), the consequences can be destructive both of inclusive substantive interests themselves and of confidence in the world constitutive process as a whole. The renunciation to jurisdiction of the International Court of Justice asserted by Iceland and France in the environmentally related cases of Fisheries Jurisdiction (concerning the legality of Iceland’s declaration of a 50 nautical mile exclusive fishing zone) and Nuclear Tests (concerning the legality under customary international law of nuclear tests in the atmosphere) is of this type. It is possible that either or both countries may have sound cases on the merits, but they should be prepared to defend them in an international forum against conflicting environmental claims.

This is not to say that there are easy answers to the polemics of unilateralism, bilateralism, regionalism, and multilateralism as approaches to the application of international environmental law. It is merely to realize that the traditional international legal order is essentially a laissez-faire system, unexperienced in collective enforcement actions to deal with non-security matters. Given the urgency of present ecological imperatives, flexible approaches to application on the part of those most directly concerned are required until the world constitutive process develops its own adequate means of application.

**Termination.** Termination is the ending of a prescription and the disposition of legitimate expectations created while the prescription was in effect. The prescriptive function does not itself operate to terminate a great many old prescriptions. Composite procedures must, therefore, be applied for putting an end to old crystallizations of community expectations.

In the environmental context, due to the extensive and fundamental interdependencies with other areas of policy-making, it will often be necessary to smother the costs of change and of selective impacts. The Helsinki Rules on the Uses of the Waters of International Rivers understand this and provide for compensation of prior interests where international rivers are adapted to new uses. Similarly, special time delays and other compensatory measures may be called for in the inauguration of new fisheries regimes and arrangements for mining of the seafloor for manganese nodules and other substances. Stabilization bodies for the purpose of easing economic and trade dislocations based on old patterns of exploitation have, therefore, been proposed as part of the Seabeds regime to be covered under the new Law of the Sea Treaty.

In sum, where _rebus sic stantibus_ has been invoked without deliberate, inclusive performance of the termination function, serious economic and other disruptions in the world public order have been known to occur. The international crisis precipitated by the unilateral modification of concessions and the oil embargo of this year is just one outstanding recent example.

**Appraisal.** Appraisal is the evaluation of the manner and measure in which the public policies have been put into effect and of responsibility therefor. Basically it represents the intelligence function applied to the decision process itself.

The most comprehensive recent examples of this function are the "Jackson Report," which reviewed the United Nations Development Programme, and the report by the Pearson Commission, which appraised the International Bank for Reconstruction and Development. The motivations behind the creation of the United Nations Institute for Training and Research (UNITAR), and the Joint Inspection Unit of the United Nations Secretariat involved performance of this function, and the same can be said of the United Nations Committee on Resources in a more directly environmental context. Finally, the mandate for the United Nations Environment Programme explicitly charges the United Nations Governing Council with the responsibility "to receive and review the periodic reports of the Executive Director on the implementation of environmental programmes within the United Nations system."

An ever-present difficulty with appraisal is its "sensitive" character. Evaluations of success or failure are no trivial matter from the viewpoint of a responsible official or agency. From the point of view of the global constitutive process as a whole, self-appraisal of environmental performance is essential in order to be entertained realistic expectations about the consequences of change.

**APPRAISAL AND RECOMMENDATIONS.**

On overview, two major characteristics of past trends may be observed. First, the underlying thrust in the formulation of past claims about resources has been primarily in terms of state-centeredness rather than commitment to inclusive community interests. There have been increasing claims to special state competence over resources and few efforts to regulate, plan, and develop their use and benefits for the greater sharing and wider sharing of values among all peoples now and through time. It is far from evident that these claims can be justified even as provisional measures by reference to the limitations inherent in the contemporary international decision-making system.

Second, such limitations as have been imposed upon unilateral egocentricity in claims to resources have been formulated from perspectives other than the specifically environmental or ecospheric. The Stockholm Conference was in some measure successful in developing the mixing environmental perspective, but the new international awareness is still fragile and tentative. The "energy crisis," for example, has provided disturbing indications of the perspectives of governments, multinational enterprises, the press, the public, and all sorts of groups and institutions. As one eminent analyst has put it: "There are signs of an increasingly widespread tendency to consider last year as the 'year of the environment' and this year as the 'year of the energy crisis.'"
The many deficiencies in past decision described above can be expected to continue in the absence of the formulation, evaluation, and implementation of more appropriate policy alternatives. Some of the policy alternatives requiring consideration may be indicated by summary reference both to the main features of the process of use of resources and to the different types of decision making in world community processes.

Use of the Environment

In future decisions about competence over resources, the oceans and the seabed should be maintained with as high a degree of inclusive enjoyment as possible. This perspective should guide policy makers in the new legal order they intend to create at the upcoming Law of the Sea Conference. The expansion of exclusive coastal state competence over the seas should be confined to a minimum, and, whatever the precise constitution of the new Seabed Authority to deal with resources beyond the limits of national jurisdiction, it is essential that it be faced with the widest sharing and sharing of the available values and to share the valid interests of all parties concerned once properly established. Although in some ways this task represents an unprecedented challenge to the inclusive decision-making system, certain analogies can be found in the work of existing international organizations, such as the International Civil Aviation Organization (ICAO).

Similarly, air, weather, and climate must be recognized as resources within the inclusive domain. Recommendation 70 of the Stockholm Action Plan recommends interstate consultations for activities which carry a risk of effects on climate. The Bangkok Conference on World Peace Through Law went further and proposed establishment at the earliest possible date of a Convention on Weather Control. We fully support this recommendation and urge that the United States call now for a comprehensive international treaty concerning control of weather and climate modifications, both inadvertent and deliberate, which have effects or potential effects across national boundaries. We also recommend that some international agency, perhaps the World Metereological Organization (WMO), be explicitly charged with undertaking inquiry and recommendation in this area.

Regulation of Enjoyment

Controlling Injurious Use

Resources existentially enjoyed. Governments and all effective users must cooperate to minimize the irritation of claims to use of sharable resources when such enjoyment can have injurious effects on the rights and interests of others or common interests. In keeping with this aim, the new Law of the Sea Treaty must keep pace with the advances of technology and design an effective environmental code for the oceans, taking full account of the implications of such modern innovations as nuclear ships, superconductors,
likely to affect them. Beyond this, technical data and other relevant information should also be supplied to some centralized international body—perhaps UNEP—in regard to proposed means of enjoyment of exclusive resources which affect the regime for the common enjoyment of inclusive resources.

Planning and Development

Resources exclusively enjoyed. The most urgent need is for overall organizational arrangements to integrate intelligence, planning, and promotional activities with respect to all the varying components and features of the earth’s natural environment. The Governing Council of UNEP is, to some extent, charged with these functions, but it has not been endowed with the capabilities for their continuous performance. Aided by such broadly inclusive planning, actual development might go forward most successfully on a regional basis. Such regionalism should, however, take account of the larger ecological entities and be organized in accordance with natural ecological subsystems rather than synthetic political agglomerations.

Resources exclusively enjoyed. Comprehensive planning and development is needed at all countries at all levels—from local, to metropolitan, to drainage basin, in larger and ultimately national and transnational levels. Many countries already have environmental agencies or ministries for overseeing and managing the resources they enjoy exclusively, and the status and performance of these bodies should be improved. Whatever the institutional architecture, the function of planning and development needs to be provided by governments with respect to all environmental variables. Cooperative planning for exclusive resources—as is illustrated by the Conference on Human Settlements—is useful, but it is also essential that responsibility be delegated to and assumed by continuing organizations which can implement the policies by actually carrying out the planned development.

People in Relation to Resources

Increased voluntarism in personal choice should be the goal of the international community as far as rationality and integration of peoples is concerned. In the final analysis, however, neither this goal nor any other goal of environmental protection, preservation, and enhancement can be achieved in the absence of effective checks on numbers of people. Voluntary restriction would also, of course, be the most desirable policy with respect to population growth, but its time may be past. It is essential, internationally and nationally, to make available the education and technology necessary for voluntary birth control. Yet, there remain to be removed certain legal impediments to voluntarism—not only antiabortion laws, but also all anachronistic regulations which still prevent free access to and distribution of family planning information and contraceptive material. Positive educational and promotional efforts on the part of Zero

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Population Growth (ZPG) and other programs should further be welcomed. Beyond this encouragement of voluntarism, the case for planned, compulsory regulation of reproduction, as compatible with basic freedom of choice, might be given a fuller hearing. It might be found preferable and possible for global decision-makers (rather than leaving the determination to the apathetic horizons) to agree on policies that take account of human rights to a liveable environment and a decent quality of life as well as of the rights to individual propagation, of differential rates of resource consumption as well as of differential reproduction rates, and of the rights of women to self-expression and self-determination as well as of the claims of nations to people as bases of power.

This is World Population Year, the declaration of which implies acute awareness of these problems. The 1975 World Population Conference will face an extraordinarily difficult challenge to cooperative policy making and implementation.

World Constitutive Process

Intelligence

If fully implemented, "Earthwatch" could provide the international community with a comprehensive environmental intelligence function. High priority is therefore accorded to its rapid inauguration. Despite its promise, the system could bear improvement. First, in addition to biochemical confirmation, the assessment program should seek to incorporate intelligence regarding the social factors that are also fundamental to the "environmental" perspective. Social scientists have only begun to develop "social indicators" that would enable standard recording of these variables, but some sort of monitoring of the social or sociological costs and benefits is essential to enable any meaningful assessment of policy-making for the human environment. Second, the program should be expanded to identify and keep track of developments affecting the environment both in the international and in national legal systems. The second session of the UNEP Governing Council gave a mandate to the Executive Director to convene further informal working groups of legal experts to advise him on how best to contribute to the future development of international environmental law, but this is only a very minor aspect of the overall function. Lawyers in general must accept the role of committed activities, rather than hoping that the small secretariat will provide the momentous impetus needed. Third, as a basic foundation to all of this intelligence activity, further studies should be undertaken to clarify the confusions and difficulties of The Limits to Growth and to evaluate its basic recommendation of "zero-growth" economic strategies in light of both natural and social conditioning factors. At the present time, there is no global, little regional, and inadequate national political-economic planning for the long-term future. Fourth and finally, freedom of scientific and social
scientific research is fundamental to the successful implementation of Earthwatch. At the Law of the Sea Conference, lawyers, scientists, citizens, and others may become concerned advocates and mobilize support among effective allies, for appropriate environmental policies. One has only to think of the widespread demand for a moratorium on whaling, including its promulgation as a recommendation of the Stockholm Action Plan, to recognize how little international public opinion alone did for the whales. It is essential to supplement this with active support within relevant areas.

International public opinion, although insufficient in and of itself, is not inconsequential. Environmental advocates should be putting more energy and channeling more resources into the supportive activities of education, training, and public information. Due to the scope and expense characteristics of such campaigns, in our age of mass participation and wide thrust of communication, technology, locally organized public interest groups backed up by charitable foundations can and do make a unique contribution.

Prescription

The Stockholm Conference clarified a lot of customary expectations, and the United Nations General Assembly has since reinforced many of these expectations. Environmental policy has also been crystallized in a number of international agreements. The prescriptive order is, nevertheless, incomplete. We recommend, therefore, that the International Law Commission, in its current stage, of potential international environmental norms and come up with recommended standards of behavior and action. Greater use might be made of the United Nations General Assembly, of delegation of competence to specialized bodies, and of procedures comparable to those of the ILC, for securing the authoritative promulgation of such standards. Along with this initiative, support should be given to the movement for uniform national laws about the environment—at least to the extent that they have transnational reach (environmental, trade, development assistance, or otherwise).

Concerning particular substantive areas, massive environmental protection will be a major concern of the Law of the Sea Conference, and many agreements can be expected to evolve out of this umbrella exercise. International decision-making at the World Population Conference will deal with the most pressing international environmental issues today. It is past time for negotiation of conventions on land-based sources of all marine pollution and on weather and climate modification. The environmental effects of supersonic aircraft are also worthy of serious consideration.

Innovation

The principle requirement for improvement of the innovation function is for nonofficial actors to be accorded greater access to relevant areas. On the international plane, short of change in the statute of the IUCN, this can be better advanced both by increased willingness of national governments to represent environmental causes and public interest groups and by provision of alternative international arenas open directly to nongovernmental actors. Through development of uniform national laws and on the individual national level, what is needed is relaxation of standing requirements before courts and administrative tribunals to accord greater recognition to groups advocating common environmental interests.

A further idea deserving discussion is provision of an international ambassador charged with invoking processes or intervening to enforce as representative of inclusive concerns what the common environment is threatened. Whether this be the Executive Director of UNEP or some other individual or organization, the ambassador would have to be directly connected with the Earthwatch intelligence facilities and supplied with a competent legal staff.

Application

As far as the application function is concerned, the authority of particular states to make applications of international standards appropriately clarified should be recognized and extended. This is especially so where the applying state has an exclusive interest compatible with and in furtherance of inclusive community interests, such as the cases of Canada seeking to protect the unique environment of the neighboring Arctic and Australia and New Zealand seeking to prevent entry of radioactive contamination of the atmosphere in South Pacific areas.

The environmental role of nonstate actors should also be enhanced. A special World Environment Court does not seem to be called for at this time. The IUCN can, however, be streamlined (through use of chambers, assessors, as elsewhere) and other dispute settlement procedures (negotiation, good offices, mediation, conciliation, arbitration, judicial settlement in other courts, and administrative tribunals) should be tailored more readily to take account of and to give greater weight to environmental factors in reaching their decisions.

Termination

The biggest problem in termination occurs with respect to developing countries. At Stockholm it was repeatedly emphasized that the developing countries most of the environmental problems are caused by underdevelopment. The efforts of advanced industrial states to combat theills caused by modern technological development should, therefore, be allowed to
preclude the economic and social progress of the poorer nations. In the short-term, special provisions to accommodate the legitimate expectations of developing countries may result in the creation of "pollution havens" and other undesirable side effects. In the longer term, however, all nations individually and collectively must accede to new prescriptions more fully reflecting environmental imperatives.

Appraisal

It is perhaps too early to expect major transformations as a result of the contemporary spurt of environmental concern in the world community. UNEP, however, has already begun appraising the functioning of the United Nations system from the environmental perspective, and this evaluation will continue and hopefully become more comprehensive. As far as the carrying out of public policies by nonofficial actors is concerned, universities, foundations, and private scholars and concerned citizens must shoulder significant responsibility for the appraisal function. In this respect, conferences such as this have a major significance in stimulating the more comprehensive and perspective development of international environmental policymaking.

The task of highest priority for all genuinely committed to a more appropriately conserving enjoyment of our most comprehensive environment, including all its great shareable resources, is, of course, that of creating in the peoples of the world the perspectives necessary both to their understanding of the conditions that affect the achievement of their common interests and to their invention and initiation of the detailed changes in global consilience that can secure such common interests. It is the confused, disoriented, and conflicting perspectives of the state-centered effective elites of the world which maintain both the suicidal patterns in speculation and destruction of necessarily shared resources and the woefully inadequate responding decisions by the contemporary global consilience process; it will require an enormous collective program in fundamental education and more general worldwide communication to change these perspectives. We do not share the views of observers who ground contemporary concern for the environment only upon imminent crises with respect to particular resources: the crisis is permanent and the resources affected comprise the whole earth-space ecosystem. The most appropriate perspective is that embodied in the fable of the My pond: the My pond doubles in size each day; if allowed to grow unchecked, it will cover the pond in 20 days, choking off all other forms of life in the water. So what happens?

For a long time the My pond seems small, and so you decide not to worry about coveting it back until it covers half the pond. On what day will that be? On the twenty-ninth day, of course. You have one day to save your pond.14

References and Notes


3. For discussion of all three conventions, see Kallman, When Happened at Stockholm, 22 Int'l J. 2, 28 (1973).
4. See, e.g., Legal Foundations of the Environment. (1978). The author, as a member of the Task Force on International Environmental Law, has prepared a draft paper summarizing the issues and developments in the field, which will be presented at the ICLE Conference on International Environmental Law, Institute of Law and Economics, University of Minnesota, Minneapolis, September 15-17, 1978. The author gratefully acknowledges the assistance of Mr. John A. Ryan, who prepared the draft paper.
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C. World Institutions

EDUCATION FOR HUMAN SURVIVAL: AN IMMEDIATE WORLD PRIORITY

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Deep down inside, I have trouble believing we are going to make it through to the year 2000.

I think about the powder keg of overkill on which we all sit, and then about the language of SALT II, the "marginalization" resolution of US-USSR arms madness, and the revelation that each year at least 3 percent of the approximately 120,000 military and civilian personnel who flog only the American nuclear arsenal are found to be "security risks" because of alcoholism, drug abuse, mental illness, and insubordination.

I think about the largely unacknowledged slaughter of over 50 million Chinese in Indonesia in 1965-1966, the unrelenting victimization of apartheid-controlled Black Africans, and the still unmitigated despair of millions of Palestinian refugees, and then about the prolonged United States' resistance to the Genocide Convention, about the ostracized diplomats that make waging stock of Security Council sanctions, and, generally, about the old Adam of sovereignty that purposefully fights delaying actions against the achievement of fundamental rights and freedoms into an increasingly restless "revolution of rising expectations."

I think about Third World poverty, illiteracy, and disease, about exploding Third World populations, and about the recent coming of long-predicted Third World famines on a mass scale, and then about the supremacy of domestic and foreign policies that resist defining where business profits ends and social responsibility begins, that gravitatingly consign most fractions of colonial GNP toward the alleviation of human want, and that (as generally) receive the moral and geopolitical implications of an ever-widening gap between the "haves" and the "have-nots."

I think about the wanton killing of precious life species, the rape of non-renewable resources, and the overall disruption of delicate ecosystems, and then about the prevalence of governments which, in their commitment to elusive self-sufficiencies, to economic expansion as the sine qua non of social progress and well-being, and to pollutants at the central issue of environmental concern, evince little or no regard for the "closing circle" and the consequent need to see our world as a total living organism, with appropriate coherent policies to match.

And then, finally, I think about the still largely unrecognized interdependence or interrelatedness of all these cancerous conditions—the nuclear war system, gross socio-political injustice, mass poverty, fundamental

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Now if one assumes, as I do, that our educational institutions should be in the business of educating for human survival, it is appropriate to ask what our schools, colleges, and universities have been doing to counter these major negative trends. That is, to what extent and in what ways have they sought to impress upon our young people that the history of our planet is as much the graveyard of species that proved themselves incapable of coping with disaster as it is a record of progressive achievement? To what extent and in what ways have they sought to impress the idea of human survival? I, of course, cannot speak for education everywhere, nor indeed for education anywhere, but at all levels in the United States. But if the general picture of American higher education over the last approximately two decades is any indication, there is ample room for anxiety.

One can take for starters the much and justifiably bemoaned Final Report of the Carnegie Commission on Higher Education, the 6-year, $66 million end-product of 21 special reports and a series of auxiliary studies, and a charge from The Carnegie Foundation for the Advancement of Teaching "to study and to make recommendations about higher education for the 1970s and ahead to the year 2000." Its findings are inescapable and well known: financial distress, loss in public confidence, and a nightmare of bureaucratic constraints—all tending toward a diffusion of responsibility and a drift in direction that seriously impede creativity, experimentation, and reform. These findings are unsparing in their own right, of course. Manifestly they bode ill for both education itself and the wider public interest. Yet even more alarming is the failure of the Carnegie Commission to address, except in passing, the ultimate basis upon which academic life claims to intellectual and political legitimacy: curriculum and scholarly values, i.e., what we teach and why. To be sure, this omission was deliberate; but it is not ironic to the point of tragedy, the more so when the future is so uncertain as to justify completely the very question of human survival, that so major a report by so enlightened a group of people did not deal among its "Priorities for Action"—the title of the report—with the humanistic concerns that are at once the beginning and end of education and the bedrock of a world order of human dignity, now egregiously imperiled. The answer, I submit, is self-evident.

Of course, it would be wrong to infer from this depressing omission that either the Carnegie people themselves or our colleges and universities are wholly disinterested in such concerns. According to a recent announcement, for example, the Carnegie Foundation for the Advancement of Teaching has established a permanent Council on Policy Studies in Higher Education, among whose functions will be, hopefully, the investigation and evaluation of curricular trends and priorities; and we all know many academicians and administrators who long have been and remain committed to these vital issues. It is nonetheless no exaggeration to say that the Carnegie Commission's near-total disregard of ultimate purpose is a mirror of our times. Beyond the outrages over secret research, academic bias, and, much too rarely, the increasing professionalization of undergraduate study, the matter of what we teach and why has become obscured—in many places after-
gather buried—by questions of governance, measurement, and procedure (e.g., the evaluation as distinct from the improvement of instruction, the quantification as distinct from the qualification of knowledge, the method as distinct from the substance of education). What is worse, given the central concern of this paper, few of our educational institutions are taking seriously the imperative of reappraising their long-standing approaches to the study of international affairs in the interest of developing comprehension and skill relative to those global problems which menace the existence and quality of life. Indeed, it is the peculiar reflection of our times that the few institutions who are addressing these matters are doing so less with assistance from the public fiscal and their own institutions than with the encouragement and help of such outside and essentially poverty-stricken nongovernmental agencies as the Center for War/Peace Studies, the Consortium on Peace Research, Education and Development (COPRED), the Institute for World Order, and the Overseas Development Council. Like the generals who prepare for the last war, we prepare for yesterday’s reality.

In sum, just as the nation of this world appear generally unmoved to save the future from potential disaster, so also do the academics. Not that questions of governance, measurement, and procedure are unimportant or that traditional approaches to international studies should be abandoned. Conversely, they are necessary and worthwhile. It is, simply, that they are inadequate to the task and too commonly diverting of responsible attention from the principal issues on the human agenda. Regrettably, it does not go without saying that this is a condition that cannot be allowed to endure.

Not does it go without saying what kinds of curricular innovations and revisions are needed to advance the cause of human survival. It serves little utility simply to criticize and deplore. The remainder of these remarks, therefore, although by no means definitive or wholly original, are by way of constructive recommendation. Following the broad contours of what has come to be known as “peace studies,” “transnational studies,” or “world order studies,” and consequently extending beyond the pursuit of human survival to include the wider goal of human dignity, they are premised on the deeply held conviction that “education for human survival cannot advance the cause of human survival very far unless it is done according to an ethical system which seeks to promote: ‘the greatest production and widest possible sharing, without discriminations irrelevant of sex, of all values among all human beings.’”

* * *

Preliminarily, it needs emphasizing that an optimal human survival curriculum, or what I choose to call “world order education,” would be in one innovative and traditional in its approach to internationally oriented instruction. It would be innovative because it would emphasize global perspectives, interdisciplinary analyses, and futuristic thinking, and it would be traditional because, in total keeping with “the complex liberal education,” it would be centrally concerned with the meaning, value, and improvement of life as a whole. The following chart, contrasting between

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<tr>
<th>Item</th>
<th>Traditional Approach</th>
<th>World Order Approach</th>
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<tr>
<td>1. Analysis is presumed</td>
<td>value-free</td>
<td>value-oriented</td>
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<td>2. Appropriate micro dimension</td>
<td>past and current</td>
<td>past, present, and especially future</td>
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<td>3. Ultimate analytical goal is</td>
<td>description</td>
<td>description</td>
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<td>4. Primary actor are</td>
<td>nation states, governmental elites</td>
<td>nation states, governmental elites</td>
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<td>5. Geopolitical emphasis</td>
<td>national interest</td>
<td>national interest</td>
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<td>6. Problems are seen as</td>
<td>discrete issues</td>
<td>basically militaristic and economic manipulation</td>
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<td>7. Power is</td>
<td>discrete issues</td>
<td>basically militaristic and economic manipulation</td>
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<td>8. Large-scale violence is</td>
<td>an acceptable means to implement policy goals</td>
<td>an acceptable means to implement policy goals</td>
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<td>9. Human survival is</td>
<td>predicted</td>
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Also, because it would presuppose a basic although perhaps unjustified optimism that solutions to the grave conditions which presently threaten human survival are within human capability, a human survival or world order curriculum would be as much concerned with how as with what one teaches and learns.

In the ensuing discussion, in which I trace what I believe should be the topical focus, guiding principles, general methodology and possible overall organization of such a curriculum, I try to make these various preliminary observations clear.

Focus of Study

The topical focus of a human survival or world order education would be as is suggested at the outset of these pages where the perspectives which prompt my anxiety about the future are set forth. Briefly, the overall field of inquiry would be the four large problem areas that now challenge severely, and are likely to continue to challenge severely, the existence and quality of life on Earth: the root problems of war, socioeconomic injustice, economic underdevelopment, and ecological imbalance. To this general statement, however, needs be added three clarifying observations.

First, it is understood that each of the four problem areas (stated affirmatively for curriculum purposes as “war prevention,” “social-political justice,” “material well-being,” and “environmental protection”), would embrace a wide variety of topical concerns. Falling under the label “war prevention,” for example, might be such study units as “violent and non-violent charge,” “conflict and conflict management,” “arms control and disarmament,” and “the military-industrial complex.” Similarly, under the rubric “social-political justice” would fall many, perhaps most, of the considerations ordinarily associated with the field of “international human (civil and political) rights,” e.g., genocide, race discrimination, political alienation, etc. The four problem areas would be seen, in short, as principal
themes for study concentration—although not, it must be added, in any mutually exclusive sense. To the contrary, as such headline issues as the worldwide energy and ecology population crises make clear, the four problem areas would involve overlapping considerations and therefore require integrative analysis. The simple point is that, as general curricular reference-point, each incorporating a diversity of inquiries which tend toward common issues of fact and policy that transcend the capacity of our Systemic system, they would serve to focus attention upon these integrative ageless problems which seem most demanding of investigation and solution as humankind moves into the twenty-first century: how to limit violence and prevent wars and other types of hostilities among nations and peoples; how to expand social justice so that discrimination and oppression will be reduced and more people given more opportunity to say what should happen to their lives; how to raise levels of economic welfare so that degrading poverty will no longer be the fate of millions of human beings; and how to restore the quality of the global environment so that people can enjoy the benefit of the Earth in good health and without fear of pollution and the waste of finite resources.

Second, it is understood that each of the four problem areas, and the diversity of inquiries that embrace, would require the acquisition of knowledge in much, if not most, of the more familiar subject-matter of international education. "Area Studies" courses and courses in national foreign policy, diplomatic history, and comparative political systems, for example, not only should not be ignored, but should be made an integral part of the curriculum if one is to come seriously to terms with the four problem areas mentioned; and the same may be said of courses in international law and organization, world trade and investment, mass communication, language and culture, ethnology, social ethics, environmental aesthetics, and other obvious and not-so-obvious relevance. At the very least, a human survival or world order course or program would mean allowing students to attack the problems of war, social political injustice, economic underdevelopment, and environmental decay with time-served knowledge and skills; it would mean blending new perspectives with old tools. To quote Montaigne, "[w]e are all framed of flags and patches and of so shapeless and diverse a creature that every piece and every moment plays on his part."  

Finally, it is understood that the four problem areas would not and should not be treated as absolutes. In the first place, not every school, college, or university has all the resources needed to bring each of these problem areas into full-scale curricular development. Decisions concerning them necessarily would have to reflect sensitivity to context, and the most one can expect is that as many of our educational institutions as possible will do as much as they can with what they have actually and potentially at their disposal. Secondly, not everyone will agree that the four problem areas noted would be the best or only topical reference-points around which to organize human survival or world order courses and programs. Different assessments about the past, present, and future are bound to produce differ-
U Thant and others are to be believed, we have only a very limited amount of time (10 to 15 years) in which significantly to alter major negative trends. A human survival or world order approach to international education would seek to involve students directly and personally in shaping the future, and to encourage them to create and evaluate alternative images of the future based on both "hard data" and free-associative imagination.

Finally, by "policy-oriented analysis" is meant a conscious commitment to the clarification and appraisal of competing values and value systems, especially in problem-solving contexts. Since no social situation (including the classroom situation) is or can be "value-free," it means engaging openly and critically, without pretending other than a humanistic kind of world ordering, with ethical or moral judgments that often are introduced or assumed without question. A human survival or world order education would place policy or value questions at the center of inquiry by urging students to ask what is humanly desirable, as well as what is politically and technologically possible, and by challenging them to be critical of the various value-laden theories that are brought to their attention.

Summarizing, a human survival or world order education would mean including but going beyond traditional approaches to international education which, over the years (although less now than before), have tended toward nationalistic, undisciplinary, too historically circumscribed, and uselessly "value-free" perspectives. It would mean focusing upon "Spaceships Earth," rather like social astronauts or cosmonauts, in ways that strongly encourage young people to involve themselves in some form of lifetime commitment to human survival and dignity on a worldwide basis. Considering that today's undergraduates will be reaching the peak of their careers at the turn of the twenty-first century when our "global village" already may have passed what many acme observers foresee as the critical millennium in the history of our planet and universe, the urgency of promoting such education is inescapable.

**Method of Study**

Quickly stated, the methodology of a human survival or world order education would be the basic methodology (or composite of basic methodologies) of the behavioral and social sciences applied to the global social process. It would involve, essentially, six operations, all of them familiar, hence necessitating only summary treatment at this juncture:

1. The identification and definition of actual and potential world problems that transcend the capacity of nation-states, including the identification and definition of all the actors, institutions, and relationships pertinent to such problems (i.e., determinative thinking);

2. The clarification and appraisal of preferred policies or values relevant to selected world problems (i.e., goal-climbing);

3. The description and correlation of past trends in the management of the problems selected (i.e., historical mapping);

4. The systematic analysis of factors that have conditioned past management successes and failures (i.e., scientific-interpretative thinking);

5. The projection of future trends with regard to the problems selected (i.e., prognosis thinking), and

6. The invention and recommendation of solutions consistent with preferred policies or values (i.e., creative thinking).

Treated separately, as they can be, each of these six operations is seen as a curricular reference-point around which could be organized the teaching of critical behavioral and social skills, e.g., problem specification, policy planning, data retrieval, systems analysis, probability calculation, and visualization strategy. Treated as a whole, they are seen as the minimum steps needed for the rational modification of any world order problem. Treated either way, they of course imply the involvement of mix, if not all, the major disciplines—data, the natural sciences, and the humanities, as well as the more expected behavioral and social sciences. This is as it should be. Education for human survival and human dignity cannot be the exclusive province of any one discipline or set of skills.

**Organization of Study**

At The University of Iowa, this writer and others are now actively working to develop a full-scale human survival or world order curriculum through which we hope to expand the horizons and talents of our graduate and undergraduate students in service to a more peaceful and just world. We have not yet completed our mission and we are sensitive to the fact that there is no unitary approach to the manner in which one educates in this realm. Nevertheless, the curriculum chart which follows—providing for the teaching about, as well as the learning of, human survival or world order concerns—may help to clarify the admittedly broad-stated images set forth above (FIGURE 1). It is to be taken, of course, as illustrative only.

* * *

Concededly, education for human survival and human dignity is a very difficult thing to achieve, and one just because of the unparalleled public and private creativity, energy, and wealth it requires. It involves also the readjustment of thought patterns and work habits that run very deep. Unlike the doctor who labels "sick" a patient who consistently ignores threats to his/her personal survival, we label as "traditional"—or "self-destructive"—a curriculum which fails to confront the threats that endanger our national and planetary future.

But innovate and revolve we must. The world has been superbly organized for everything except the life of its people, and as naturalist-poet Loren Eiseley has written, "the need is now for a gentler, a more tolerant, people than those who won for us against the ice, the tiger, and the bear." With the advent of mass education to an educational process that holds out at least the potential for heightened sensitivity to the precariousness of life and to the possibilities for upgrading human existence is the fundamental priority of our time. Even if we do not succeed overnight, the prospect that this conference can identify this fact as one of prime consideration and then at-
4. The chart is drawn, with minor revision, from Wijesekera, N. & Wray, T., 1974, A World Order Framework for Teaching International Politics, pp. 5-14, Institute for World Order.

I can only confide in the information that is available to me as Secretary General that the members of the United Nations have perhaps two years left in which to stabilize their ancient quarrelling and launch a global partnership to curb the arms race, to improve the human environment, to relieve the population explosion, and to supply the required momentum to world development efforts.

If such a global partnership is not forged within the next decade, then I must fear that the problems I have mentioned will have reached such staggering proportions that they will be beyond our capacity to control.


The attempt to do something about it may do some good. Education for human survival is not just desirable; it is absolutely necessary.

References and Notes
Galileo was embarrassed to find that he had to read books by colleagues so recent that they were still alive instead of being properly dead classics. Newton, a couple of living years later, was outraged to have his work questioned by living peers and resolved never thereafter to publish again one of these new-fangled scientific letters—we call them papers—but to go back to the normal litic process of writing a proper book.

To the accompaniment of such disturbances began the Scientific Revolution which has continued into the present age and been by far the mightiest force in producing all those changes which distinguish us from the people of the seventeenth century. Since that time there have been several crucial changes, and it is instructive for my purpose to point out that so many of them have been dominated by crucial transformations in social and technical means for handling scientific and technical information.

It is my thesis here that we are already in the midst of a new and excitingly fundamental period of revolutionary change, the Scientific Technical Revolution as we are beginning to call it, and that in this too the seemingly passive element of information is actually a crucx and a chief causal agent. It may well be that the innocent responsibility of mere libharization and the provision of incomprehensibly arcane journal literature for the egghead elite of scholarship may be the straw that breaks the back of our civilization. It is the business of a professor sometimes to exaggerate in order to inspire or to expose the weakness of an argument for constructive shock, but I shall hope to show now that such an evaluation of present needs in scientific and technical information is no oversimplification.

Increasingly and in all countries the lives of mankind are being dominated by what we call the High Technologies: those technologies that contain a high input of consumating scientific knowledge and are thereby set apart from the more familiar and ancient Low Technologies where the inputs are raw material, energy, and the labors of skilled and unskilled, but not scientifically innovative, manpower. Important though the general notion of "information" seems to be, in most fields of human activity it appears primarily as a means of communication, a conduit or channel that facilitates the prime action. In science, and in particular with all that scientific innovation which is the chief input to our dominating High Technology, the "information" is not only a means of communication but in a curiously paradoxical

* This paper was originally presented at Drexel University as the fourth in a series of six lectures on Society's Technological Needs. 126
These phenomena occur so widely together with all the long-term changes in the paradigms of science that the act of creation in science remained incomplete without the common and critical acceptance by one's peers in the whole scientific community. Not until the work is published, formally or informally, so that it is read and either rejected or built upon has work been done. The evaluation may not always be fair—every scientist probably suspects that he is a bit of a Mendelev and his work has not been appreciated as much as he would like—but it works automatically because there exists an International Knowledge Industry, a universal communal sensibility. It is the workings of this sensibility with which we are now concerned, but first we must hedge and explain that not all scientific and technical labor falls within it.

Sometimes when people feel something new in the technical areas of scholarship they do not follow this paradigms law of elusion, private property by open publication, but use the normal property law of keeping their creation and deriving benefits from it as a nation, a company, or as an individual. One may invoke secrecy at the national or the industrial level, or one might use the legal devices of patents and licences which evade a disclosure of information in return for a right to profit from the possession. Clearly this is advantageous in many respects which may be overvalued, although what one loses is the assistance of the rest of the world community, both in the process of validation and in the collaborative enterprise of proceeding further to build on his new advance.

A much larger exception in the world's scientific labor is simply that many people must be concerned not with adding to what we already know and can do, but with using that which we have now. These that teach at all but the levels nearest the research front and those that do much of the scientific and technical work of the nation use the knowledge that was built in the past by all this cumulative and testing and communicated to them by the processes of education, training, and the concentrated knowledge into textbooks, memuah, and works of reference.

Let us now turn to the International Knowledge Industry and see how its machinery has developed into the present crisis which afflicts all those that help generate, manipulate, and use scientific and technical information. The dilemma of Galileo was caused by the Guiseberg Revolution. Quite sharply around 1500 the printed book graduated from its original role of producing artificial manuscripts to become a new form of mass dissemination to a much wider audience that had been available to all. Like the windmill it had the property of requiring a large initial investment and then necessitating a steady stream of production, large in volume to amortize the costs.

Numbers of books grew exponentially, rapidly exhausting the supply of previous classics available for reprints, and developing ever wider circles of readers and writers. As the pressure became more and more various and evenly available, the pulse of publication quickened. By 1000 some real time constant of publication had been reduced to a magnitude similar to that of the length of a lifetime, and by the middle of the twentieth century it had quickened dramatically further.

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This exponential force of destiny was so powerful that ephemeral publications of many with began to abound, political and religious tracts and broadsheets and sermons, and then the newspaper. In science, benefiting enormously already through the mass potentialities to be found among the animals and instruments makers in the primordia, the force was so persuasive that the first two scientific journals were organized almost simultaneously in London and in Paris.

These two journals, the Philosophical Transactions and the Journal des Scavans produced very quickly, by the invention of the scientific paper, the major revolution of all time in the social organization and use of flow of scientific and technical information. Splitting knowledge into atomic entities instead of waiting for it to gel and crystallize into a book obviously makes it run faster and much more cooperatively. There was indeed reaction to the methods in the time of Newton, but by the eighteenth century the process settled down into a steady growth. Science encapsulated in papers became a sort of conspiracy that made knowledge run faster than people, and the scientific journals and their papers then grew exponentially much faster than books, doubling in number every decade or so and spreading to all countries and all fields.

Thus science burgeoned, as it has to the present day. It must be remembered that the mere burgeoning is no new problem. It is one that has ever since been felt, and coped with quite successfully. It is true that we have found out as much to the last decade or so as in all previous time and that 90 percent of all the scientists that have ever lived are alive now, but that has been true since the 1600s. If we have problems it is perhaps because the United States is highly developed and cannot perhaps burgeon quite as fast relatively as the rest of the world, or because something other than the burgeoning rate has been changing.

What seems to have happened as a decisive change in science is that by the last half of the eighteenth century it broke through two barriers of absolute size: the sheer magnitude of both the cumulative and rate of growth of papers being published. In rapid succession one finds that Natural Philosophy splits into an ever-increasing series of subdisciplines, such as physics and chemistry. Then the fragmentation and impossible bulk of what is known leads to encyclopedias, first in general, then in specialized scientific areas. Then to cope with the increased flood come the first abstract journals, publishing summaries of all that has been published this year, then this month, then this week. In each of the major compartments into which science has been divided.

The remedies and palliative measures introduced by the beginning of the nineteenth century seem to have been remarkably effective. All have prospered, growing exponentially in visually perfect pace with the journals and their papers which were enabled thereby to continue their expansion unchecked through this new barrier. During all of the nineteenth century and half of the twentieth we have seen the steady growth of the primary literature and the secondary devices for handling it in a comprehensive and organic unity. The burgeoning has been frightening and almost
unmanageable at all times but the whole apparatus has held together without radical renovation through cycle after cycle of the professionalization of science and technology, and the many orders of magnitude increases in the size of manpower, facilities, and financial costs.

Successive increases by a factor of 10 each decade or so have taken us through a factor of 1000 in the last century or so since the system was last overhauled. If this is true it means that what we are going through now is not just an evolution and a perfection or even a patching up of the secondary system but a dramatic and revolutionary reworking of the entire primary and secondary apparatus of scientific and technical information. Most experts agree that the International Information Industry will continue for at least the next half century or so to grow unchecked. The pay-off of science and technology is too great to leave undone anything that might be done. Even if the old established countries tire as there is a high a fraction of their manpower and money is devoted to those ends, rather than to other competing priorities, there are still many countries and vast reserves of manpower that have only just begun their scientific and technical development.

We are faced then with the fact that scientific and technical information will almost certainly continue to grow at its usual exponential rate on the world scale for our generation and the next at least, but that the older established countries and those that have developed the most are sucking the bottom of the barrel in manpower, money, and general effort in organization to keep up with the burgeoning. Again it is a matter of absolute size that creates the barrier. Even if the greatest scientific countries slacken their pace the race will go on. As Louis MacNeice has it:

The glass is falling hour by hour,
The glass will fall for ever.
But if you break the bloody glass,
You won't hold up the weather.

It is in this context that we must now examine the present set of crises to try to perceive the directions of probable change. We must look for hints of the new processes that can be engineered into providing the radical change that must be invoked rather than continuing old palliatives. We must also remember that we are dealing with an international scenario where the balance of national powers is likely to be changed quite drastically and where the needs of the most developed countries are increased as their resources decrease.

The most fundamental change I see is that the time parameter of growth of information has steadily dropped to the point where it has broken through to quite a new level. Since World War II there have been large improvements of old methods and inventions of new ones to keep up with the ever-increasing speed of communication between those at the research front. Traditional journals have been augmented by rapid publication letter periodicals which have taken on a life and a function of their own that transcends already their original function as merely "preliminary" publica-
to help each separately and in relation to each other. Our present practice seems like using a tool file of the New York Times as a history book; it would be attractive but for most purposes it is unmanageable. Perhaps worse, it would be like trying to publish the New York Times under the constraint that each issue serves as the next section of a loose-leaf permanent history text. We really want to know more about many things than we can even hope to be incorporated into the received story of the nation. I choose the analogy deliberately, for as far as I can see, what we are moving toward in the communication function in scientific and technical information is a newspaper type that parallels the Wall Street Journal and the Financial Times. The most rapidly communicative journals have moved from monthly to weekly, and I suspect that they will wish to go daily—for highly speculative or news one already uses the ordinary newspapers for scientific items unless the author is known and "proper" archival publication is jealously conserved. Presumably one could already use the accepted technologies of automated production at several printing centers, just as easy with satellite transmission on an international basis as it is now across a single continent. On a weekly basis and perhaps even on a daily one I see no reason in the competitive cost of alternative services why the newspaper format could not be produced in Russian and Japanese as well as any other language, and above the English that accounts for about half of the world's scientific and technical information.

Of course such a communication device would be a newspaper only in format and the fact that you throw it away or recycle it each day. The content would not be scientific and technical news stories quite as much as the analog of the stock market prices which no one makes those other newspapers essential. Whatever we do in scientific and technical communication we shall need these monitoring devices of the massive abstract journals—Chemical Abstracts, Physics Abstracts, Index Medicus, Mathematical Reviews, and all the current awareness tools such as Current Contents, the Citation Index, Index of Chemical Compounds, and so on. We shall also need more and more of the "quick" journals with their letter form of publication.

I believe that if one were to put all this mix together in a barrel, perhaps cutting out some of the more obviously overlapping nuclei and divide it all into a daily dose it would go into a format the same size and shape as the Wall Street Journal with enough room left over for the newer parts of the journals Science, Nature, letter, and the New Scientist and sufficient space for advertising. In the capitalist countries only to make it no more unencumbered than the present journal services—only a brave few of which are commercial and survive without heavy subsidy. I am not quite so starry-eyed as to imagine that anyone will design and deliver to us such a complete package, nor do I believe that the intertwined forces of present services will readily relinquish their holdings to any alternative. I do suppose, however, that this is where we are probably leading, willy-nilly, and that we might make transitions easier if we took step by step actions that suited rather than thwarted the process.
search result in bibliometrics which I should like now to explain. Bibliometrics sound as if it means some sort of book-counting routine indulged in by librarians to tell them how many catalogues they need to service a flow of readers. It probably includes that sort of artificial art, but it has become rather sophisticated of late and in this respect work at least it seems to me that it has produced a result of the deepest philosophical importance as well as just the thing needed to pull a practical rabbit out of this hat.

I am here today because the main work in establishing this result has been done by Prof. J. Bevan Griffith of the Graduate Library School here at Drexel and by Dr. Henry Small of the Institute for Scientific Information also here in Philadelphia. What they have done is to look, for the first time empirically, at the natural structure that is packed into the world corpus of scientific papers as they are laid down by the daily accumulations. I must explain why this is important. We used to hope that the computer would come to our aid by some sort of magic capacity to index everything perfectly forwards, backwards, sideways, and upside down and enable us to find all that good information that lay chaotically in all our libraries. As with the hopes for automatic translation by computer the results have been disappointing, and we have discovered a whole difficulty of which we were ignorant, rather than a practical and perfectible technique.

There exist some special types of scientific data which may be almost perfectly sorted into a series of pigeonholes because some natural and complete classification scheme occurs in that particular aspect of the universe that is being considered. Such data are called taxonomic, since the paradigm is the unmissable taxomenclature that was devised for the biological genera and species of botany and zoology. A similarly precise set of pigeonholes covers all the atomic nuclei, and one of the greatest information science achievements of recent decades has been the invention and perfection of the elaborate taxonomic scheme which now can be used to classify unambiguously every one of the many million different organic chemical molecules, no matter how great their complexity.

When a set of scientific papers can be described for all working purposes by such a taxonomic system we can muse thereby perfect indexing. Of course, there remain huge difficulties of trying to reconcile results expressed in different units and with techniques that prove incompatible, so that the total information can seldom be integrated automatically into anything like a perfect computerized data bank, but the basic problem of organizing the papers in tractable in that sort of situation. It seems hopeful from this that the most numerous of all classes of papers, those reporting the biological effects of large organic molecules, might be handled in this way and removed from the system which they tend to dominate by their special problems. In all such cases one should try to institute an entirely separate machinery for primary publication and secondary handling and encourage authors of papers to write for this system rather than in the more free and general way that is possible outside the taxonomic constraints.

Most reviews of science are not blessed with the perfection of a taxonomic classification for the new things they wish to report. Even a bird-watcher, normally a very taxonomic information gatherer, may sometimes wish to report data that pertain not to any particular species of bird but about hirons in general, or he might have data that should be classified so that it might be found by a meteorologist rather than another bird-watcher. In this case our papers are not taxonomic, and it becomes clearer daily that we can never expect even the cleverest computer supplied with the most cunning schemes of indexes and descriptors to give us anything like the powers of recall and of relevance needed by workers at the research front. We even have good reasons for supposing on the basis of information theory that this is one of the fundamental and powerful principles of incompentence built into nature, like Heisenberg's Uncertainty Principle or the speed of light limitation in Relativity.

What Griffith and Small have done is to use the Science Citation Index computer program to get the general pattern of how papers are related to each other to a greater or smaller degree by citing each other. We have known for a long time that something like this should be possible but the difficulty is that the system is very noisy not only because of errors but also because there is much citation that does not follow any pattern but is smeared out all over the network of papers because we use citation for so many purposes and above the linking of papers that bear substantive relation to each other.

The actual trick they have used is very ingenious, counting co-citations with suitable thresholds of intensity, but the point is that it gives good clear orderly data for the first time it works. The spectacular result is that the universe of recent atomic of information are arranged in separate molecular clusters. Papers hang together naturally in bunches, so that each paper in the bunch is related strongly to all the others in the same bunch and only paper weakly to any in neighboring bunches. Not only can one detect the existence of the individual bunches but the relative place of each atom in the molecule can be found, and the arrangement of the molecules relative to each other can also be determined. The work is still in its experimental stage and much remains to be done, but it looks as if it only tells us much more about the nature of knowledge but it also gives the crucial clue on how to cope with it after the frustrating of indexation.

Fortunately for us the universe of scientific and technical information is not a continuum with every subject bearing upon every other in an indivisible whole. The usual major divisions we have now, Organic Chemistry, Solid State Physics, Metallography, Cosmology, are all much bigger than any natural molecule and may simply be the debris from a once single molecule that has grown and split many times over through history. The actual clusters become obviously identified when one looks through the names of the individual atoms of papers in them. They correspond to subjects like: mitochondria superconductivity paramagnetic shift reagents Australia antigen solid state critical phenomena. In general they are exactly the sort of thing answered when you ask a re-
search scientist what specifically he is working on. Doubtless these molecules change with time, evolve, and alter the words used to describe the same team of people as it moves on. The nice thing is that we know now how to keep track of the changes and one could even hopefully produce a great Operations Room wall map for world science that charted the new territory of information as it was won and showed with flashing lights and colored markers where the action was and from which laboratories in which countries, which research grants, and which key people.

For the present purpose all I need is the knowledge that these molecules of atomic information are the products of the so-called Invisible Colleges of people who live in a sort of nutrient fluid supplied almost entirely by each other's work. It is this unique subfields that should each be served by their proper journal. Physics or Chemistry or Mathematics is far too large and unrealistic as an entity except perhaps in the professional social structure of university departments, although each could reasonably be dissected into its component clusters as autonomous sections.

My proposition then is that we use a refined operational version of the Griffith Small process to take scientific and technical nomenclature information and split it into bite size chunks. Each subfield, as monitored in its evolution is known to correspond to a rather stable but growing core of key workers in its invisible college with a large floating population of lesser researchers, mostly at the formative stages of their careers. Let us tailor the primary journals to each subfield separately, trying always to see if an international high status journal can be generated and maintained by such a population of probably not more than about a thousand key people all over the world. Rather less than a thousand, perhaps only a few hundred such journals could probably cover and control the whole of current literature.

Of course we would still have the residual problems, by no means trivial, of authoring such material into textbooks and reviews, but the old idea of "divide and conquer" makes the problem seem to me to be far from insurmountable. The same constantly changing but constantly monitored classification scheme into the new subfields could be used to divide SciTech News into appropriate sections and incidentally the new operations room wall map would give instant alert on the occasion of breakthroughs. I think that again we have here a plausible objective rather than an ideal, but I hope by now I have given an outline to show that we may look with hope rather than despair at the needs of society on the brink of this new revolution in scientific and technical information.

THE RESPONSIBILITIES OF THE UNIVERSITIES IN THE ENVIRONMENTAL CRISIS

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INTRODUCTION

The role of the universities in the environmental crisis is very important and vitally necessary for a solution. The responsibilities of the universities fall into two categories: education and research. The education role is one of assimilating knowledge from the many different areas and integrating it to arrive at an overall conclusion. The research role is to undertake research projects to fill in the blanks in our information.

THE RESEARCH RESPONSIBILITY

It is traditional that breakthrough discoveries generally are made in universities. Thus it was that Dr. Haagen-Smit discovered the photochemical nature of what we know as smog some 20 years ago at the California Institute of Technology. Dr. Philip Leighton of Stanford and Dr. James Pits of University of California, Riverside, contributed substantially to this enlightenment. Out of the understanding obtained came the rules for auto exhaust which the Environmental Protection Agency is now enforcing under the Clean Air Act. Detroit, for reasons not clear, did not understand the importance of air pollution and did not lead in the discovery of its ultimate cause. The California Air Resources Board a few years ago managed to persuade the Governor of California to award some $10 million for research on air pollution to fill in the gaps, for Dr. Haagen-Smit's picture was not totally complete. For instance, we still do not know, unless it has been recently discovered, the nature of the particulate matter which obscures our view. The Haagen-Smit theory said or implied that the particulate matter had nothing to do with the eye irritants, so a team was put together of people from the universities working with the industrial laboratory of North American Rockwell Science Center in Canoga Park, California, Dr. Whithby of the University of Minnesota, and others collaborating to attack this basic fundamental question, "Where does the particulate haze arise?"

Another example is the matter of power transmission. This utilization problem apparently can be solved only by the discovery of new superconductors of high enough transition temperature and adequate physical strength characteristics. This work is being led by Dr. Boyd Matthies of the University of California, San Diego, who is also industrial consultant to Bell Telephone Laboratories and the Los Alamos Scientific Laboratory. It is fair to say that of the people working on this vital problem, he and one
or two others have lead the attack in the past. So the responsibilities of the universities to make breakthrough discoveries remains unchallenged.

There is something about the atmosphere and the fierce competition among the graduate students and young faculty in universities which facilitates finding the answers and solutions to problems. We cannot ever know how this works. It is one of the two predominant sublevels of human behavior. Certain industrial laboratories have managed to capture some of this atmosphere. The General Electric Laboratory under Irving Langmuir, Stinner, and Coolidge who laid the basis for the giant company's present day businesses, the Bell Telephone Laboratories with their unexcelled record of performance, some of the drug company laboratories, and one or two of the chemical company laboratories such as duPont's Jackson Laboratory all serve to prove the rule by being the exceptions. Such successful organizations are needed desperately to overcome environmental research projects in the academic atmosphere. This is very important for the basic procedure is essential to our getting on with the energy and environment solutions, and it is necessary to make the directors and administrators of research and development funds realize this great truth.

Our principal difficulty in research and development in this period is not lack of financial support but prior administration. Here are a few facts:

1. People differ by orders of magnitude in ability and it is a very rare research director who realizes this simple fact. Science is no more subject to democratic rule that are the arts.

2. Truly difficult breakthrough problems can be solved only by the ablest people, although many are employed. The best people must somehow be interested and active and given their head.

3. The fundamental breakthrough work usually is not expensive relatively, for there are so few people in the top categories.

4. Large sums are spent in cut and try figuring together in the absence of a full basic understanding. This work is absolutely essential and should not be frowned upon or neglected, but where major breakthroughs are made, a development phase must be evolved, in which dozens of relatively unimportant but essential questions must be answered for the overall application to be made. This process is called development and consumes 95% of the total outlay.

5. In every cloud there is silver lining. The one essential thing that must be admitted by all, the single silver lining that is certain to come to us is that the great basic innovations are a habit of mind, not just discovery. A Fermi is not a Henry Ford and vice versa, although the Fermi's sometimes think themselves as great development engineers.

The competent administrator must realize and hold these four basic facts. Among the curios of people is a good research and development administrator, and they sometimes are the geniuses themselves. Passing by the living to avoid hurting feelings, I name a few: Gilbert Lewis, the chemist at Berkeley; Ernest Lawrence, the physicist at Berkeley; and Arthur Compton, the physicist at Chicago. Please note that all three were at universities.

Usually the good administrators are not of the genius category. I shall

hand this list with General Leslie Groves who was in charge of the Manhattan District.

The superconductor which will make the transmission of electric power over long distances economical and possible, the ultimate understanding of the nature of the semiconductors, the sharp effect of the earthquake and the particle line, the question of how much NO is to be tolerated, the question of sulfur dioxide being emitted by brown coal and tobacco, and the question of chronic low level hazards to health will require breakthrough solutions and, therefore, should be attacked in a fundamental manner. We have hundreds of thousands each year on problems which revolve to these broad questions but are not aimed at the problem as a whole.

We need a kind of environmental research which does attack the problem as a whole, a kind of understanding of the multifaceted nature of most problems, and an urging to work on a group of disciplines all bearing on a single central question.

Let us examine one more example. Coal is certainly to be consumed in large and larger volume as our crude oil supplies dwindle, and this involves many matters—from mining methods to chemical processing for gasification and liquefaction—but are the subjects of extensive research and developments in the industrial and government laboratories. But, at the same time, there are fundamental questions urgently needing breakthrough solutions. One of these is the application of catalysis to the processing of coal. Heterogeneous catalysis is a very mature field interested almost exclusively to workers in industry who, by the nature of their employment, have not had the freedom to attack the fundamental aspects. Thus it is a field based very poorly on fundamental law and is bidnder principally by recipes and empirical formulations and so it is not possible for anyone to predict ahead of time the detailed behavior of any given system. This is the face of the fact that heterogeneous catalysis is the heart of the chemical processing used with such remarkable efficiency to convert crude oil into useful products. There has been relatively little in the way of catalysis work done on coal in the last 30 years. The Germans during World War II developed the so-called Fischer-Tropsch process which enabled them to power their war machine from coal but since World War II the work on the Fischer-Tropsch process for conversion of producer gas (a mixture of carbon monoxide and hydrogen and water vapor and nitrogen obtained by heating coal, steam, and air) into higher hydrocarbons has been minimal. I have been involved in recent months in an effort to put a program on the use of coal synthesis together and have come face to face again with this ancient adage that if you have a tough problem regarding breakthrough answers, you must, in general, involve the universities for the basic solutions are far more likely to come from graduate students working with gifted professors than from any other sources. The new idea essential to dramatic breakthroughs in coal processing remain to be discovered. For example, one of the main items in our research proposal is the direct conversion of coal powder into methane and CO2 using steam. Strangely
enough, this reaction is thermodynamically permissible and, of course, would constitute a fantastic new source of methane which is the mainstay of clean fossil fuel power plants and of ammonia for fertilizer and nitric acid. Our shortage of natural gas has become dramatically obvious and has led to tremendous efforts, but the prospect of processing coal to natural gas has been neglected. Coal contains objectionable amounts of sulfur and many of the known catalysts are sulfur sensitive, so it is a fantastic challenge which at the present time can only be approached empirically by trying various candidates and by trying to understand why they behave in the way they do. The real answer is to build a fundamental theory which faces these problems and attracts the best graduate students in chemistry and chemical engineering to work in the field of heterogeneous catalysis. This should help greatly in oil refining as well for we are desperately dependent at the moment on foreign supplies of platinum and the new solar powered oxidation catalyst probably will be platinum, further aggravating the balance of payments question and our dependence on foreign control by South Africa and the USSR. Years ago, before platinum came into the oil refinery, base metal oxides were used with considerable success. Platinum, however, has proved to be superior so far to the base metal oxides as they are known so they largely have been phased out. These challenges are cosmetically interesting, and it is clear that the solutions will require much more fundamental knowledge of the two dimensional reaction site which we call a solid surface.

The role of heterogeneous catalysis in nature may be important as well. There is a school of thought at the University of Chicago, headed by Professor Edward Anders, who believe that the organic compounds found in meteorites were produced by Fischer-Tropsch reactions. Hydrogen and carbon monoxide are not unlikely constituents of the primordial nebula. Other theories exist and my personal view is that it is more likely that the major part was due to the intense radiactivity which ionized the gases and led to the production of all the organic chemicals by plasma chemical processes. In the laboratory we have shown that such systems produce polymeric compounds, even amino acids, in good yields. Aside from the question of whether Dr. Anders is correct or not, it certainly is so that the minerals and metals in meteorites have catalytic properties. A screening program in my laboratory has shown that all transition elements, those elements beginning with scandium and ending with zinc in the first row and going down, from yttrium to uranium and from lanthanum to mercury in the second and third rows, and their compounds that have been tested, are catalytically active to some degree and in fact that elements like potassium and calcium which are neighboring also possess some catalytic activity. There is a most remarkable difference between platinum and gold and nickel and copper in their abilities to catalyze hydrogenation or dehydrogenation reactions. Zinc, cadmium, and mercury are very nearly inactive although not entirely so. There is a remarkable example; molten zinc chloride has the property of dissolving coal and in this dissolved state, hydrogenation can be accomplished simply by exposing it to high pressure.

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hydrogen. This is one of the processes being developed for direct hydrogenation of coal. The transition elements are the most reactive catalysts known. The elements neighboring to the transition element block in the periodic table possess some activity, and there is a slight possibility that silicon has found a way to have some transition element character even though it is far removed. We know, for example, that phosphorus and sulfur form more than four bonds and it is thought that this may involve d orbitals which are stabilized in the particular molecular or surface site. Acidic sites on silicates can be made by introducing aluminum oxide into the silicate structure. The fourth position around aluminum, which because of lattice structure needs to be filled, can develop a strong enough solidity to dismember hydrocarbons, removing hydrocarbons and leaving a positive ion called a carbonium ion absorbed on the surface. This leads to isomerization of hydrocarbons, an important matter in oil refining for the reason that isomeric hydrocarbons have a far better octane number, burn more slowly and therefore, do not knock in the cylinder. Professor Michel Boudart of Stanford has shown that tungsten carbide in many respects resembles platinum.

It is completely clear to the workers in the field that enormous breakthroughs in understanding heterogeneous catalysis and therefore in its usefulness are possible and hopefully imminent. The universities should step forward and encourage fundamental research on heterogeneous catalysis. The funding agencies in Washington should do so also, and the leading professors should turn their own attention towards this problem in energy and environmental research which is so important.

These examples of various environmental problems needing breakthrough research are a small fraction of those needing attention as anyone who has attempted to write an impact statement must realize. The depth of our ignorance is known only to the environmental experts. Most people suppose that somehow or other we do know the effects of low intensity chronic insults. However, the opposite is true. No one knows whether the radiation we naturally receive from cosmic rays, uranium, thorium, potassium, and radon in our surroundings and in our own bodies is harmful. Because of this and our general ignorance of these difficult matters, long delays in the installation of atomic power plants can occur. Ignorance is very expensive and we cannot afford to remain ignorant of such effects. It is not clear how one can do research on some of these problems but that in itself is a challenging problem. Most urgently facing us are fields ranging from new drugs and new food additives to food irradiation preservation to increase the food supply substantially; all of these matters urgently need research on the effects of chronic exposure to radiation. If these data could be made available, they would have a most important bearing on the speed with which innovative plants and processes could be brought to life.

In the years I served on the Atomic Energy Commission, I nearly launched a national program of pairing radiation detectors on ordinary people to keep records on the total dose received. We readily calculated that it would take about half of the people in the country and a total lifetime experience...
before we could determine answers to such questions as whether cancer is due to radiation. This project would be quite feasible now because the necessary sensitivity in cheap unobtrusive dose meters (a small piece of plastic about one-fourth the size of a dime and about as thick) could serve the purpose. Perhaps some such attack should be examined again in an attempt to get at the facts of the radiation exposure hazard.

We need to think about organized research programs in the universities which are multidisciplinary in nature. Several such organizations have arisen and are established in various universities in the United States. For example, UCLA, the University of Arizona, the John Muir Society, and Dartmouth College joined together in a project financed by the National Science Foundation to study the effects Lake Powell is having on the environment in the great area surrounding it. A multidisciplinary and continuous watch on an observational program faithfully reported is underway on this important problem. More arrangements of this type are needed.

The Institute of Geophysics and Planetary Physics at the University of California has branches on three different campuses, is affiliated with three other campuses, and is in a position to attack environmental research problems of a multidisciplinary nature by utilizing the skills of the various campuses. As Director of this Institute, I am encouraging strongly that proposals of this sort be made.

There is plenty of work for scientists and engineers in the university in the field of the energy and environmental crisis in every department. What we need to do is put the packages together better so the student is more attracted to these areas.

The Responsibilities of the Universities in Education in Environmental Problems

The Environmental Doctor

A long career, much of it spent in public service, has taught me a lesson which I think applies to our present situation and dilemma: the findings as to fact and consequences must be separated from policy-making decisions because it is necessary to gain objectivity. If one feels ill, one does not do his own research, investigation and diagnosis. Nor does one conduct a poll for the determination of cure. One calls a doctor of medicine to assess the situation and to advise on a course of action.

Why is the M.D. called? What is it that he does that no one else can do or does do? He takes the broad overview of the health of the individual, consults specialists in the various pertinent fields of the health sciences and using all of the laboratory tests results and the advice of the specialists, gives a diagnosis and a recommended course of action. The specialist cannot do this. Neither can the untrained individual either singly or en masse via the ballot.

The medical doctor's role is that of the expert, objective weigher of the evidence and advice of the specialists. He does not usually make decisions, but recommends and counsels.
and in order to do this he must be educated in all of the aspects of the environment.

Let us begin the definition of this new profession by excluding functions it does not include. It does not include sociology and the political aspects of human behavior, or public health, because these areas are covered by existing professions and it is necessary to limit the scope. Of course, it may be necessary to include courses in general medicine and public health as well as in the social sciences and in law in training the Environment Doctor so he can properly interact and cooperate with his fellow professionals and the governmental and industrial officials who will be hiring him at a consultant.

Who will want his services? I would say nearly every judge hearing a case involving the environment, nearly every government official faced with decisions involving the environment either directly or indirectly, nearly every company executive deciding on plant locations and new product uses, and finally nearly every lawmaker working on legislation involving any aspect of the environment.

I hope he will be a licensed professional with a right to practice and serve all customers under his license. He may just hang on his shingle or he may be fully employed by some agency or industry, but he will in all cases preserve his objective integrity, just as medical doctors and lawyers do now.

He will be trained in a special graduate school course extending over some 5 years beyond the bachelor's degree, at the end of which time he will be licensed by the state and will enter practice. His course of study will consist of 3 years of classics in graduate school and 2 years of supervised field practice in close analogy to the year of internship and residency for the M.D. degree.

The first experimental trial is underway at UCLA in a joint effort by the School of Engineering and the Institute of Geophysics and Planetary Physics and several other departments. The degree is administered by an interdisciplinary committee. In this way a serious trial is underway.

There is hardly a single new idea in this proposal and yet in total it leads to a new course of action, a new profession, a new school at the graduate level, a new dedication, and a new use of technology and technological knowledge and will succeed in the universities. This may help free men to live with the increased population which seems to be inevitable. At least it should help him to make better use of his resources and opportunities.

I have here some pamphlet texts in prospective students in the program. We are now in the happy state of finding that our original predictions are proving correct. The internship has worked exceedingly well. Our students have many every choice of industries and government agencies. One student has had two offers from federal agencies in Washington, D.C. We have 30 students in the program and we have raised about $100,000 so far to finance the program. In order to complete the experimental period of 5 to 6 years, we will need approximately an additional million dollars and we have hopes of succeeding in raising this money. The experiment is one of international significance. It appears to be that there is a great demand for professionals to prepare environmental impact statements, therefore, there may well be the need to have dozens of schools in the country and abroad training Environment Doctors.

We have not really faced the question of licensing as yet, but we still in the next year or so, decide whether to create a new professional society and try to have laws passed restricting impact statement writing to those licensed in the new profession. Of course, we would not be able to preserve the interests of licensing to UCLA graduates only, but the state board examinations would be tailored to the kind of training they receive and we expect this many broadly experienced people would have little problem in passing the state board and being licensed.

General Environmental Education

Not all college graduates should be Environment Doctors. However, some training should be given to the general undergraduates and to the adults in the surrounding community on the great questions in his energy and environmental ways we face today. Many schools, universities, and colleges do not, but I think we need a few of us and it should be done in a more regular basis. On atomic power alone at UCLA, only the specialists are trained, yet atomic power is one of the most vital hopes for our future and ignorance about it is causing tremendous difficulties and delays. Universities should teach courses in which atomic power is discussed, described, and considered carefully. In the same course might be included oil power, coal power, natural gas power, water power, geothermal power, solar power, and windmill power, i.e., a whole course on the generation of electrical power. Another course might be the air pollution problem in all its manifestations, including such hidden subsidies as the platinum supply problem.

The food crisis we are heading into appears to be much more serious than most people realize. People should be told about this general subject so that they will not be surprised to learn that one pound of food consumes five pounds equivalent of hydrogen fuel and that meat is a wasteful way of acquiring protein. These basic facts which the professionals know are not known to the average layman. A large part of our problem is the ignorance people have about such matters. Sometimes one suspects that it is carried into very high places.

Environment hazards should be a subject of a general course. In fact, the whole conglomeration of problems in energy and environment deserve treatment. Perhaps one could manage by giving a special course on energy and the environment in several different departments in the university. How would be to have a course in the history of energy and environment, the sociology of energy and the environment, or the chemistry of energy and the environment. Perhaps it would be best to have an interdisciplinary curriculum, somewhat similar to the Environment Doctor program in the graduate school, in the undergraduate school instead of training the professionals but as giving general information to the undergraduates and to the members of the surrounding community. Perhaps this could be
a noncredit course. In any event, the universities have a large responsibility to teach people about the new technology and the environmental issues.

When I was on the Atomic Energy Commission, we conducted night school for the Washington Press Corps on atomic matters. The reporters attended faithfully and we received compliments and thanks. Even a subject as technical as atomic energy can be broken down and explained so that a nontechnical person can get the gist. People should be told about the facts of our food supply before the crisis appears. There should be series of articles in the newspapers and courses in the schools, colleges, and universities, not to scare people but to warn them and make them aware of a worldwide catastrophe.

CONCLUSION

I am pleased to have been invited to participate in this Conference and those of you who may be interested in our UCLA program on the Environment, I do not need to visit us. I want to thank the National Science Foundation and the Schlage Family Charitable Trust for the bulk of the $800-000 that has supported our program to date.

D. World Population and Environment

WORLD PRIORITY NUMBER ONE: POPULATION AND SUBSISTENCE

René Dumont
Institut National Agronomique
Paris, France

In October 1962, I published Faits Start in Africa; in June 1966, The Hungry Future.* I have been severely criticized for a long time. My first paper on French Indochina, written in 1930, told of the danger of a 1 percent yearly increase in Tonkinese rural population, now North Vietnam.

I was attacked strongly from the right and the left, mainly Catholic and Communist, as a neo-Malthusian. Since that time, world population has doubled.

In 1970, everybody was talking about "green revolution," Mexican wheat by Rossbaugh, and miracle rice from IRRI Philippines, from Los Ballos near Manila. Yes, we do have now a much higher wheat harvest in Pakistan and India, because Punjabi and Haryana are irrigated and in the hands of good farmers.

However, we are still waiting for a real "rice revolution." Less than 30 percent of India's arable land is irrigated, compared to more than 70 percent in China. The average foodgrains obtained during the years 1970-1973 in India is about 104 million tons yearly, and probably 120 million are obtained from dry matter of tubers, which are included in Chinese "basic foods" statistics. In China, for the same period, the crops harvested are just double the Indian figure, about 243 million metric tons. However, India has more than half the number of Chinese: 570 million people, compared to 730 million in China. Per capita, this means 210 kg of food in India, compared to 330 in China, a ratio of less than 2:3:1. In addition, there is much more equal distribution in China, while the situation of the poor in many parts of India is continually dramatic (I was in Bihar in October 1973). A general austerity seems much more acceptable in China. The China-India competition will be soon unavoidable, with many political implications.

In all the developing countries, after a slight improvement during 1967-1970, the amount of food cultivated per capita is now decreasing. A. Bocarme, general director of FAO in Rome, advised us, 18 months ago: "Except for a miracle, the second decade of development is already lost, as far as food and agricultural production is concerned." We have many "miracle races," but no "miracle harvest." With the new varieties, some rich rural people

become richer in India and Pakistan but many poor become poorer, and unemployment and underemployment figures are still increasing. They have now become more pressing. Unemployment and underemployment have now reached the same order of priority as underproduction.

There are so many useful things to do in every village of Bangladesh, such as to improve water control (irrigation, drainage, floods control), and there are so many people without any work for at least 3 or 4 and even 6 months every year! The landless and the too small farmers, who represent 40 to 50 percent of the rural population, are in such a situation. How can a link be found between the workers and work? Land reform, land taxes, and many such solutions could be found, if a political will were to exist, but the urban privileged minority have the political power, while at the village level the moneylenders and landlords are their main support. Democracy and socialism are still the official targets of "Social Bangla." The small farmer can generally neither receive credit at a reasonable rate nor have the basic necessary knowledge to realize the green revolution. The Cornell experiment has not reached a significant part of the rural population.

Everywhere in developing countries, except for a few special cases (like Taiwan, Mexico, Ivory Coast), the rate of growth in agriculture is too low. To realize the more urgent "rural leap forward" badly needed, some basic political changes are also badly needed. The conventional type of education tends to push the farmers' sons out of agriculture: in the first instance it made civil servants and clerks, but now it really turns out people to be unemployed, and who are often unemployable.

There is a great difficulty in increasing increased agricultural production, and it will require serious efforts in reducing the growing birth rate. After 20 years of family planning, only 13 percent of the 100 million of Indian fertile couples use contraceptive methods effectively. United Nations demographers are now predicting 6.5 or 7 billion people on our "small" planet for the year 2000, and a "possibility" of stabilization at the level of about 12 billion people, around the year 2050. In that case, with two billion people, the agricultural and the demographic ones, we will have very soon a general and terrible famine, long before the end of the century. Please do not say this is impossible, because some famine is already among us, even if we do not like to speak about it.

Birth rate is linked with girls' general level of education. A functional literacy, which could be generalized quicker than conventional education, could take some time to reach a higher proportion of girls. In China, a political will coupled with pressure of public opinion at the village level allows a higher reduction of births among those of a similar income level in other developing countries.

Where it is more important to reduce the birth rate—in over-populated areas, such as in the Indian subcontinent, South Asia in general, Caribbean, etc., etc. Yes, but if the Club of Rome is right (and generally speaking, I agree that it is), the number one priority is to reduce the population which
The statement that the energy encased in food represents a very small and diminishing fraction of the energy consumed in fuel and electricity is frequently encountered. However, in most instances the food energy itself has been computed incorrectly. What measured on the basis of the calorie content within the food as eaten, food does in relative terms rate rather low in energy, particularly in developed countries. This is a misleading figure as it does not compute the calories expended in producing the animal products. Table I illustrates this.

The difference in calorie intake per capita per day between the United States and India is not, as generally assumed, 1310, but rather 9422 calories. This in itself reflects an awesome discrepancy which illuminates a much overlooked aspect of the food and people issue. It is not sufficient to count heads, not to add up calories in the food eaten. In any kind of valid comparison, the nutritional standard is a factor that must be considered in both these procedures of appraisal. In addition, this example illustrates how much less it takes to keep an East Indian eating than an American. Such data also open up entirely new vistas on basic economic relationships, such as personal income, salaries, and expenditures.

This paper exposes the scope of such comparisons by bringing into focus a far more comprehensive energy evaluation of daily food, which includes most of the calories required to raise food. Judged in such a manner, each human involved in the production of food or food in modern agriculture receives an input of energy which frequently surpasses the energy which crops capture through photosynthesis, a relationship which seriously questions the basic energy economy of such agriculture. Everyone knows that cars and airplanes are run by fuel, but how many realize that more than one-third of the human family maintain themselves through food gained by an extra input of fuel, mostly of fossil origin?

**HISTORY**

The direct input of such fuel into food production has indeed a very brief history. It really began in the 1840s when fuel-powered ships brought fertilizers (guano and later, bone meal) from South America to Europe, primarily to the United Kingdom. Coal was not used to power sailing vessels or food- and feed-carrying cargo trains until the latter part of the nineteenth century. After 1910 transportation vehicles relied almost exclusively on fossil fuels. Most agriculture functioned without the input of outside fuel until almost 1870 in Europe and 1900 in North America. The direct use of fuel in agriculture started with the manufacturing of fertilizers after 1922. The striking feature of these developments is the briefness of the period during which fossil fuels have operated behind the food scene. From being a novelty 130 years ago they have reached significant proportions only in the last half-century, becoming a true driving force after World War II.

As early as the mid-nineteenth century, however, researchers pointed out that most agricultural efforts to induce higher “artificial” yields of crops would inevitably involve considerable expenditure of energy, both in the manufacture and transport of fertilizers as well as in irrigation and the control of weeds. Irrigation costs (pumping up and out) need to be added.

**ONE-TIME TRICK**

One of the major happenings on the Western agricultural scene, largely in this century, was the substitution of the tractor for horses, mules, and oxen. Primarily this dispersed was new engines, which became directly or indirectly available for human feeding. In many countries this, in one single operation and within a relatively brief period of time, sparked agricultural production. It is however, far too little recognized that it constitutes a one-time trick, a reversal of which would have and will have profound repercussions. Some 400 to 500 million people around the world currently get daily food through this one single happening.

**TRACTORIZATION**

Fuel efficiency evaluated in mechanization, or more specifically tractorization, is something specific to this nation. It is almost unbelievable that in 1850 (two-thirds (65 percent) of all work on United States farms was performed through the muscle power of men and animals. As late as 1920, more than 20 million horsepower was provided by horses and mules (Table 2). Through tractors, 1.13 X 10^8 kcal or 80 liters of gasoline are burned per capita in the United States (Table 3).

Electricity is used in considerable amounts on United States farms, increasing 5-fold between 1940 and 1956. In 1959 the generation of such electricity for farms through electric power plants required around 0.5 million kcal for each United States citizen.

---

*Table 1: Calories in Food Intake, kcal per person per day (1930)*

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Calories</th>
<th>Plant Calories</th>
<th>Animal Calories</th>
<th>Feed Calories</th>
<th>Total Energy Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>3,300</td>
<td>1,189</td>
<td>1,411</td>
<td>10,017</td>
<td>31,986</td>
</tr>
<tr>
<td>India</td>
<td>1,900</td>
<td>1,871</td>
<td>107</td>
<td>766</td>
<td>2,634</td>
</tr>
<tr>
<td>Difference</td>
<td>1,400</td>
<td></td>
<td></td>
<td></td>
<td>2952</td>
</tr>
</tbody>
</table>

*Paper originally given at a symposium on Energy and Society, December 1931, called by the Swedish Academy of Science.*
The cultivation of each acre of land currently requires a direct energy input of $2.52 \times 10^6$ kcal, or formulated another way, the feeding of each American requires an extra fuel input equivalent of 660 liters of gasoline per year. This constitutes twice as much energy as the amount actually contained in the average food intake. Yet this figure includes neither the energy expended in making the farm equipment, nor the critical costs of storing and marketing the food. The energy required to make the seed, rubber, paint, and other commodities necessary for this huge industry should also be added to the farm budget.

In such a broader context the relative standing of food energies as far more dominant. Although it remains true that in developed countries food is, in relative terms, on a descending scale, that trend is reversed when a more accurate energy accounting is introduced. Even the energy involved in the manufacture of fertilizers apparently boosts the energy base behind food, a factor which applies not only to developed countries, many of which import considerable amounts of fertilizers for plantation crops, such as sugar (Cuba, Reunion, Mauritius, Fiji), bananas (Ecuador, El Salvador), cotton (Egypt, Peru), and others. The figures in Table 4 are preliminary and limited to nitrogen. When broadened to all categories of fertilizers and taking into full account transportation, this commodity alone also in developed countries amounts to from 5 to 10 percent of total energy account.

**Table 2**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Tractors (hills)</th>
<th>Modern (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1930</td>
<td>5</td>
<td>4.4</td>
</tr>
<tr>
<td>1950</td>
<td>3</td>
<td>6.9</td>
</tr>
<tr>
<td>1980</td>
<td>115</td>
<td>4.6</td>
</tr>
<tr>
<td>1989</td>
<td>203</td>
<td>3.4</td>
</tr>
</tbody>
</table>

* Data from Reference 5.

**Table 3**

<table>
<thead>
<tr>
<th>Source</th>
<th>Calories/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractors</td>
<td>1.27</td>
</tr>
<tr>
<td>Fertilizers</td>
<td>0.94</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.22</td>
</tr>
<tr>
<td>Other uses</td>
<td>0.65</td>
</tr>
</tbody>
</table>

* See also Reference 6.

The Scenario

Prior to the use of machines and fuel in crop production about 16 cal (12-22) of digestible energy were realized for each caloric input. When machines were teamed with draft animals in traditional agriculture, the gain of cropping systems fell to between 3 and 6. As a rule, with increasing investments, the energy returns have been persistently declining after reaching increased outputs per hectare and per man-hour down to a ratio of 2 to 0.3. For a surprising number of modern cropping systems a 10- to 50-fold increase in the man-controlled energy input only doubles or triples the digestible energy. Substantial expenditures fail to produce corresponding increases in yields. The law of diminishing returns prevails.

Moving man's feeding from a clearly positive energy balance in close alliance with the running capture of sun energy via the green plants in pastures, crops, and forests to an imbalanced or even unequivocally negative energy balance and this time primarily by resorting to the bank accounts of trapped (solar) energy accumulated over thousands of years, constitutes a major upset in the condition of man and his relationships with Living Nature. There is basically nothing wrong in using bank accounts, but it is highly imprudent not to be aware of the big drawings and still more to fail to refill them.

**Table 4**

<table>
<thead>
<tr>
<th>Source</th>
<th>Energy Value (Btu/acre/yr)</th>
<th>Energy Value (Cal/acre/yr)</th>
<th>NEE percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>11,144</td>
<td>640</td>
<td>5.7</td>
</tr>
<tr>
<td>USSR</td>
<td>4,446</td>
<td>381</td>
<td>9.2</td>
</tr>
<tr>
<td>Poland</td>
<td>4,233</td>
<td>414</td>
<td>10.2</td>
</tr>
<tr>
<td>China</td>
<td>536</td>
<td>173</td>
<td>33</td>
</tr>
<tr>
<td>UAR (Egypt)</td>
<td>298</td>
<td>210</td>
<td>77</td>
</tr>
<tr>
<td>India</td>
<td>191</td>
<td>146</td>
<td>77</td>
</tr>
<tr>
<td>El Salvador</td>
<td>190</td>
<td>177</td>
<td>53</td>
</tr>
<tr>
<td>Mauritius</td>
<td>157</td>
<td>177</td>
<td>28</td>
</tr>
<tr>
<td>Indonesia</td>
<td>113</td>
<td>119</td>
<td>107</td>
</tr>
</tbody>
</table>

* 1 kcal = 0.105 kg coal equivalent.
spent on the farm but far away in manufacturing chemicals, building tract- 
ers, developing new varieties and new breeds, making fertilizers, long- 
distance hauling over oceans and across continents, and in maintaining big 
armies of scientists, extension agents, administrators, clerks, and other 
office personnel to hold the system together and make it flow. This study 
focuses attention on the driving force of man’s extra input of energy, 
which is by far the largest supplement to the prodigious free flow of sun 
ergy. Oil pipelines, refineries, supertankers, smelters, and gas and 
drum belong to this new indispensable infrastructure.

**The Marketing Bill.**

Urbanization has, however, added still another major cost item to the 
food bill. Processing and packaging are persistently demanding greater 
attention, as man has come a long way from the days when small cities and 
villages were easily served by adjacent farmlands. Transportation and 
marketing have become dominant, both in price structure and in energy 
demands.

As Table 5 indicates, we have evidently created a third sector which is 
consistently growing in pace with the congregation of humans. An un- 
expected consequence of the concomitant specialization of farming is that 
even farmers depend on the same vast delivery system. If projected on to 
the global scene, however, one can seriously question whether this model of 
operation is feasible in less developed countries. Can that world absorb itself 
and resource base implied in these trends? Equally valid is the 
query: Can we in the affluent world continue to burden our food accounts 
with these huge extra charges? When viewed in this manner, our 
freedom is precarious.

**In The Red**

Most surprising is, however, the fact that when all energy inputs on the 
far are added up, many a Western farmer is employing far more energy 
than his crops collect. This obviously becomes still more conspicuous in 
animal production. Many examples can be given to substantiate this kind 
of imbalance. For instance, soybean-producing Iowa farms are using up 
more fuel per bushel than the calories carried in the harvested soybeans; 
the amplitude according to various computations by this author is 2.35 to 
3.3 times.

**Table 5**

<table>
<thead>
<tr>
<th>Country</th>
<th>Private Fuel</th>
<th>Energy Cost on the Farm</th>
<th>Energy Units Purchased and Transformed</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>462</td>
<td>1015</td>
<td>652</td>
</tr>
<tr>
<td>Australia</td>
<td>650</td>
<td>1005**</td>
<td>652*</td>
</tr>
</tbody>
</table>

*Transporation accounts roughly half of this total.
† Calculated from Reference 3.
Corn has been researched in this regard and shows an energy input around half that of the crop. My calculations reach similar figures when judged as gross return. The energy returned is a low 0.20 X 10^4 kcal. This renders a failure ratio of 2.2 and 0.69, respectively.

The net result obviously would be higher for less corn were channelled via livestock. Many dairy farms are using 3 to 5 times more energy than could ever be raised through crops on the same acreage. In the United Kingdom the ratio is almost 18 liters of gasoline fuel for each kilogram of milk protein. This is in the region of 0.20 X 10^4 kcal. The homogeneous fat and carbohydrates that go with this protein are taken into account, the ratio drops to 14.5.

Whitling has cited as an example of similar energy inconsistencies, as each whaler brought home in oil only 2/3 to 3/4 of the total amount of fuel used by the ship. Besides oil, the whaler brought back gudlurhul trusses and meat, and it must be remembered that both milk and soybeans represent valuable protein sources. Nevertheless, men need to make himself acquainted with the total cost of his food bill, particularly since energy costs unquestioningly will mount in days to come and already are a key factor behind rising food prices.

If energy-intensive farming of the kind practiced in the United States, the United Kingdom, and parts of the Nordic countries were applied world-wide and were to give the present world population a corresponding nutritional standard, this would require some 55 to 40 percent of the total world energy account. This is completely beyond the realm of possibility and definitely calls for entirely new and different strategies in world food production.

The right kind of energy input

There is no doubt about the possibilities of enhancing organic production (1) by modifying the plant base (selection of crops and selection) and (2) by supplementing and complementing the availability of mineral plant nutrients (fertilizers); (3) by removing water restrictions (irrigation) or surplus (drainage); or (4) by protective harvesting and utilization (storage and processing). This latter constitutes removal of food from the ecological hazards of Nature's cycling precipitates via predators and competitors in the shape of microorganisms and pests that cause spoilage or disease. All these operations involve or imply an energy input by man into the basic flow of current sun energy but basically the removal of constraints. Whether the agricultural production dictated by the sun energy flow can be sustainably exceeded through direct energy stimulation is still very much an open question. Modern agriculture has developed with little concern or consideration for economizing with such energy inputs. It is thought-provoking that in large parts of Asia the return in food per unit input of energy is far higher than in Western systems.

**New Approaches**

An area of key significance in moving toward more energy balanced agricultural practices is a more effective marshalling of the soil microflora in nitrogen fixation and mineralization. Tillage practices need readjustment to these goals. More perennial crops may be another logical step. Such measures would further have the ecological advantage of counteracting the hazards of excessive use of fertilizers as well as of minimizing losses of minerals through leaching. A greater emphasis on nutritional aspects as a qualifying gauge of yield increases would move the matter of the C/N balance (the calorie-protein relationship) into the center position it deserves, supplanting the current overemphasis on efficiency of photosynthesis to frequently believed to be the "only source of food."

The urgent need of restoring a functioning urban ecosystem has been discussed in a special paper.

This ties in with a whole range of questions centering around nutrient disposal and sewage utilization. Regional and rural planning will be forced to look at the rapidly mounting energy costs in all links of the strained food chains.

**The Key Issue**

The global use of resources is currently growing at a far greater rate than population, the former doubling in 14 years as compared to 30 years for human numbers. As the world population doubles, industrial activities...
Corn has been researched in this regard and shows an energy input around half that of the crop. My calculations reach similar figures when judged as gross return, but drop below 1 when taking into account the net return as human food (Table 6).

The net return obviously would be higher if less corn were channelled via livestock. Many dairy farms are using 1 to 5 times more energy than could ever be raised through crops on the same acreage. In the United Kingdom the ratio is almost 18 liters of gasoline fuel for each kilogram of milk protein. This is a caloric ratio of 41. (172 X 10⁶ kcal of gasoline as against 4200 kcal of protein). If the concomitant fat and carbohydrates that go with this protein are taken into account, the ratio drops to 14.5.

Whaling, once hailed as an example of similar energy inconsistencies, as each whale brought home in oil only 3/4 to 5/6 of the total amount of fuel used by the ship. Besides oil, the whale brought back glandular treasures and meat, and it must be remembered that both milk and soybeans represent valuable protein sources. Nevertheless, man needs to make himself acquainted with the total cost of his food bill, particularly since energy costs unquestionably will mount in days to come and already are a key factor behind rising food prices.

If energy-intensive farming of the kind practiced in the United States, the United Kingdom, and parts of the Nordic countries were applied world-wide and were to give the present world population a corresponding nutritional standard, this would require some 33 to 40 percent of the total world energy account. This is completely beyond the realm of possibility and definitely calls for entirely new and different strategies in world food production.

### The Right Kind of Energy Input

There is no doubt about the possibilities of enhancing organic production by modifying the plant base (selection of crops and genetic engineering), by supplementing and complementing the availability of mineral plant nutrients (fertilizers), (3) by removing water restrictions (irrigation) or surplus (drainage), or (4) by protective harvesting and utilization (storage and processing). This latter constitutes a removal of food from the ecological hazards of nature's cycling processes via predators and competitors in the shape of microorganisms and pests that cause spoilage or disease. All these operations involve in principle an energy input by man into the basic flow of current sun energy but basically the removal of constraints. Whether the agricultural production dictated by the sun energy flow can be sustainably exceeded through direct energy subsidization is still very much an open question.

### New Approaches

An area of key significance in moving toward more energy-balanced agricultural practices is a more efficient marshaling of the soil microflora in nitrogen fixation and mineralization. Fertilizer-practice needs readjustment to these goals. More perennial crops may be another logical response. Such measures would further have the ecological advantage of countering the hazards of excessive use of fertilizers as well as of minimizing losses of minerals through leaching. A greater emphasis on nutritional aspects as a qualifying gauge of yield increases would move the matter of the C/N balance (the caloric-protein relationship) into the center position it deserves, supplanting the current overemphasis on efficiency of photosynthesis to frequently believed to be "the only source of food."

The urgent need of restoring a functioning urban ecosystem has been discussed in a special paper. This ties in with a whole range of questions centering around manure disposal and sewage utilisation. Regional and urban planning will be forced to look at the rapidly mounting energy costs in all links of the strained food chains.

### The Key Issue

The global use of resources is currently growing at a far greater rate than population; the former doubling in 14 years as compared to 30 years for human numbers. As the world population doubles, industrial activities...
quadrapled. Percent increases in such inputs as fertilizers, pesticides, and power exceed the corresponding gains in yield by 2 to 3 times. In other words, intensification of agriculture has to be achieved by taking entirely new approaches, reversing this present trend.

REFERENCE


THE WORLD FOOD CRISIS: PROJECTIONS, MODELS, AND PARADIGMS

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"The major problems of feeding the less developed world are seen to lie in political rather than physical limits." 1

INTRODUCTION

This paper is concerned with the global implications of recent work in the field of food/nutrition planning. The material specifically concerning nutrition has been drawn largely from the Study Seminar held at the Institute of Development Studies by Leonard Joy and Philip Payne, to whom we are much indebted.

We start with the intuitive realization that the world food situation is, in one sense, critical. As to the nature of the crisis, we identify two distinct explanatory/action paradigms which have been adopted by food/nutrition planners and by other professional writers in this field.

In Section II we examine and attempt to synthesize and draw some lessons from our discussion. In Section III we examine the interaction between these approaches and forecasting techniques which have been used to explore the future world food situation. Finally, in Section IV we advance a choice of forecasting techniques which we feel most appropriate to our synthesis of the rival approaches to the problem.

1. THE RIVAL PARADIGMS

A. The Aggregate Supply and Demand Approach

In the two decades following World War II the situation was generally seen by concerned international agencies was that some large fraction of the world's population was either underfed or eating an inadequate diet. The proposed solution to this problem was then to increase the world aggregate food supply. For example, the FAO Third World Food Survey 2 of 1961 estimated that during the period 1957-1959 200 to 500 million people were underfed and that some 60 percent of the population in the less developed areas lived on diets which were inadequate in nutritional quality.

The argument here generally followed the Malthusian pattern—that food production would never increase rapidly enough to meet the population growth. This view has been generally modified in recent years, and recent models are less pessimistic regarding the growth of food production. It is difficult to ascertain the extent to which these modifications have occurred, and the extent to which they have in fact occurred is difficult to assess. It is possible, however, to see that the trends in food production have been quite dramatic, and that there have been significant increases in the productivity of the agricultural sector.

B. The Distribution Approach

The distribution approach views the world food situation as one of inadequate distribution of food, rather than inadequate production. The argument here is that the problem is one of reducing food losses and waste, and improving the efficiency of food distribution. It is argued that the solution to this problem is to improve the infrastructure for food distribution, and to ensure that food is accessible to all populations. It is argued that this can be achieved through policies to encourage the development of local food markets, and to ensure that food is transported efficiently and economically.

C. The Choice Approach

The choice approach views the world food situation as one of choice, rather than production or distribution. The argument here is that the problem is one of making the right choices about what and how to produce food. It is argued that this can be achieved through policies that encourage the production of high-value crops, and that reduce the production of low-value crops. It is argued that this can be achieved through policies that encourage the development of new agricultural technologies, and that reduce the use of traditional agricultural practices.
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supplier must be planned to eliminate existing shortages and to keep pace with rising food demand. This demand was seen to be made up of two components: that due to population growth and the due to rising wealth, which leads to the basic economic theorem of aggregate supply planning.

Required supply increase = Increase in demand = Increase in population \times basic per capita needs + Population \times (1 - (increase in per capita income / change of demand))

By this approach (which I shall label the supply approach for brevity), the FAO estimated, with the aid of a fairly sophisticated linear programming model that the food supplies of developing countries had to be increased by 75 percent over the period 1965-1980 and by 25 percent over the period 1965-2000.

This approach has a number of basic assumptions, these may be presented as:

Assumption 1: Economic demand = human needs

Assumption 2: Adequate food supply \Rightarrow adequate nutrition

Rejection of, or qualification of, either of these two basic assumptions leads to a quite different conception of the problem as we shall see later. Nevertheless, the aggregate approach as I shall label the above, has held and still holds, considerable vogue in dealing with the world food situation both at the level of analysis, and in practical planning.

Viewing the situation in terms of aggregates has also engendered a number of concomitant propositions. Of these, possibly the most well known is the so-called “protein gap.” In the context of Assumption 2 above, nutritional analysis which leads to a diagnosis of protein deficiency in a given population (e.g., the symptoms of kwashiorkor) can be immediately identified with a deficiency of the aggregate supply of protein rich foods. Thus in the two decades following World War II, the prime preoccupation of nutritional experts was with the aggregate deficiency of the suitable protein supply in the poor world. As recently as 1972 George Bergstrom was able to say: “The phenomenon of world malnutrition is, however, to a major degree due to a shortage of protein.”

The recent rejection by food/nutrition experts of the concept of the “protein gap” is indicative of the recent change of approach away from the food supply position. What has happened is that the theoretical “safe” levels of protein intake recommended by nutritionists have progressively fallen to a level whereby aggregate supplies of poor countries have now become nutritionally inadequate, with the subsequent disappearance of the “gap.” Table I shows the dimensions of the changes. With these new figures, nutritionists such as Prof. Lea are able to state with confidence that, “People whose caloric intakes are adequate are not generally to be found suffering from protein deficiencies.”

<table>
<thead>
<tr>
<th>Year</th>
<th>Adult</th>
<th>Child</th>
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<tr>
<td>1950</td>
<td>23.5</td>
<td>17.5</td>
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<tr>
<td>1975</td>
<td>24.5</td>
<td>18.5</td>
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The disappearance of the “protein gap” was largely caused by a revolution by clinical nutritionists of the basis upon which “safe” levels of nutrient requirements should be calculated. (The 1950 recommendations were based on data drawn from the eating habits of working class United States families whereas the more recent figures take into account the cultural and social bias inherent in such data.) The repercussions of the discovery of the aggregate adequacy of food supplies have, however, spread far beyond the field of clinical dietary assessment.

From the twin premises that first there is enough food in the world and second that the nutritive composition of much food is also satisfactory nutritionists have been forced to accept the conclusion that the nature of the “food problem” is one of distribution.

The realization that people are hungry because of maldistribution, institutional barriers, and misdirection of social and political priorities has provided food/nutrition experts with a completely new paradigm—the distribution approach. The shift of consciousness may be illustrated by the use of some simple statistics:

The supply approach can be stated in two stages:

(i) Obtain an adequate aggregate food supply.

(ii) Institute a nutrition program which will ensure a balanced diet for the population.

The problem of Stage I is to determine and then plan for an adequate supply, where

Required supply = Population \times \text{“safe” quantity of nutrient}

The “safe” quantity (S) may be calculated by taking the mean requirement (M) and adding 2 times the standard deviation of the distribution to provide 97 percent adequacy (Figure I, top graph). Thus, already agricultural planners will plan to produce well in excess of theoretical needs. The planner must now look at calorie/energy distribution, this is usually represented by a skew distribution (whether the population is the world, a nation, or an area) (Figure I, bottom graph). The supply oriented planner now needs to decide upon a required supply which will ensure that 97 percent of the population receive at least the “safe” quantity. He will accordingly, if he is unable to alter demand's pattern, have to plan for a supply which will shift by demand in this context we mean more or less what an economist would call effective demand, that is, the ability of an individual to purchase. In a money economy this is effected directly by urging wealth in a subsistence economy it reduces the ability of a peasant to produce food. Thus, while we refer to effective demand, we mean buying power and purchasing the capacity of the subsistence farmer to grow food.
the entire skew distribution in the positive direction until \( S \) is exceeded by 97 percent of the population, i.e., that everybody’s intake is increased by the same absolute amount). This, of course, has the effect of enabling consumers at the ‘rich’ end of the distribution to consume even more.

Sukhatme* has calculated that the application of this logic to Mahatras would require a target of protein supplies of almost 4 times the sum of individual mean requirements. Such a target would be both unrealistic and, if taken seriously, dangerously counter-productive. Many global projections, however, are based on the same spurious logic.

B. The Distribution Approach

The distribution approach to food and nutrition planning may be characterised by the following quote from L. Jay:

To see the nutrition problem as a ‘protein crisis’ is to place a mistaken emphasis on protein... The basic fact about the nutrition problem is that it is primarily a poverty problem: a problem of ineffective demand rather than of ineffective supply; for food not just for protein (Reference 5, p. 5).

The paradigm demands that the adequacy of supplies be determined with reference to the number of individuals or classes of individuals who are now underfed, which means working from individuals to national and supra-national aggregates—from micro to macro—and not vice versa.

The distribution paradigm thus requires extremely sophisticated analysis and, for a solution to the problem, the construction and implementation of nutrition plans at all administrative levels. These plans must necessarily be strategic, not nutrition plans in the accepted sense, but overall societal plans

which take into account all of the galaxy of planning concepts including nutritional goals within the ultimate objectives.

Assumption 1 of the supply paradigm is replaced by NEEDS ≠ DEMAND (3). The inequality being produced by the dichotomy between physiological requirements and economic and cultural barriers to the fulfillment of those requirements.

Assumption 2 is demolished by the overwhelming evidence which indicates an inequitable distribution of consumption on a global, national, regional, and area scale, and even on the level of intakes of the individuals who comprise a family unit. Furthermore, at the lower end of this distribution per capita consumption falls below the levels required for the full realisation of human potential.

C. A Synthesis

The supply paradigm is thus inadequate for the theoretical explanation of the existence of malnutrition. In terms of actual world shortages or lack of available food supply, this seems to be more apparent than real in recent years. The following quotation emphasizes the point:

The per capita availability of food grains is about 2½ times the requirement. If protein (all sources) is taken as the main qualitative measure factor and its daily requirement is 70 grams per capita, the total availability is also more than twice the requirement.

Similarly the solution suggested by the supply approach—increase in aggregate food supplies—is clearly inadequate to solve the nutrition problem. Here, a case study might be illustrative: the so-called “Green Revolution” in northern India. A recent study comes to the conclusion that whereas unbridled short-term increases in wheat and rice production have occurred in India since 1967, the wretched social and nutritional condition of the Indian population has further deteriorated owing to the implementation of the “high yield varieties.” Landowners with easy access to capital in areas with irrigation have greatly benefited. In the Punjab 75 percent of households subsist on less than 2½ hectares of land; of these only 10 percent were able to utilize the new methods. Thus while a small minority of the rural labor force have enjoyed higher income and nutritional levels, the majority have experienced a fall in their real income and nutritional status. From 1961 to 1968 the daily wage rose by 89 percent while prices rose by 92 percent in spite of an increase in agricultural production of 6½ percent. The nutrition problem is further aggravated by the large farmers switching production to the high yield varieties away from pulse crops which are the traditional source of protein for much of the area.

The lesson to be drawn from the application of the supply paradigm to India’s problem is that technological solutions to the food supply situation cannot work when unaccompanied by thoroughgoing social and economic change.

It is this kind of change—political, social, and economic—which is the basis of the solution presented by the distribution paradigm, the major objective being the alteration of the shape of food consumption distribution.
On the global level there is little evidence to suggest that the political will exists to bring about the needed redistribution of global income and wealth which would be required to compress and normalize the present skewed distribution of consumption. The following four features of the world trade in food indicate the extent of the inequity of the present world system:

1. Nineteen-twenths of the exports of poor countries consist of food, feed, and agricultural products.
2. The United States ranks next to the United Kingdom as the largest importer of protein.
3. The United States is the largest buyer of fish protein.
4. The Third World supplies all the world's sugar, coffee, tea, cocoa, and bananas and is a major supplier of oils and fats to the rich world for industry and animal feed.

On the national level the prognosis is equally unencouraging. If we omit the possibility of worldwide revolutions, the time scale required for internal adjustment of food intake distribution seems very long. In the case of the United Kingdom, it seems that the development of food consumption patterns has followed both paradigms. To some extent the United Kingdom distribution is still skew, although much less so than that for, say, Maharashtra. In addition, the entire distribution has moved continuously in the positive direction. This change in distribution has undoubtedly been caused by the growth of political power of the working class, expressed through Trade Unions and the Labour Party and coincided with a rise in overall efficiency, both processes taking place over 150 years.

From the regional level down to that of the family group it would seem that there is more hope for the distribution approach. Redistribution of consumption at the micro-level does not seem to be fundamentally incompatible with the current political ideology of many countries with a severe malnutrition problem. This is because of the dual nature of the causes of inequitable distribution. The first major cause is rooted in political/economic realities, whereas on moving toward the micro-level the cause of redistribution seems to be more related to ideology, attitudes, and culture, many of which are remnants of, say, precapitalist society. It is this constellation of causes which are marginal to economic reality and could possibly be amended by a massive program of nutritional education. It should, of course, be realized that the time scale for such structural changes is similar to that required for the alteration of the political realities.

However, such alteration of structural factors can at best only serve to alleviate the problem. In the case of the Punjab, discussed above, it seems that only land reform within the region could provide a lasting solution, and land reform is extremely unlikely given the existing political philosophy and practice of the state government.

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D. The Lessons

It may be fairly concluded that regarding the world food crisis as a problem of limited aggregate supplies is of limited utility. It would seem that an attack on the inequitable nature of world and national nutritional systems has far more potential to create a world free from hunger.

However, given this essentially political and somewhat utopian conclusion it is nevertheless still impossible to ignore the problems of supply. There are two reasons why problems of supply persist. First, it is that the process of social and political change takes place over a long period of time. If we keep this in mind together with the urgency of the present food crisis and the pressure of existing population growth, the inevitable conclusion is that aggregate food supply must be increased and at an unprecedented rate.

2 is within this context—that of very sharp social and political change—that the pronouncements of the more sensational commentators on the world food problem make sense:

Most experts agree that the world food production needs to be devoted to eliminate the present hunger gap and give every human new living on earth an acceptable minimal diet (Reference 4, p. 172). On the other hand, since we must be fairly confident that by time redistribution of income and food via the political process is possible and desirable, we can avoid the more pessimistic conclusions of the type of analysis:

It is certainly evident that no conceivable increase in food supply can keep up with the current population growth rates for long.

There is also the less pragmatic point that income redistribution will generally lead to an increase in aggregate demand which will, of course, require an increase in supply. Here, however, supplies are eluded to match desired patterns of consumption while nutrition plans ensure that need is translated into effective demand. Unless it is so translated, new planning for supplies to meet needs is more likely to result in local "surpluses" while the nutrition problem is aggravated.

Thus we see that within the time-scale required for social reform food supplies must be increased, but that an indefinite exponential growth of food production need not be demanded. In a study of the social and technical food systems the physical limits and potential of food supply must be examined, and any likely alterations in the distribution of consumption must be analyzed. In parallel with this approach it will also be necessary to investigate the social and political barriers to the attainment of a more equitable distribution of consumption between and within nations, regions, and families.

II. Paradigms and Projections

A. System Models

The use of systems analysis to investigate global problems was given renewed impetus by the work of Meadows. For a fuller description of sys-
systems analysis, the systems approach, and the recent crop of world models, to which we shall refer briefly here, see Clark et al. In the systems approach, the world food (or agricultural) subsystem is one of a number of subsystems which are assumed to be dominant in supporting life in the world. The main subsystems considered usually try to represent agriculture, industry, population, and natural resources. The study of the interactions between the subsystems, over the very long term (15 to 50 years) is the main purpose of the systems approach.

The Meadows food subsystem (Figure 2) was constructed to determine the ultimate limits of food production and has been evaluated within this context by Marstrand and Pavitt. For the largely pessimistic and conservative assumptions which it incorporated. This subsystem has a very important effect on the overall behavior of the model. If the resource depletion and the pollution "modes" of collapse are avoided, the combination of diminishing returns in agriculture and a growing population leads to the draining of all investable resources into agriculture and yet another collapse. Thus

![Figure 2. Meadows agricultural system.](image)

Meadows’ model essentially suggests that food production cannot keep up with population growth. However, the weakness of his methodological approach—leaving aside the specific criticisms of Marstrand and Pavitt—is his high degree of aggregation and lack of commodity pricing which lead him into treating the world food problem as a problem of supply. The high level of aggregation incorporated in the model renders it usually inappropriate for an examination of the distribution approach. Demand in the model is calculated by Equation 1 given at the beginning of this paper, and thus is based on Assumptions 1 and 2 which we have found to be untenable. One major feature of the subsystem, thus, is that food consumption is assumed to be already equally distributed throughout the population; furthermore, the mean food intake figure based on the current world inedible distribution is used as the base point for all the forecasts. Thus Meadows has built into his model the statistical fallacy discussed on p. 162, his agricultural subsystem being under strain but because of physical limits but because of the social and political barrier which create global inequality. Similarly, if he had included a pricing policy in his model and treated the problem as one of both supply and demand, it would have allowed shortings of commodities to be reflected in price. This would have had two main effects. First, agricultural investment would have been stimulated, and second rich people would have been able to price increases in all but the most basic foods. Collapse, due to the food system, would then have been postponed in the model. An approach of this type has been made by the Department of the Environment’s Systems Analysis Research Unit in their world model. They believe that if population growth is greatly reduced, demand thus being mainly affected by rising incomes, rather than by rising population, it is possible by a combination of investment and substitution to avoid collapse in the world system. (However, this conclusion, being based on the same aggregated subsystem as that of Meadows is hardly more realistic.)

All the recent world models have attempted to take care of the major criticisms of the Meadows model, e.g., they have all been disaggregated into different geographical regions and different commodities. None have so far been completed and thus complete descriptions and results are not available. The Barloche model, agricultural subsystem (Figure 3) is very similar to that of Meadows except that the effect of increased urbanization on the area of arable land is considered explicitly but land erosion is considered to be controllable by good management practice. Further, the Barloche subsystem is divided into three subsectors: agriculture, livestock production, and fishing. Demand in the model is stimulated by a “basic needs” function, but prices are not considered explicitly. Again the model is supply-oriented but should eventually indicate whether an aggregate of basic needs (the basic needs vary between the five geographical zones considered) can be met by aggregate production.

One of the tentative conclusions of this modeling effort is that at least Latin America could feed its population adequately, without external dependence, within a fairly short space of time. The critical assumption in
the Bariloche model are that the Latin American economy could be free from external influence and that within the geographical zone all political and planning priorities would be oriented towards satisfying the basic needs of the population. These are both assumptions with enormous political significance and as such place the Bariloche model well within the distribution approach—although perhaps not within the realm of immediate political possibility.

A Dutch group under Linnemann has adopted a systems approach to examine what package of material goods, including food, are necessary to support human life (according to predetermined “norms”) over a period in which world population is expected to double. If these “norms” are not met, the group is to examine what policies should be followed in the areas of production and distribution in order to meet the requirements set by the “norms.” The agricultural subsystem work has similar objectives to those of Bariloche in attempting to determine “potential” output levels; again the main emphasis is on supply.

Lactic information is available so far concerning the agricultural subsystem of the Mesoponic interactive world model. A food production and pasture land use model has been constructed which allows the assessment of a number of food-related issues including the need and availability of phosphorus required for intensive agriculture and the consequences of timing and magnitudes of natural disasters such as drought or crop failure due to disease. Again the food subsystem is modeled from the supply point of view; however, the improvements in our view, over the models so far mentioned is the interactive implementation (see Hopkins for a description of interactive computer simulation models). This allows small perturbations to be introduced and by an interaction with their propagation effects being monitored during a run of the model. An advantage here of the systems approach is that the effects of perturbations in other world subsystems on the food subsystem can be examined interactively, for example, the possible decline in production of oil over the next 10 years as different energy sources become relatively less expensive, its implications for the production of fertilizers and finally its effect, after a number of delays, on food production.

In the Japanese society’s world model (the agricultural subsystem in again a supply model) with demand being measured by what is called “potentially desirable demand.” Detailed definitions and descriptions are not available, but their approach is similar to that of Bariloche and Linnemann.

8. Traditional Projections

The projections which are used by most countries in estimating food demand and supply use traditional forecasting methods such as trend extrapolation or simple statistical regression and are in the main over the short to medium term (5 to 10 years). A readable, but journalistic, summary of population trends, food production, and trade based largely on statistical data from the 1960s is given by Bergstrom.21 Typical problem areas which could have widespread effects are discussed. For example, in the chapter entitled “Japan—the Time Bomb” Bergstrom considers the implications of Japan having only 17 percent of the total agricultural acreage required to feed itself inside its borders.

Apart from projections for individual nations the main source for medium-term projections (5 to 15 years) on a global basis is the FAO. However, for particular blocks of countries, the OECD and World Bank seem to be the main contributors. To our knowledge no work using traditional econometric techniques is being done on the supply and demand of food past the year 1985.

Over the World Bank reviews the major factors affecting food de-
mand in the long run in less developed countries. He also reviews some United States Department of Agriculture long-term projection studies of demand for food in 13 less developed countries, and summarizes the broad lines of the FAO commodity projection model for the world for 1975 and 1985. Prepared with two main objectives: to assess the potential increase in demand for food and its impact on nutrition and to evaluate the prospects for world commodity trade. They were a vital element in the preparation of FAO's Indicative World Plan for Agricultural Development. The study, which covers both the developed and less developed countries, examines the implications of two separate assumptions regarding the economic development: a pessimistic one, implying no improvement in economic growth rates in developing countries, and an optimistic one, assuming a real improvement over the past from a recorded growth rate of 4 percent per annum in the early 1960's, to 5.5 percent from 1965-1975, and 6 percent from 1975-1985. The study examined demand, supply, and trade prospects for the years up to 1975; only demand for food was projected for the following decade. We describe this study in more detail than others in this paper because (a) it is complete and (b) it is wide ranging and a useful source of data. Using their optimistic assumption, the FAO estimated the total demand for food in less developed countries to rise by 45 percent from 1965-1975 and 110 percent from 1965-1985. They stated that if food supplies increased at a rate matching the projected increase in demand, a substantial proportion of the world's population would still be hungry in 1975, i.e., calorie levels would not be adequate. However, by 1985, the food problems in terms of calorie intake would be near adequate control. Using their pessimistic assumption, the FAO estimated that per capita demand for food, held steady by lower income growth, would just reach by 1965 even the level projected for 1975 under the assumption of rapid economic growth. The methodology used in these projections was essentially similar to that applied to the 1970 commodity projections. The study does not, surprisingly, attempt to discuss the validity of these projections against actual data—this would obviously be an interesting research question—in order to evaluate the usefulness of the methodological approach. The first step in the "long-term" study was to select assumptions for growth rates of population and Gross Domestic Product for the following two decades. The second was to assemble data on production, trade, and domestic utilization by country and commodity for the base period 1961-1963. The third was to project the potential demand for 1975 and 1985 by major commodity groups on the basis of these assumptions. The fourth was to project agricultural production and to analyze the implications for trade. This culminated in the discussion of national and international commodity policies presented in the main text of the report. Projections were made for individual countries wherever data were available. For example, the demand for food was projected separately for 99 countries, which, together, accounted for about 96 percent of the world population. In the model demand and production were considered separately. The demand for food assumed constant prices and was projected on the basis of growth in per capita private consumption expenditure for the two assumptions. Four types of demand functions (log-log, semi-log, log inverse, and log-log inverse) were used according to their goodness of fit to data obtained from household surveys and assumptions of expected changes in the elasticity of demand. In his summary of the FAO projections Onisogumi criticized their blanket adoption of the same methodology for all developed countries. Centralized planning economies probably depend more on policy and administrative measures than do market economies. Also demand projections of less developed countries based on aggregate national areas are not very meaningful since they conceal major differences between the rural population which lives mainly in a subsistence economy and the urban population which lives in a market economy. Thus in a country with a rapid urbanization, projections based on national averages could be misleading. The projections of production were based on the main historical trends of individual commodities, being supplemented by a review of national plans and of available economic projections made by various governments and institutions. It was assumed that the projections of this study should have been associated with a given set of technological devices, investments, institutional measures and, more generally, of policies to be specified. It is what was attempted in the detailed regional studies made for the Indicative World Plan where the targets selected correspond to the set of policies and measures recommended. The OECD attempted an analysis similar to that of the FAO but for OECD countries and Oceania only. In order to be comparable with the FAO study the OECD chose the same base years 1962-1963 and gave projections for 1975 and 1985. The major conclusions of the report were, first, that agriculture in the OECD area has the potential to expand its output more rapidly than the growth in requirements within the area, and this without any stimulus to output beyond those given by current policies and, second, that OECD countries would charge from a net importer of agricultural products ($1.5 billion in 1963/3) to net exporters in 1975 and 1985 ($2.3 billion in 1975 and $3.3 billion in 1985). The content of the exports would be in the main meat products, the surpluses arising because of increasing yields and reducing demand. The trends show that except for Japan and some Southern European countries, average food consumption is decreasing in the OECD area. This, the report suggests that the main questions facing OECD countries will be the possibilities of increasing exports to less developed countries. The methodological approach of the OECD work is essentially the same as that of the FAO's commodity projections except that price trends are explicitly included. Thus, demand and supply are considered separately. Demand is measured by extrapolating consumption which is a function of
income and price; the extrapolation function, as in the FAO work, is chosen on the basis of expected caloricities of demand. Data are derived from both OECD and FAO food balance sheets, which provide data on production, trade, and various utilisations of food commodities. Population was assumed to correspond to the "medium" assumptions on which the FAO projections were based.

Production projections were obtained assuming continued trends. Under the general assumption that policies remain broadly unchanged, in general, projection of production is independent of that for consumption, except for poultry meat, pig meat, and eggs, where the report judges that the supply of these commodities can adjust relatively quickly to the market situation. Some inputs was also taken of increased use of fertilizers and help on land use of reclamation schemes or increased urbanization.

The OECDl work took more account of structure than the FAO and thus moved more toward a more structured econometric model. We consider a trend extrapolation model to be a nonstructured econometric model. A structured econometric model, although essentially using trend extrapolation, makes more effort to explain relationships and thereby then explain more of the trend variation.

C. The Future of Food Forecasting

The world system models consider supply and its ultimate limits as the main food problem facing the future. The evidence we have quoted suggests that adequate production is not as vital a problem as the need to stimulate demand. To be fair the emphasis of the world models away from the demand-supply dynamics is largely due to the fact that they are considering a number of subsystems and cannot be expected to go into great detail in each subsystem, especially since the main point to systems analysis is study of interrelationships. The traditional projections clearly look at account of demand but do not directly relate supply to demand, and it could be argued that, since precise estimates of future demand and supply are so dependent on so many unquantifiables and unknowables, it is hardly worth using complex systems analysis or highly structured econometric methods instead of simple extrapolative techniques, for both techniques are, at best, not very useful.

If, as this last sentence implies, the future is unpredictable, then what is the point of attempting to predict it? Part of an answer is an example outlined by Thomas, who remarks:

The development of models in Western and Eastern Europe appear to have been for different reasons. Both countries in Western Europe were reacting to the failure of traditional forecasting techniques to predict the important changes in energy supply from 1973 onwards (depletion of oil for coal). A failure which was intimately linked with the inadequacy of extrapolations and isolated regressions to forecast breaks in the trend. Other Western European countries found that even fairly sophisticated econometric analysis failed to elucidate the effects of alternative policy measures. 10

That is, there is a need for tools with which alternative policy measures can be evaluated, albeit crudely. Here lies the slight advantage of the simulation models of the systems analysts and econometricians since they attempt to present an underlying structure of what is happening now and what has happened in the past. Then, if the description is accurate enough and the assumption made that if present trends continue the model will give a reasonably reliable forecast of the future, alternative policy measures can be studied. For a longer discussion of the utility of systems analysis applied to forecasting world problems see Clark et al. 11

We have seen that the systems models which have already been constructed do not adequately take account of demand and distribution and that extrapolative projections consider demand and supply separately in the main. Thus a model which considered the demand-supply dynamics of the world food system would almost certainly be an improvement on existing models. Its main objectives would be to show the effects on supply of increased income and/or population growth with particular attention being paid to small perturbations likely to have cumulative effects. Briefly a possible approach to the building of such a model could be as follows. The demand part of the model could use the equation of the FAO projections as a first step. The advantage of adopting this simplifying step would be that it would act as a proxy to a more complex demand structure which could be added at a later date—the problem of modeling demand in great detail is the complexity that would be introduced. The ILO Barahe models models assume distribution in detail, its economic sector basically being a demand model of a developing country economy. This model could be used to stimulate demand in the developing nations part of a world food model, it is disaggregated into an urban and rural sector and could thus deal with both types of demand (the world would probably have to be disaggregated into at least developed, developing, and centrally planned economies); since the major areas of malnutrition are in the developing nations, a more detailed model of demand there would be of more interest than one for the developed nations or the centrally planned nation. A major criticism of the ILO model 12 this reply is not modeled, although it is soon to be added 13 this, the development of a supply sector for a food model could also usefully draw on the ILO work. A disadvantage of the FAO projection, already stated, is that prices are not explicitly stated and thus demand would, unlikely anyway, have to be considered in quality and not in money terms. Secondly, in order to examine the effects on the model of changes in income distribution, the FAO projection equations would have to be modified accordingly. Another disadvantage of the FAO projection is that populations are treated as an endogenous variable. The Barahe model calculates population dynamically in response to the other sectors of the model. Thus, the world model would not need to rely on United Nations estimates of population. The reply model could be based on the Barahe work mentioned earlier, although the specific objections of Marstrand and Pavitt would have to be incorporated. In short, such a model would enable one to examine the nutritional consequences of political and social change. A tendency toward a reduction of
global inequality could either be introduced as an endogenous variable, or else the consequences of micro-changes such as land reforms or increased fl of water could be evaluated using reduction of inequality as a criterion of effectiveness.

The model would thus contribute both to understanding the dynamism of change in the world system and also to our analysis of the present nature of global food system, a contribution both to the problem of understanding the world and to what is perhaps a more pressing problem—how to change it.

References


NEW DIMENSIONS IN HUMAN POPULATION

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INTRODUCTION

The island of Singapore, with its 2 million inhabitants on 200 square miles, is affectionately known in the technical world as "high-rise heaven," because 40 percent of its population resides in high-rise government housing built in the last 4 years, 14- to 24-storied units, some in separate redevelopment areas, but most in well-planned towns, and it is projected that this may soon rise to 70 percent. The population density is around 5000 per acre.

Hong Kong is not far behind. With a present population of 4.1 million, expected to increase to 6 or 7 million by the year 2000, it has more than 2 million people who live above the 10th floor. The Ferry Street complex in Kowloon has a density of 2000 per acre, as has the much-more-sought-after Wah-Fu Estates (one building alone of which has a density of 9000 per acre). One-third of Hong Kong's people live in high-rise, low-cost housing, and this is projected to be 50 percent in 10 years. Buildings are usually of 24-story height.

In another part of the world, Madrid, 95 percent of the city's 3 million inhabitants live in high-rise apartments, and 75 percent of these prefer this type of living. There simply are no "suburbs" there, for the edge of town tapers off to 8-story apartments—then countryside beyond.

Yet here in the United States, the 14-year-old Pruitt-Igoe houses in St. Louis—designed by eminent architects and the recipient of major design awards—will be torn down soon, because even the poorest of the poor refuse to live in them! And in San Francisco, a "high-rise revolt!" took place a few years ago by its population against the deposing of their city's endowment of visual richness, architectural heritage, and natural beauty of shoreline, which have been brought together in an extraordinary combination of urbanity, vitality, and cultural charm. Similar, but less publicized, complaints against tall buildings have occurred in Toronto, Washington, Phoenix, and even in New York City, where the prestigious Urban Design Council has proposed to modify the 1961 zoning laws, which were based on LeCorbusier's concept of high-rise towers on limited ground area.

What is this changing dimension which appears to have gripped the emotions of the whole world in relation to human habitations, using that term in its broadest sense to include residential, commercial, industrial, educational, and recreational uses? This dimension is, in a word, "up." It has evolved in importance as a consequence of the worldwide phenomenon of enormous migrations from rural farms to the large industrial centers, the cities, in a process known as urbanization, which in turn results in the
social pressure for more working and living space than is available from the ordinary two-dimensional aspects of these city's areas. Not surprisingly, for example, one-third of the world's population now lives in cities, and in the past 10 years the number of cities having a million or more residents has increased from 30 to 130. With 66 percent of Americans living in cities in 1970, it has been estimated that by the year 2000, some 90 percent of more of Americans will be urban dwellers.

Where more people are crowded into cities, there are, of course, more buildings. As more land is built up, structures start getting taller in order to use vertical space. Accompanying that solution, however, other problems intensify—crowding, transportation, economy, livability, services, and impacts on the environment and on the people. Tall buildings are praised by some as a logical solution to encompass more people, to save space, and to create a more harmonious environment for humans and nature. Others, however, contend that such is tall building solution tends to contribute to the already overwhelming problems of the city and its environment.

To sort out the pros and cons of this debate, an international project on the Planning and Design of Tall Buildings has been organized under the aegis of the National Science Foundation, in which some 1000 to 1500 specialists throughout the world are in continuous discussion and consultation with respect to the problems encountered in tall buildings, in order to devise plans to create viable, habitable, and operable structures within the total environment. The latter is defined in broad terms to include the natural environment (which we all seek to preserve), the man-made or artifact environment (which includes the city and its buildings as well), the human and social environment (which is of so much concern to us in our everyday life), and even man's own ego environment (or that which controls his inner, psychic well-being).

With a scope of subject at once so broad and complex, we resort to a systems approach to its many intersections by drawing upon all the inter-disciplinary professionals involved—the urban planner, the architect, landscape architects, and engineers, as well as the related aspects of the natural, social, and behavioral sciences, of esthetics, economics, political sciences, and law, which are of so much importance in today's society. We likewise remain mindful that our considerations must include the financier, the developer, industry, the government, as well as the owner-user, including the public itself.

It is not at all surprising that the progress to date has indicated that the most difficult question is not, "Can the tall building be built?" (for in actuality even the mile-high tower proposed by Frank Lloyd Wright is feasible, physically), but rather, the important question is, "Should it be built?" This reflects the tremendous impact the tall building has on the human and social (political and economic) environments above referred to, besides on the natural and man-made environments in a more physical sense.

To provide insight into these masters, about a third, or fifteen of the total number of committees on this project (and whose output will comprise the first of the expected five monographs on the total subject, mainly directed toward what may be termed "people problems"), will under my direction be focusing on the following areas:

**History and Philosophy of Tall Buildings**

The first element in a system's approach to high-rise building planning and design will be to determine the needs and objectives of the high-rise building, and these two committees will probably start architecturally by asking, as Frank Lloyd Wright did: "Why the skyscraper?" They will seek answers in the rich history of the architecture of tall buildings, in such work as that of the man whom Wright called "Der Moosiker," namely, Louis Henry Sullivan. They would be expected to explore the whole gamut of possibilities ranging even to Wright's visionary "mile-high" tower and the far-out proposals of his ex-disciple, Soluri, with his superheroes or "aceolites."

These committees will seek, philosophically, to determine what are the motivations for the high-rise. Are they in the desire to satisfy a primordial instinct, to rise above self? Or, do they lie in the urge for distinction, monumentality, dominance, power? Modern office block and residence block towers, motivated by economic power, differ from their antecedents in early times when tall buildings were designed either for abstract, religious power (Tower of Babel, the great cathedrals, etc.) or for sheer physical power (the turreted towers of medieval palaces). Obviously, the reasons for the emergence of the high-rise are closely allied to the emergence of cities as the focal points of modern life; both are urban in character and serve the needs of an industrialized democracy.

Can the high-rise buildings form order and to the city, rather than disrupt the physical landscape? Clearly, the dualism of the high-rise building and our urban society offers the greatest challenge to the urban planner who must lay the future ground for what Jean Fournaisé calls "la société de l'homme moyen riche," and it is the designer who has the opportunity to develop a new, expressive architecture for the tall building which will fit the city with logic and cohesion.

It is anticipated that a brief history of the high-rise building will be prepared which would not be limited to the United States, but be worldwide in its coverage. This history should be used in the way Sigfried Giedion employed it, that is, not solely "as a compilation of facts, but as an insight into a moving process of life." Thus, it is expected that the committees will weave into the structure of their output something of the underlying philosophies which have made the tall building a part of our culture and a forecast of the trends which may be ahead of us in the future. The excellent recent account by Winston Weisman, entitled "A New View of Skyscraper History," could serve as a starting point.

**Architecture of the Tall Building**

This committee will cover a broad perspective of the architecture of the tall building not only as a basic cultural form representing the spiritual
and creative aspirations of man, but also in a general way its larger functional, internal space usage, form-giving, and esthetic aspects. It will thus concentrate on the preliminary architectural planning aspects of design, rather than on the minutia of architectural details.

TALL BUILDINGS AND URBAN PLANNING

Closely related to architecture, yet in a distinct class by itself, is the subject of the evaluation of the contribution which the high-rise building makes to the urban environment, its effects on local, community, and regional life, on social and human factors, and the need for communications, contact, choice, opportunity, and mobility which underlies the very existence of cities—in short, the whole area of urban planning.

The planning committee will focus on the use of the tall buildings (including the trend toward multiple usage), land use, and space use. It will also concentrate on the relationship of the building to its site and to the landscape and will include all those elements of transportation services and amenities (such as parking, delivery services, light and power, water supply, sanitary, and other municipal services) which form a part of urban living.

This is admittedly a broad scope, but it is also one of the most challenging areas in planning and design for tall buildings. An excellent prior attempt in this direction has been published by Hina Arpegger and Otto Glaser. This book is a fine presentation of international viewpoints on urban planning for tall buildings and presents illustrative analyses by examples with the usual thoroughness found in continental European practice.

ECONOMICS OF THE HIGH-RISE

This committee will address itself to the economic and financial analysis of the factors influencing costs, optimum height, and general comparisons of materials. It will seek to unlock and release some of the general knowledge gained from experience by many of the large contracting firms specializing in high-rise work as guidelines for the benefit of all professionals and the industry as a whole. Since the relationships applicable to different high-rise usages—residential vs. commercial—probably vary, there will be a bifurcation of the approach to these different usages.

Quite apart from the usual consideration of construction economics, the financial and investment aspects of tall buildings will also be considered, as well as regulatory restraints of codes and zoning laws, tax, labor, and other constraints. Maintenance considerations, demolition planning, and other factors may also be studied.

HIGH-RISE SYSTEMS METHODOLOGY

The 1960s have been basically characterized by the adoption of the systems approach to technological problems, and in the 1970s this is being extended to social and environmental problems under the neologism of technological assessment.

This committee is exploring the possibility of providing a systems frame- work for the entire process of building, conception, design, construction, operation, and even demolition. This important area offers some of the most significant opportunities for development, since it encompasses the application of computer software not only for design automation, but also for augmenting the entire decision process in planning for tall buildings through the use of models and simulation.

PSYCHO-PHYSIOPHLOGICAL ASPECTS OF TALL BUILDINGS

This committee is undertaking a review of the important psychophysiological S.O.R. (stimulus-organism-response) mechanism which leads to environmental stress or discomfort produced in human beings occupying tall buildings. These may be kinetic stresses due to accelerations produced by wind or by elevator travel, as well as by vibrations or acoustic noises, and they may also comprise anxieties produced by visual effects of such motions (as in swaying light fixtures, sloshing of water basins, etc.) or by altitude, pressure, or temperature changes, or even decreased perceptual acuity in certain climatic conditions. An evaluation of existing data applicable to high-rise building design will be attempted.

OTHER SOCIO-PHYSIOPHLOGICAL FACTORS IN TALL BUILDINGS

This committee will explore the ramifications of some of the behavioral problems associated with human residence in, or working in, the tall building environment. This leads to many complex sociopsychological situations. For example, does the crowded (sometimes called lack of privacy) usually cited as resulting from concentration of population density in high-rise buildings, actually lead to neuroses, delinquency, and violence? In reality, it is known that in such extremely dense centers of population as Singapore and Hong Kong, man can remain healthy. Perhaps our need here is to consult with specialists on central nervous system processes who can inform us as to the nature of the appropriate environmental stimulation needed to maintain a healthy mental state.

POLITICAL AND ORGANIZATIONAL ECOLOGY

The initial plan for this project somewhat purposely avoided the single, overriding, and most important constraints on the tall building planning and design process, namely, the political factors. This was a mistake, and therefore all committees have been asked to include those political factors in their deliberations. A secondary consideration, of course, was that we did not wish to overlook the golden opportunity afforded by the many diverse local, national, and international political viewpoints to evaluate our treatment in a constructive way.

The term "political" does not necessarily infer the theoretical and ideological philosophies of political thought, but rather what David Rogers calls "the political and organizational ecology of cities ... their "value climates" ... specifically their interest in group politics, coalitions, governmental structures, and political ethos (that) have such a profound effect on the cities' capacity to mount efficient and effective development pro-
environmental controls will be considered, as well as delivery, services, such as goods and materials, via pneumatic devices, centralization, tunnel systems, conveyors, entrances and exits, ramps, structure, control equipment, signing and security.

INTERFERENCE EFFECTS

Another committee will focus on the adverse effects of TV interference (generation of "ghosts"), and radiation, light glare, and noise reflection.

ENERGY CONSERVATION

Special consideration will be given to potential energy savings in lighting and service and other systems in high-rise buildings.

OWNERSHIP, MAINTENANCE AND MANAGEMENT PROBLEMS

A special committee will explore problems of usage, joint tenancy or ownership, and operation and management of high-rise buildings, both for residential and commercial use.

PROJECT MANAGEMENT

A committee will investigate the ramifications of the concept known in the United States as Construction Management, broadened to include the complete life-cycle aspects of planning, design, construction and use of tall buildings, ranging from conception, planning, preliminary and final design, construction inspection, scheduling and cost control, operation and maintenance, even to the final demolition of the building.

SUMMARY

It is clear that in this project we have undertaken a very broad task in relation to the tall building planning and design process, covering many areas in which relatively little in the way of research, development, or broad professional practice has been undertaken in the past. This has been particularly the case with those aspects dealing with so-called "people problems" which have been emphasized in this paper. The Committee should complete its assignment in the form of a genuine technological assessment of the role of the high-rise building in our future urban society, and in so doing it is hoped this will fill many significant gaps in the entire planning and design process.

Indeed, this endeavor illustrates how the design professions (planners, architects, landscape architects, and engineers) are following the best traditions of the Interprofessional Council on Environmental Design (ICED) by relating the tall building to the quality of life of the people of the city, which thereby is transformed into what Charles A. Blessing describes as "... an anthropomorphic entity—living, breathing, moving, acting." They have done this by calling not only on their own professional specialists, but also on psychologists, physiologists, economists, social and political scientists, in order to assure that the urban essence of the tall building concept will not elude them in their deliberations. All who are interested will be welcome to join in this work.
ON THE WORKING ENVIRONMENT

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I am attending this conference after having been, for some 20 years, in charge of the Paris Office of the International Labor Organization (headquarters in Geneva) and so I am aware of the concern of this organization with environment.

The ILO is not a scientific organization. It was created half a century ago to promote social progress through international legislation. This, from its first beginning, it was concerned with assuring the working people the best possible conditions of life and the necessary protection during the time they spend at work.

It is a fact that one of the most powerful forces for social and economic change to emerge in recent years is the protection of human environment. What used to be the exclusive concern of scientists has suddenly caught the limelight of world attention and has become a major issue in domestic policy in many industrialized countries.

As you know, the United Nations created a new organization and an Environment Fund of a $100 million was set up to promote a worldwide action plan. The various specialized agencies of the United Nations system, including the ILO, are prepared to cooperate in this aim in a joint interdisciplinary effort. The new activities started in many countries have a profound economic and social impact both at the national and the international level, and any discussion of social change must take into account the effects of environmental protection.

While this protection raises general problems of environmental pollution and management of natural resources, the concern of the ILO affects a quite particular and, we believe, a very important aspect of environment as it is directly related to the protection of human life, i.e., health and safety at the working places not only in the interest of the people concerned but also in the interest of economy, the hazards caused both by machinery and by atmospheric pollutants, noise, heat, vibrations, and physical and nervous strain, and the combination of two or more of these environmental agents. Over the years, the framework of the working environment has been broadened by the proliferation of buildings, equipment, and processes to the needs of the human operator, according to ergonomic principles. A further dimension was added to achieve greater job satisfaction and a better quality of life.

At working places which are not satisfactory human life is subjected to many environmental conditions. A few years ago, the French National Security Fund reported that in France one worker died in an industrial
been given to the means of balancing the costs and benefits of environmental protection or to the way of meeting such costs without impinging on economic stability. The slogan, "the polluter pays," oversimplifies a highly complex problem.

The ILO has an obligation to employers and workers affected by environmental protection measures to ensure that environmental improvements and economic development are reconciled. Measures to mitigate the possible adverse effects of environmental measures, including measures for retraining of workers and manpower, should be planned from the outset as an integral part of the approach to the protection of the environment.

An investigation of labor-intensive and low pollution technology, for instance, a comparison of the real costs and benefits of synthetic vs. natural products, is of importance in this respect. So, the entire problem of the relationship of environmental protection and development implies many employment aspects, for which policy recommendations must be derived. Environmental policies with significant employment effects include the management of natural resources and human settlements, i.e., the distribution of populations between rural and urban environments in relation to the employment opportunities and the quality of life. Therefore it is desirable to examine the employment effects of environmental policies. These are seen in which the ILO is engaged through the International Labor Office launched in 1969.

The socio-economic aspects of environmental protection are at present under consideration because of the income distribution effects which are implied in the policies adopted to finance environmental costs. A start has already been made in this direction by introducing environmental components in the program of the International Institute of Labour Studies which operates in Geneva under the auspices of the ILO. Further work in this area may help to clarify the social and economic impact and provide a basis for rational choices between the dual objectives of development and environment, possibly by developing, in cooperation with other international organizations, social and environmental indicators.

Cooperation is necessary and constitutes a natural practical extension of work invested in research and standard setting to prevent injury to life and health in the place where people spend a large part of their daily life and where the impact of scientific progress becomes the most precipitous for them. Prevention is quite a broad domain, including medical, physiological, psychological, and technical aspects. This is why, necessarily, I think it is absolutely necessary to establish, internationally, much closer links than in the past between the competent scientific organizations and the ILO which has the possibility, through its relations with the governments, the employers, and the workers, to help promote understanding and support of environmental action and so to facilitate the necessary solutions.
WORLD ENERGY POLICY: A GLOBAL FRAMEWORK

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INTRODUCTION

Throughout human history the foundations of civilizations have rested heavily on their particular supplies of energy. Ancient Egypt under the Pharaohs, Athenian Greece, and the American South before the Civil War depended on human slaves as a primary energy resource. The nineteenth century Industrial Revolution in Europe and North America was coal-powered, as is the process of industrialization now underway in the People's Republic of China. Drives for secure oil supplies by Germany and Japan were one of many causes of World War II. Our dominant urban form, megalopolis, is based on transportation technologies requiring an abundance of gasoline.

The world community is now on an energy crossroads. We arrived there suddenly as a result of the emergence of OPEC as an effective cartel of oil exporting countries, and the recent Arab use of oil as a weapon in their conflict with Israel. However, for several years a handful of experts and some industrial leaders have been issuing warnings—largely unheard—that the world's stocks of oil and gas were exhausting in a matter of decades if current exponential growth rates in consumption continued. The Arab actions in the wake of the October War merely strengthened and focused the forces already at work into a major global crisis.

The shock of a 4-fold increase in the price of crude oil in 1973-74 and the enormity of the flow of wealth now underway from Western Europe, Japan, the United States, and many of the less developed countries to the OPEC countries, has created immediate economic and political problems of enormous magnitude and complexity. These problems must be dealt with promptly and effectively to permit economic development to continue, albeit painfully and slowly, and to avoid major threats to international stability and security. However, in seeking solutions to current problems, we must not lose sight of the longer-term issues. If we do lose sight of the future in solving immediate problems, we may plant the seeds of much worse energy crises a few years or a few decades in the future.

Whether viewed as an acute emergency or a chronic condition, the energy crisis has drawn forth vocal advocates for every conceivable particular interest at the local, national, and international levels. It has also produced an avalanche of studies, each supported by its own flood of statistics. This rhetorical and intellectual outpouring, viewed as an aggregate, appears to support one central conclusion which I accept as a working hypothesis: namely, that the energy crisis is at bottom a political institutional matter.

World Energy Crisis

The world energy context may be viewed historically to perceive long-term developments and the momentum behind current trends. The context may also be explored in search of the characteristics that determine strategic energy options presently available and that future policy may be designed to affect. In considering the world energy context, two broad developments appear to have overriding importance: nationalism and multinational enterprises.

World War II left prostrate victors and vanquished alike, except for the United States. Nationalism filled political vacuums in the Middle East, Asia, and Africa, prevented the return of European colonialism in most areas, and caused the birth in only two decades of over half the world's current number of states. Moreover, emergent nationalism in Western Europe successfully resisted the emergence on that continent of strong supranational institutions.

Concurrently with the development of nationalism, large private corporations received their worldwide search for raw materials and markets. They succeeded in integrating all phases of economic activity from resource extraction to retail distribution of manufactured products, and they developed the capacity to operate on a global scale. In the early post-war years, the more powerful multinational enterprises were controlled by United States shareholders, but, as the economies of the European countries and Japan recovered, their own business interests penetrated foreign markets and took on multinational attributes.

The privately owned major oil companies were the most powerful multinational enterprises yet to develop. For decades, the new and often fragile governments of oil-rich but economically backward nations were no match for these corporate giants. Multinational corporations, justifyed by the oil companies, may have appeared to host governments or be the agents of Western economic imperialism. However, these entities have seemed to the governments where their ownership was based to be increasingly autonomous in the world arena. In short, the multinational corporations were becoming independent actors beyond the reach of any national government to control.

There were, of course, consistencies between political nationalisms and multinational economic enterprises and concurrent development led to numerous localized conflicts. Governments nationalized foreign investments and multinational corporations sought support from their corporate domiciles and, occasionally, even independently supported attempts to
overthrew governments hostile to their activities. With the emergence in the early 1970's of OPEC as an effective intergovernmental oil cartel, these incidental collisions between nationalism and multinational enterprise escalated into a worldwide confrontation.

The communist countries—the Soviet Union, Eastern Europe, and China—viewed self-sufficiency for themselves (the Soviet Union and Eastern Europe exchanging substantial energy raw materials), and they consistently sided with the forces of nationalism in the less developed countries. The Cold War, however, permeated the entire course of events in the oil-rich Middle East.

Furthermore, the nuclear arms race between the United States and the Soviet Union may be viewed as a third development of overriding importance, one that has deeply affected the world energy context. The failure of the United States proposals in 1946 for nuclear weapon disarmament and for developing civilian nuclear power on a supranational basis, followed by the clash development, of nuclear technology for military purposes, provided the technological foundation for the world's only present alternative to fossil energy. Ironically, the widespread use of nuclear power may, if not effectively safeguarded by international means, greatly enhance the opportunities for nuclear violence in the world.

With these overarching themes in mind, we turn to the major historical trends intrinsic to the world energy context. From this perspective, the three decades since the end of World War II may be broadly characterized as follows: first, abundant supplies of low-cost energy from fossil fuels; second, electrification; third, realization of economies of scale; and fourth, nuclear power research and development.

In the first place, the period from the end of World War II until a few months before the Middle East October War was an era of cheap energy. Energy from fossil fuels became not only cheaper compared with the prices of other commodities, but also cleaner and more convenient to use. Oil and natural gas supplanted coal in residential and transportation sectors and also made substantial inroads in the industrial sector and electric power generation. This transition from coal to oil occurred, especially in the industrially advanced OECD countries, and consumption of low-priced natural gas grew fastest of all in the United States.

During the cheap energy era, the principal actors in the world arena, politically and economically, were a very large and vertically integrated oil companies. The largest of these were privately owned. Their task was to find, produce, refine, and market the world's low-cost deposits of petroleum. In the performance of their work, the major multinational oil companies were relatively unhampered by national governments. Two restraints were United States oil-import controls, instituted in 1959 to protect the higher-cost domestic oil industry from foreign competition, and the substantial taxes on petroleum products levied in Western European countries in order, among other things, to protect domestic coal industries. Oil revenues in resource-rich areas were relatively easy to obtain and revenues to the host government were kept low. Governments generally en-
largely nullified the strategic importance of the Suez Canal, as far as oil transport was concerned, although not with respect to military deployments. In addition, one large oil refinery is adequate to serve the needs of several small countries. The most economical electric power plant size means that relatively few plants are needed, and interconnections of power grids across national borders may be required. Hence energy technology dictates a multinational scale if it is to be used efficiently in many regions of the world. The result is deep interdependence as a physical fact. Furthermore, the large, complex, geographically scattered, yet intimately interrelated facilities involved in a large-scale fuel cycle, require highly centralized managerial control if they are to be operated efficiently.

In contrast to these efficiency requirements, however, politicization of the energy industry seems inevitable for a variety of reasons. The uneven distribution of energy resources among the nations of the world and the vital role of energy in all societies are two obvious facts. In addition, large-scale energy technology, implying a relatively few large facilities, tends to locate itself in one high political and strategic center. Despite the fact that the output may be distributed in several countries, the essential energy production or processing facility will be located in only one. The government of the country where the strategic facility is located will have a potential for control that other governments will not.

Finally, the highly centralized, large-scale, technically complex operations in the transportation, refining, and conversion steps of the various fuel cycles tend to create possibilities for intentional interruptions of energy supplies that would create widespread damage if they occurred. Such interruptions could occur not only as a result of a political act by the host government on whose territory the strategic facility was located, but interruptions could also result from an act of war against the host government, or a terrorist attack, or simply as a result of domestic turmoil and civil strife. Of course, vulnerability to interruptions or the extent of damage if they occur may be reduced by using energy technology on a smaller and less economical scale, by stocking up in advance, and by employing decentralized organizational forms. However, the economic and environmental costs of these approaches may be large. Moreover, safeguards against interruptions or diversions of fuel supplies could be applied to the various fuel cycles or by international agencies, but it may be doubted whether the nations concerned would grant any such international agency sufficient authority to be effective.

The fourth major feature of the world energy context in the post-World War II period has been the development of nuclear power. The uranium fuel cycle used in the generation of electricity employs the same fissionable materials and processing and conversion facilities as the fuel cycle used to produce materials for nuclear weapons.

Moreover, the Cold War with its nuclear arms race provided the political foundation for the enormous effort in money and technical manpower devoted to the development of nuclear power technology over the past two decades. The United States Atomic for Power plan in 1952 was motivated by...
a complicated set of factors that included recognition of, and frustration with, the approaching US-USSR strategic nuclear stalemate, realization that any chance of the development of civilian nuclear power under peremptory international control was lost, and belief that denial of access to nuclear power technology to all countries except those which acquired nuclear weapons would be morally indefensible and likely to accelerate nuclear development on a nationalistic basis. Although couched in terms of international cooperation, Atoms for Peace fostered a worldwide political atmosphere which helped to sustain competitive power reactor development programs in the United States, United Kingdom, France, Canada, and the Soviet Union, even as international cooperation in civilian nuclear research of a scientific character was expanded worldwide. International competition was much more effective than international cooperation could ever have been in accelerating the advent of economical nuclear power. Nevertheless, that development still took over a decade and the investment of several billions of dollars to achieve.

Not only was nuclear power development carried out on an internationally competitive basis, but it was essentially a government-controlled operation in all countries, including the United States. The money spent for research and development were public funds and government agencies determined how these funds were to be used, although in the United States much of the actual work was done by private enterprise under government contracts. In the United States two giant electric equipment manufacturers, both vertically integrated and selling everything from turbine generators to clock radios, were among the major government contractors. Both firms generated on a global scale through a complex network of affiliations and licences.

The central point here is the primarily political motivation and organization of the drive for nuclear power, in contrast to the primarily economic character of the drive for low cost fossil energy that was occurring at the same time. Over the years, the pace of nuclear power development had relatively little to do with a clearly perceived need for the energy on a particular time scale due to fixed fuel exhaustion, although the arguments were made by the experts. More important, while the governments that were engaged in the international nuclear power competition focused their attention and resources on the development of commercial nuclear technology, fossil energy resources and technology were almost entirely overlooked. The private sector was investing moderate sums from retained corporate earnings in coal mine mechanization and off-shore oil and gas technology, but nothing like the amounts that governments were prepared to devote to the race for a nuclear power reactor.

With the light water reactor using low-enriched uranium fuel, the United States seems to have emerged the major winner in the competition for the first generation of fission power reactors. Which country will win the competition now underway for a commercial breeder reactor remains to be seen. The race is, true to form, being run on a primarily national basis. It has involved massive infusions of money into a single technological type—

the liquid metal fast breeder reactor. Can that many governments, aided by their industries, technologists, and taxpayers, possibly be wrong?

The upshot of devotion to nuclear power development is that nuclear fuel is now economically very competitive with fossil fuel in the generation of electric power. In fact, this situation obtained in many places before the recent enormous oil price increase and substantial increases in other fossil fuels prices.

In any event, the economic feasibility of nuclear power casts two major factors: fossil fuel costs that are high compared with these generally experienced during the cheap energy era and an electric power supply system that is already large enough and with a projected growth rate high enough to absorb a large increment of power generating capacity. Thus nuclear power may still not be a practical option in many countries with relatively small installed electric power capacity. In general, the advent of nuclear power would seem to reinforce most of the major existing trends in the world energy context, including decentralization and economies of scale.

While the worldwide oil industry was politicized only recently, the nuclear power industry was politicized from the start. To this extent, nuclear power development is likely to continue to be highly political. Moreover, the widespread use of nuclear power inevitably broadens the risk of nuclear weapon proliferation to governments and also to non-governmental criminal or terrorist groups. It remains to be seen whether nuclear power technology is compatible with a world community in which violent behavior is widespread.

ACTORS

Who are the main participants in the processes of claim and counterclaim, action and reaction, where energy policy is made and implemented globally? Oil has been by far the largest energy commodity flowing in international trade. Compared with oil, trade in coal, natural gas, and LNG has been small, although international commerce in nuclear fuel and technology has been growing rapidly. Until the 1970's the United States was largely self-sufficient in energy, as were the communist countries as a group. Thus, the primary actors in the energy field in the world arena were the multinational oil companies, most of them owned by United States shareholders. The emergence of OPEC as a multilateral, intergovernmental oil cartel, and the widespread nationalization of oil reserves and production capacity by producer country governments has prompted the governments of consumer countries to respond in a variety of ways. The general effect has been to shrink the area of autonomous action of the multinational oil companies from both ends. Whether this result is good or bad will be argued for years from diverse points of view, but the shrinkage in the autonomy of the multinational oil companies that has occurred so far (still leaves them with substantial economic and political power in the process of deciding on a global scale who gets how much oil at what price. The fuels that governments of both producers and consumer countries have acted to restrict are—
role of multinational oil companies and the possibility of further constraints in the near future may suggest that the nation-state is emerging or reasserting itself as the primary actor in the energy field.

Much current thinking tends to view nations simply as energy importers, self-sufficient, or exporting. This is too simple. For example, the United States is currently the world's largest oil producer and also a leading oil importer; a coal exporter, a natural gas and LNG importer, and by far the world's largest exporter of nuclear power reactors and suppliers of uranium enrichment services. Another example, Canada is, on a national-wide scale, self-sufficient with its developed energy capacity and potentially more than self-sufficient, given its underdeveloped energy resources. Nevertheless, since there is at present no operable transcontinental pipeline, oil and gas flows from fields in the western Canadian provinces to the United States, while the eastern provinces are almost totally dependent on oil imports from the Middle East. As a third example, the Sheikdom of Kuwait, a small sparsely populated patch of desert situated on top of an immense oil reserve, feels itself effectively restrained from nationalization by its lack of technical "know how." Thus, analysis in depth of a particular nation's energy posture and potential is likely to reveal a very complicated picture.

There is a tendency when thinking globally about energy, as about other matters, for some persons to divide the plane into the Free World and the Communist Bloc. Until recently, the Soviet Union and East European countries developed their energy resources and economics in general on a largely self-contained basis, although substantial energy transactions occurred among the socialist countries themselves. However, the Soviet Union is now exporting nuclear fuel and some natural gas to Western Europe and is considering a number of massive deals to exchange some of its oil, gas, and coal reserves for Japanese, European, and/or American fossil energy technology. Meanwhile, Eastern Europe is importing increasing amounts of oil from the Arab countries. Even the government of the People's Republic of China, which has made energy self-sufficiency a master of high principle and is relying on its immense coal reserves to achieve it, is now exporting small amounts of oil to Japan and is considering importing oil technology from Japan or the West.

Finally, the most recent tendency is to divide the nations of the world into rich and poor or industrial and Third World. The impasse for such a division has come from the poor countries, apparently to dramatize their plight and increase moral, if not political, pressure on the rich countries to render them aid. Regardless of the merits of such a polarization for other purposes, with respect to energy policy a division of the world into rich and poor tends to confuse the analysis. For example, some poor countries are rich in energy resources. Nigeria, Indonesia, and Iraq have large oil reserves, while Niger and Gabon have large uranium deposits. On the other hand, some of the most industrially advanced and affluent countries are almost self-sufficient in indigenous energy resources. Japan and Denmark come to mind in this regard.

Willich: World Energy Policy

To round out our impression of the actors on the world energy scene, one further level of complexity may be introduced. National governments must be disaggregated and the dynamic balance of domestic political forces within each nation must somehow be taken into account. For example, the economic fortunes of the United States-based multinational oil companies depend in part on the personal political fortunes of those struggling for leadership of the major political parties in the United States. The attitude of Saudi Arabia toward oil prices, production rates, and exports to the United States is influenced, if not determined, by the Monarchy's hostility toward communism and fear of domestic insurgency fomented by outside communists.

Just as domestic political factors condition energy development and production policies of exporting countries, so do they influence policies affecting consumption in the importing countries. It may be noted that most of the countries in the world with functioning democratic political institutions are large energy importers. It remains to be seen whether democratic institutions and parliamentary forms are necessary to be changed in times of economic growth and abundant energy supplies, or whether such injustices can also deal effectively with conditions of chronic scarcity requiring stringent rationing and conservation.

Thus, the energy posture of the major consuming and producing countries merit analysis with the same care and attention to detail as the United States and the Soviet Union have applied over the years to the analysis of their own and each other's military postures. A nation's posture with respect to each fuel cycle—oil, coal, natural gas, nuclear, and hydro being the chief of primary interest at present—may be assessed with reference to the source materials, facilities (transport, processing, and conversion), know how (technology and organization), financial capital, and industrial structure (including government-industry relationship). The nation's posture with regard to energy consumption may be subject to similar scrutiny in terms of growth rate and efficiency of energy use. (Perversely, the inefficient energy use may be held back by a partial supply interruption than the efficient use.) The analysis would be aimed at assessing a nation's strengths and weaknesses, existing and potential, in the energy field, and in determining the nature of its linkages with other actors.

Parallel analyses of private multinational corporate actors and inter-governmental organizations in the energy field may be conducted. Here again the effort would be directed toward an appraisal of the capacity of each of these types of institutions to act independently in the energy field and of the interconnections between each actor and the others in the world arena. In sum, how we describe and categorize the main actors in the world energy context will largely determine how we evaluate their performance. Such an assessment will also determine how we structure institutions to manage the international and global aspects of energy problems in the years ahead.
short run arises from the exorbitant prices the OPEC members can and do charge for their crude oil, prices that are unrelated to the very low Persian Gulf production costs. The word "prices" rather than "costs" is thus intended to highlight the continuing need at every step in each of the various fuel cycles for prices charged to bear a reasonable relation to costs, including, of course, an appropriate return to the owners of resources and operators of transport, processing, and conversion facilities. Second, the qualification that energy prices should be "equitable," rather than "reasonable," implies not only a reasonable relationship between prices and costs, but also a notion of distributive justice. Hence, in allowing energy resources throughout the world, it may be desirable to consider factors other than ability to pay the asking prices, even though those prices were derived from economic criteria. Three reasons for departing from economically efficient pricing might be distribution of a minimum level of energy deemed essential for the health and safety of any social community, restriction of energy consumption to a maximum level deemed essential to conserve the world's nonrenewable energy resources, and preservation of an appropriate relationship between the price charged for energy exports and the prices paid for goods and services in exchange. Nevertheless, before adopting any departures from economic pricing of energy, the scheme should be carefully weighed against the alternative of direct subsidies.

Finally, the term "acceptable environmental consequences" is included expressly as an integral part of a world energy policy goal. Many persons may presume that an energy pricing scheme would include a mechanism for internalizing environmental and social costs. However, there is substantial evidence of a tendency among policy makers to ignore or suppress concern for environmental values in developing credit programs to solve energy problems. There also appear to be major risks in doing so. For example, energy consumption on a worldwide scale may turn out to be limited not by limitation of our appetites, nor by resource exhaustion, but by the capacity of the biosphere to absorb the heat rejected without uncontrollable and irreversible changes in the earth's climate.

Finally, we may inquire whether a comprehensive statement of energy policy goal is biased in favor of energy consumers and against producers. At first glance, "abundant energy at reasonable cost" would seem heavily consumer-oriented. "Assured supplies of sufficient energy at equitable prices with acceptable environmental consequences" may also appeal to the vested interests. However, "assured" supplies for consumers implies assured markets for producers, "equitable" prices implies a balancing of all relevant interests, and "sufficient" energy signifies not only that consumer countries have a legitimate interest in exporting country production policy, but that third producer countries have a reciprocal interest in importing country energy conservation policy. As with other public policy areas, criteria are necessary in the energy policy process to provide a means to measure intrinsic performance toward achievement of specific energy policy goals, to provide a means to evaluate the extrinsic impact of proposals and actions in the energy field.
posture may appear to be a security threat to neighboring countries with- out nuclear weapons, requiring an offsetting response. Other steps toward the development of complete energy self-sufficiency by one nation may also appear provocative to another. For most nations, interdependence in en- ergy is an inescapable fact. The People’s Republic of China, one of the most self-contained economies in the world, nevertheless exports small amounts of oil and imports oil extraction technology. More fundamentally, primary fuel cycles extend the globe with complex production, transporta- tion, processing conversion, and distribution networks. No nation in- volved in these networks can pull itself away without damaging itself as well as many others.

When we think of energy security in global terms, therefore, the choice between self-sufficiency and interdependence is exact. For most of the world, the question with respect to energy security may be stated as follows: How can mutual security be developed and enhanced in energy relationships that are necessarily interdependent?

I have played with the words in the tentative statement of policy goals and criteria long enough for us to understand that each term begs a variety of questions and marks a number of deep-seated value conflicts. Indeed, my goal formulation does little more than state the problem. Such word play is an important game, however, in clarifying intentions and com- municating effectively in a political process that is based partly on assent. This is especially the case in international diplomacy.

Hopefully, diplomatic rhetoric will eventually produce a broad consensus on an energy policy goal or set of goals for the world community that are sufficiently definite to have operational significance, unlike my statements or, for that matter, Dr. Kissinger’s authoritative declaration. In the meantime, however, it will be equally important for diplomacy to prevent, or at least to minimize, the use of coercion to solve energy problems.

Strategic Energy Options

In our pursuit of desired policy goals through preferred institutional structures, the basic strategic options we have to select from are necessarily circumscribed by the world’s resource base and by our past actions and policies.

On a global scale we are limited for the next decade or so to four stra- tegic options: (1) restore cheap oil; (2) develop higher cost fossil fuel re- sources; (3) accelerate fusion power; and (4) limit energy demand. To illustrate the opportunities and constraints in the current strategic context, the restoration of cheap oil would not be possible if there were not large oil reserves producible at very low costs in the Persian Gulf and else- where. Such oil reserves remain for everyone to contemplate. As a second example, fusion power or solar energy is not a strategic option now or in the immediate future because economical technology has not been developed. Either or both of these technologies might have been ready now for widespread application if their development had been pushed as aggressively as fusion power in the previous decade. However, this did not happen.
All four strategic options specified above are interrelated. Furthermore, they can be pursued in ways that will either complement or complement each other. Thus, development of higher cost fossil energy resources or limiting energy demand may induce a drop in oil prices. Alternatively, combined high revenue may be realized on cheaper oil by simply pegging the price at or near the price of higher cost alternatives.

Obviously, the relevance of a particular option and the capacity to pursue it will depend on the energy posture of the nation involved. Some may adopt tactics enabling them to pursue a combination of all four strategic options simultaneously. Others will have very limited capacities to pursue any option. Some nations may want to halt their actions with others in joint or common efforts, while other nations will prefer to act independently. And, of course, some will remain as aloof as possible.

RESTORE CHEAP OIL

The world’s known reserves of low-cost oil appear adequate to meet projected worldwide demands for a few more decades at least. Therefore, one option is to reduce substantially the current world market price for crude oil. The level might be determined competitively, or by application of appropriate standards of economic efficiency.

The era of cheap oil might be restored in various ways. One way, and probably the least likely, would be the discovery of oil provinces comparable in magnitude and production costs to those centered in the Persian Gulf. A second, and somewhat more likely way, would be for the OPEC cartel to be broken and vigorous price competition restored in the world market for crude oil. Some may argue that the OPEC price agreement could be breached by concerted government action of the OECD consumer countries. Others may argue that the OPEC cartel would be more effective, namely, disincentivizing the operations of multinational oil companies downstream from the wellhead, thereby achieving a more competitive industry structure.

A third way for cheap oil to become readily available on the world market once again would be for the OPEC cartel to self-destruct. Of the three possibilities, this is perhaps the most likely to occur, given the absence of a political consensus and the disparate economic needs of its members. Indeed, cracks in the common front have already surfaced on almost every substantial issue—price, production ratio, nationalization, and conditions for future foreign investments.

If economically efficient oil prices were re-established, the outcome according to economic theory would be a worldwide allocation of oil that would result in the greatest benefit to the largest number. The primary beneficiaries would be the present generation of consumers in both rich and poor countries. World prices derived from costs rather than monopoly power would induce a growth rate in demand for oil that would drain even the Persian Gulf’s low-cost reserves in a few decades.

The $7.10 per barrel current cost of the multinational oil companies to obtain oil from Persian Gulf sources, 10 cents is the cost of production and $7.00 is the government revenue. This shocking fact colors the entire world oil scene. The current level of oil prices will have inflationary and recessionary effects on all national economies (except for the oil-exporting countries), will retard economic development and reduce food supplies in poor countries, and will convert an oil weapon into an even more powerful money weapon in the hands of a few Arab countries.

Time will not necessarily resolve the problem because last reserves of low-cost oil will remain for decades, if the governments of the producing countries are able to maintain the OPEC cartel. Thus, restoration of these oil prices will remain an energy option for some decades to come and whether it is exercised will depend on political factors.

DEVELOP HIGH-COST FOSSIL ENERGY RESOURCES

At or near current world oil prices, a range of alternative energy resources may become economical, including oil and gas resources in the outercontinental shelf and Arctic region, natural gas liquefaction and long distance transportation, coal gasification or liquefaction, and oil extraction from tar sands and shale. (We could also include in a longer time scale non-fossil resources such as fission and solar energy.) There is no shortage of paths to pursue to bring large supplies of energy within reach, assuming the benefits are deemed to outweigh the risks and costs. However, the outstanding fact about every one of these options is that it will require large investments of capital and many years before any of them will make a substantial difference in the world energy picture. Moreover, many of them require the development of new technologies before commercial exploitation can proceed. Finally, the environmental costs appear substantially greater than use of existing low cost fossil fuel resources.

We might think that future generations would benefit substantially if higher cost fuel resources were developed now. We might also believe that investment in higher cost energy resources would reduce demand pressures in a sellers’ market and pave the way toward a break-up of the OPEC cartel. However, just as the cost of effective substitutes for Persian Gulf oil established a ceiling on the monopoly price that OPEC may extract, so also the OPEC monopoly price may be viewed as a price floor on which private investments in alternative energy resources rest. Governments will either have to underwrite private investments and guarantee them against cheap oil, or make investments themselves directly in higher cost fossil resources. The cost of these actions will be high and ultimately borne by the consumers in the prices or taxes they pay.

ACCELERATE Fusion Power

The acceleration of fusion power is already occurring in a number of countries, notably France and Japan, in response to the oil crisis. The central issue is whether to accelerate fusion power in view of the unresolved uncertainties that the industry faces. These uncertainties do not relate primarily to the future price of oil or other fossil fuels, nor to the future de-
imposes, and reduces emission of wastes. Moreover, a nation with high per capita energy consumption can, by conserving, make more energy resources available to those with low consumption rates.

There is a wide discrepancy in the capabilities of governments to limit energy demands. Despite the obvious foreign policy advantages of energy conservation, it would seem that countries with democratic political institutions may have a much faster time limiting demand than more authoritarian forms of government. Indeed, it remains to be seen whether parliametary institutions can survive in prolonged periods of scarcity of essential resources.

Regardless of government capabilities to act, there are severe limitations on what can actually be accomplished by energy conservation, especially in the short run. For example, the existing stock of energy conserving technology—buildings, automobiles, industrial machinery—may be made more efficient but retrofitting or replacement takes time as well as money.

There are also practical limits on the ability of any government to institute cutbacks in energy consumption that would be reflected in reductions in employment and economic activity. There is always danger of a downward spiral destroying the economy or bringing about the downfall of the government, or both.

Thus, while talk of energy conservation is easy, decisive action is difficult. Perhaps the most fortunate are those few privileged societies who have wasted the most in the past. In such circumstances, less may really be better. However, for most of the nations of the world and the overwhelming majority of the world's population, essential energy demands are likely to remain unsatisfied for the foreseeable future.

CONCLUSION

All aspects of energy policy rest on expectations of stability. Hence, energy policy requires concrete expression in the form of law operating within and also among nations. Economic and political forces in the energy field have recently made many of our national laws and institutions into obstacles to the effective solution of the problems at hand and emerging. The same forces unleashed in the world arena have wiped the slate quite clean of international legal principles and generally accepted norms of national behavior regarding energy development and use. The need to rationalize energy relationships at worldwide, long term, and urgent. Thus, a primary task in the years just ahead will be the development of new legal foundations for stable and mutually beneficial international energy transactions in the world community.

LIMIT ENERGY DEMAND

Prices, government allocations and rationing, and long queues are devices to limit demand. Reductions in demand for energy would diminish the magnitude of many energy problems and extend the time for solving them. From an international perspective, reductions in domestic demand for energy can lengthen the lifetime of energy resources, reduce the need for
Since all human acts are also communications, the two kinds of change are intimately related. (4) Since the human agents who consider and make such changes are themselves part of the system that they are trying to regulate, their action (or inaction) is bound to have effects on the system beyond those invited by the perceived problem and perhaps beyond their own anticipation. So the success or failure of any intervention has to be reckoned by considering its costs and benefits in more than one dimension and over a span of time that is itself problematic. (5) The constraints that limit possible action (and inaction) include not only scarcity of resources or technologies but also differences in the perceptions and value judgments of all who have any power, positive or negative, to influence policy. Both trends of constraints can be changed within limits, including limits of time, but by different means. (6) The historic process within which policy works is itself generating change far beyond all those deliberately initiated by human policy. One manifest source of these changes is the instability of many of the political subsystems of which it is composed.

We stress these facts not because we doubt the usefulness of the "vortex" on which we are engaged but because we think it essential to the success of that enterprise that they be borne in mind. They can be summarized by the statement that we are part of a process that is both historical and dialectical. We may differ in our understanding of these terms and we conclude this section with a note of some of these doubts and differences. However, we do not differ in believing that, whatever the future of material progress as this has been understood by developed countries through most of the last two centuries, progress towards a more humane society, and that towards higher standards of what being human means, is possible, desirable, and sufficiently recognizable to guide action in the actual contexts of life for men and societies.

One of the elusive theoretic questions to which we have no agreed answer is the way in which men take personal and collective decisions involving the comparison of estimated costs and benefits that appear disparate and impenetrable. Some economists concerned with policy positulate a "welfare function" that somehow subsumes such diverse factors and makes possible the comparison of alternative courses; men constantly and confidently make such choices, while others, including professionals, at that time and later, confidently criticize them. We believe that this is a supremely important and valid function of the human mind and that much can be done to make it more effective. We are concerned only to point out that for at least some of us it is a dialectic process different in important ways from the process by which knowledge has accumulated in the natural sciences.

RECOMMENDATIONS

Any such doubts on differences as may divide us have not prevented us from discussing and reaching partly agreed on conclusions in three important areas. The first concerns the apparent conflict that frequently arises between development policy and environmental policy. The de-
ever, is not wholly or perhaps even mainly a technological problem of food production or the logistical threat of limited resources.

Today the amount and kinds of food produced, the amount of cereal converted into animals for food, and the distribution of the world between nations and classes are largely determined by market mechanisms and by government interventions designed to benefit national economies. We will not try to summarize how our discussion of these complex factors but we have no hesitation in assigning high priority not merely—or even chiefly—to the study of increased food production, but to the study of a system that elicits and distributes the present volume and mix of foodstuff and to the means whereby this may be made more responsive to human need.

Food distribution is only one example of the presently universal pattern that the poorest come out worst. We have, therefore, paid particular attention to the distributive aspects of the developmental process. This process has produced gross inequalities of wealth and income both within developed countries and between them and the rest of the world. As Professor Riesenberg’s studies have shown, the just of these trends is abating in most, if not all, of the developed countries, partly as a result of political action, but not in the second countries, except those underdeveloped countries that command but do not yet depend on resources needed by the developed world. Oil is, of course, the most familiar example of this. We believe that the gap between rich and poor needs to be reduced, both within nations and between nations. However, these two problems are different and invoke somewhat different solutions.

Where changing terms of trade give underdeveloped countries a favorable balance of payments with the developed world, the fact should be welcomed as correcting by orthodox economic means the injustices to which we have referred. This should apply whether the change derives from a change in the international value of raw materials or from successful competition, by relatively underdeveloped countries, in the market for products involving simpler technologies and more intensive use of labor. We do not believe, however, that international market mechanisms will suffice to meet the needs of those countries that most need and have least to offer. We recognize, therefore, a need to supplement the market by transfers of money or by required purchasing power on a much larger scale than hitherto, as well as a need to make it more efficient. We observe that all developed countries within their own orders have recourse to the same device, partly for ethical and political reasons and partly to sustain the market.

We advocate these changes chiefly because we find it ethically unacceptable that starvation and extreme deprivation should coexist with such abundance as is to be found in parts of the developed world. We advocate it also for two other reasons. First, experience seems to show that deprived classes multiply faster than those with a higher standard of living, so we believe that reducing extreme deprivation will contribute to producing a more balanced world population. We advocate it also because we believe that whatever the political system of a country, its citizens will claim and
exercise the rights and responsibilities of citizenship better if they are relieved of the pressures invoked by the need to survive in conditions of extreme deprivation.

The extent to which developed countries can thus contri but e to the support and development of those which are less developed is subject to several constraints. Some of these are inherent in the political, economic, and social status of the potential recipients, which vary greatly. The main variables seem to us to be as follows. (1) Some, although undeveloped, have a high ratio of resources to population while others are already pressing on their resources so intensely as to create immediate crises of famine and to offer no clear prospect of relief even in the longer term. (2) Some areas are characterized by systems geared to maintaining existing wide differentials of wealth, land, and income and show no present intention to modify this form. (3) Some lack the infrastructure needed to support the degree of development that the potential allows, notably administrative and technological skills. (4) Some are opposed to developments on Western lines, either because they fear to introduce some features of contemporary Western culture or because they mistrust the instruments of Western penetrations, whether the multinational corporation or implicit political dependence.

Concerning these constraints we think it useful to make only the following recommendations. (1) Whatever form of aid is offered and received should be a form desired by the recipient state and acceptable to the providing authority as likely to advance the objectives here recommended. (2) Aid offered should as far as possible be free from implied political or economic dependence. (3) Aid commanded by the two preceding criteria should not be withheld merely because it is likely to be resisted, although investments that are ultimately self liquidating are to be preferred in that they ultimately free resources for other uses. We think it utopian to suppose that the redistribution of wealth and wealth producing power throughout the world can ever be achieved solely by the criteria applicable to successful investment. (4) Aid should be adapted to the current needs of the recipient country. In highly populated but undeveloped countries, labor intensive activities are likely to need occupation for more than capital-intensive activities. In India, for example, it is clearly more important to increase yield per acre than yield per man.

Apart from the constraints inherent in the recipient countries, four major constraints are inherent in the potential donors. The first is their willingness to give. Present levels of international support through governments and international organizations, although substantial, are far less than the situation requires. The role of multinational corporations, although expanding, a controversial. Both involve major shifts in standards of collective and individual responsibility. The second constraint inherent in the position of potential suppliers is their ability to supply what receivers want. They are largely geared, both technologically and mentally, to supplying the needs of highly developed, capital-intensive societies. The third constraint is their own instability, especially the financial instability, repre-

sented by inflation informally and imbalance of payments externally. A fourth constraint, collective rather than individual, is the inadequacy of international organization in those fields that require forms of regulation beyond the simple transfer of buying power, notably the regulation of the use to be made of the oceans.

The first of these constraints will be greatly exacerbated by the need to equalize the distribution of wealth within countries. Hilberto it has been commonly assumed that the poor can become relatively richer without denying some increase of income to the rich, merely by skewing the distribution of that part of the income in GNP which provides net real personal disposable incomes. It seems that this had ceased to hold in America as well as in Britain, in 1973, and that powerful forces are at work to stabilize or even reduce total net disposable incomes, in real terms, at least for a few years. The most obvious of these forces are the worsening terms of trade for oil and the need for vast investments in developing atomic and other sources of energy.

Some of us think that this check to the growth of personal incomes is not likely to continue for more than or 3 years so long as GNP continues to rise. At least one of us expects it to continue much longer, perhaps indefinitely. In any case, it is a fact today. Any reduction of income disparities even within developed countries will have to take place in today's conditions by reductions in real terms of the latter incomes in favor of the lower ones. We do not think that this painful process can be safely or expeditiously left to the resilience of inflation.

We believe, therefore, that high priority should be given to studying how to move toward greater equality of incomes, within and between nations, on the lines indicated by Professor Timberg. We believe further that many other problems arising from inequality of human rights will be abated by reducing inequalities of incomes.

A formal example of a need of high priority is a consistent and efficient management of the oceans. Their importance is 2-fold: (1) They are the final dumping ground of all wastes of rivers and hence of large areas of land. Their pollution has assumed frightening dimensions and needs control. (2) They are the producing medium of seafood, oil, and metals from nodules. An orderly and equitable sharing of these production processes is an interest of both developed and developing countries. This implies avoidance of over-fishing, a shift from fish hunting to fish farming, and a licensing of exploration and exploitation of the oceans' mineral riches. This process should be fitted into the oceans' functions of maritime transportation and maritime research.

OPTIMAL DECISION LEVELS

All social processes which together constitute human history require consistent decision-making: political, economic, cultural, and so on. For each type of decision-making optimal levels exist, that is, levels at which the decisions lead to the highest world welfare attainable under given circumstances. Numerous decisions are made at the family or the enterprise
level, many others at local, state, or central government level, and still others at the level of trade unions, employer associations, and so on. The main reason why decisions taken at lower levels may not be optimal is that they have external effects which are taken into account insufficiently. The most important criterion of optimality of some level of decision making of a given type is that the level should be high enough to make externalities negligible.

With the growing interdependencies in the world—as a consequence of technological development—the optimal level for some important policy and economic decisions has become supranational. Business has been aware of this and has created multinational enterprises. Governments of nation states, however, have been reluctant to recognize this need, to the detriment of the welfare of their populations. Since the 1930s' beggar-my-neighborhood policies have been frequent and rightly have been criticized. Some of the international agencies, such as the IMF, were created with the purpose of avoiding some of the bad policies of the 1930s.

Between 5 and 10 important areas of international socioeconomic policies nowadays require supranational decision-making and the institutions necessary for it. Among them is the management of the oceans, already listed as an urgent priority. Other examples refer to decisions on the monetary system (where IMF does not yet have sufficient machinery) and to decisions on international development financing. The World Bank is probably the best equipped international institution in the field of financing through loans. However, inside well-integrated national communities development financing out of a current budget financed from current revenue is far more important. Such financing is done by the Treasury, which for this reason is the most important institution inside each country. A similar institution is badly lacking in today's international community—at least the noncommunist community.

Still another area in which supranational decisions are badly needed is trade. Since the Havana Charter of the planned International Trade Organization (ITO), drafted in 1947, was not ratified by the United States, all that remained of the original and excess approach to some international decision-making in the trade field, was GATT, a more-organization-center. Because trade policies remained in the hands of nation states, it has been possible to maintain the suboptimal present trade patterns to the detriment of all peoples, where labor-intensive products are produced at too high costs in some developed countries and capital-intensive products are produced, also at too high costs, in some developing countries. This has implied mass unemployment in developing countries and foreign workers in developed countries instead of more employment at home for these foreign workers.

Other examples of subjects where supranational decision-making would be better than national are those of research and development and of commodity agreements. As a consequence too little research and development is undertaken to solve problems of developing countries and some problems of large countries (the United States and the Common Market) are able to stay outside the sugar agreement.

All these examples show that the unimaginative policies of nation states which so far stick to the fiction of national independence have brought us to a highly undesirable state of world affairs with weak and unstable monetary systems, with a highly unsatisfactory division of labor among countries, and with much more poverty than is necessary. Intellectuals should not hesitate to continue their warnings that our system of international cooperation—or lack of it—is the best example of antiquated social structures. It has been rightly said that they will be wiped out by the "development of the productive forces." Better than waiting for their collapse we should consciously replace them by more modern structures, that is, structures obeying the criterion of optimality, or, in other words, without externalities.

We spent much time discussing the role of the intellectual in the process of change and social learning which will certainly involve our own countries, if they are to play their parts in resolving these or any other problems of high priority to a society in transition. By intellectuals we do not mean only academics, or even only those who have had a formal higher education, but all those who are concerned with the problems that this conference is pursuing and who are able and willing to support their concern with disciplined pursuit of understanding. We cannot anticipate all the ideas which are, but we summarize a few of them. (1) The nature of the dialectic process in which we are engaged requires all who would play a useful part in it to keep their own assumptions under constant review. (2) It also requires that this monitoring process be to some extent institutionalized. We welcome the increasing practice in both private and public sectors of institutions evaluating the results of their policies. However, experience shows that the lessons to be drawn from such exercises are often ignored, unless the information is available also to concerned people and organizations outside the institution concerned. Organizations that might play this role include professional organizations, voluntary bodies organized around special interests, institutes within universities, and international organizations both public and private. Foundations could play an important role in such developments. (3) There is need also for public education in the interrelatedness of policy issues and the variety of costs and benefits involved in any policy. Such education calls for the invention of new instruments and devices such as the "social planning" referred to in our prospectus. (4) There is an acute need for better theorizing about the dialectical process involved in policy-making and about the roles of all concerned. We welcome the advances that have been made in this field in the past two or three decades but we believe that the time is ripe for a major shift in our understanding of the political process as a dialectic extended in time.

We believe that this sharpened concern for understanding our own and our neighbor's situation is needed not only as an instrument to facilitate...
desirable change by generating consensus and abating suspicion, but we believe that it is also good in its own right, deserving a high place in our priorities. For, as we are beginning to learn, even the most desirable of services cannot be packaged and delivered, like goods to consumers, without losing much of their virtue or even going bad. The most important of all development is the development of individuals capable of mutual understanding and mutual trust.

ON THE "WESTERN HERITAGE"*

Geoffrey Vickers
Little More
Going On Thursday
Reading, England

I should like to put one thing on the record. It is a partially considered thought and it may not fit into our deliberations, but it has been borne of the experience of this last week, which I have personally found extremely rewarding, and it concerns the real meaning of this ambiguous expression "the West." We of the West, and the rest of the world, have come to identify this more and more with science and technology. The future of science and technology has become increasingly startled up beneath problems of limits to growth. I think it might be well if we took a rather longer perspective and remembered that in the days of our grandfathers, the West meant the blessings of civilization, shall I say, my grandfather, other people's great grandfathers, or great great grandfathers? The West meant the blessings of civilization, and the blessings of civilization meant the Christian religion, secular education, and parliamentary democracy. The increasing abundance of the material infrastructure was regarded as a desirable and perhaps necessary support for this conscious construction.

But what the confident nineteenth century thought it was taking to the rest of the world was not science and technology. It was the combined cultural package that I have roughly summarized under these three headings.

Later, it seems to me, there came a pause when even the West began to regard this heritage as somewhat mixed, and when the still separate gifts of science and technology became more dominant, then a sense of an uncontrollable dynamism that had been somewhat released by the Western industrial system began to produce a sense of inevitability. The original sense of mission was replaced with a sense of inevitability: this was the way the world was going, and although the mission of the West to carry this enlightenment to the darkened corners of the world was no longer felt to be wholly beneficial, it was an inevitable force that would beat everybody into the same pattern. Even at this stage the marriage of science and technology had not really taken place in the sense in which it has taken place now.

Still less was the link between all this and the earlier version articulated. Even when the report on the resources of the future was produced by a committee in this country sometime in the late 1940's or 1950's, the whole of this infrastructure of resources and development was seen as something that was a necessary base for "freedom."

Since then we have moved away, and the last chapter of this, which is the

* Addendum to Group Report I.
some of the limitations crowding in from a finite planet, is really only the last wave of a change that has been going on for a long time. Even if there had been no Club of Rome, no book about the Limits to Growth, and no formulated question or formulated debate about this, the West would still be taking stock, exactly as this conference has been taking stock, today of what its new standard for, what it was contributing, what it had inherited of enduring promise, and what it had generated of frightening threat. All this would be true if there had been no Club of Rome, and although I reasonably think that the Club of Rome or the Limits to Growth has probably served a useful dialectical purpose in starting a debate on many issues, all of which deserve discussion, and some of which, like the almost uncontrollable population issue, deserve thought now in the context of the manageable 20 or 30 years, it has also revealed an extremely important issue relevant to society in transition, which would be there even if there were no pressure of physical limitations.

The fact that this needs saying, as a reminder, has indeed only surfaced in my mind after a week's exposure to this discussion. This shows, I think, how far we have moved even in the West and within the western culture and within the frame of western emphasis, from what our previous ancestors, only a few decades ago, regarded as "the West." I am not quite sure how these thoughts fit into anything that has been written, said, or done in the last week, but as they had surfaced in my mind this morning, I accept your invitation to put them into the mill.

WORLD PRIORITIES—ENERGY RESOURCES AND ARRANGEMENTS: GROUP REPORT 2


In this statement we address ourselves to one of the world's major problems, energy utilization. Our analysis and recommendations are framed as follows: (1) elements of the world energy situation, near-term (to 1985) and long-term (beyond 1985); and (2) recommended directions and priorities for action, near-term and long-term.

ELEMENTS OF THE WORLD ENERGY SITUATION

It can be said that energy use is a prime component of the high standard of living to which all people aspire. Thus, the improvement of man's material well-being has been accomplished by a rapid rise in the rate at which he uses energy. In the past, abundant supplies of readily accessible fossil fuels have been available at low cost and have flowed relatively freely across national boundaries. Thus, our use of energy has grown exponentially; in the post-World War II period this growth has exhibited a doubling time of about 15 years. Although this growth has occurred throughout most of the world, it has notlessoned the vast inequality in energy use between rich and poor regions. The United States, with 6 percent of the world's population, uses 33 percent of the world's energy; the per capita consumption in the energy-poor countries is only about 1 percent of that in the United States.

We identify the major elements of the energy situation in the present and near-term future to be:

1. In regions of the highest use, the absolute magnitude of growth has outstripped the capacity of the fossil-fuel industry to keep pace with that growth. For a variety of reasons the number of reserve built in recent years has been insufficient.

2. Our growing awareness of the adverse environmental impact of fossil energy sources has introduced an additional impotence into the nations' planned programs of energy expansion.

3. From the large spectrum of technological possibilities only one new energy technology has been developed since World War II—nuclear energy —and the rate of its development and introduction into the energy economy has been slower than had earlier been anticipated, because of both technical and environmental problems.

4. Recent international events have included both sharp increases in

* Chairmen.

Rapporteur.
the price of the essential fuel, petroleum, and restrictions of its flow across national boundaries, creating a widely perceived "energy crisis" and exacerbating the other problems cited.

Looking to the longer term future, we identify three major components of the energy situation:

1. We have become fully, albeit belatedly, conscious of the finite extent of our earth's resources and of its life support system. Our fossil-fuel resources will be essentially exhausted in about one century (somewhat earlier for liquid and gas, somewhat later for solid fossil fuels) if we continue our present patterns of use. Therefore, we must develop alternative energy technologies for the future.

2. We must accept that the exponential rise in energy consumption must continue, indefinitely, throughout the world. It will cease either through a rational plan of our design or by disruptive events that are not in our control, such as a power blackout and/or international conflicts over increasingly scarce supplies or transportation of the environmental sovereignty of nations.

3. At the same time, we recognize that the per capita energy consumption of the poor regions of the world must continue an exponential rise until it is approached that is adequate but not unacceptably below that of the larger energy consumers.

Our Recommended Directions and Priorities for Action

The Near-Term Future (to 1985)

Recent political events have transformed what had been perceived as a future problem, by a few experts, into a situation that causes populations worldwide as a crisis. The western industrial nations and Japan had already been relying increasingly upon imported oil—a reliance that was lowest in the United States at 18 percent of oil demand in 1973 and highest in Japan at 90 percent. Recently, the supplies of oil from the Middle East have become drastically more expensive, and in October 1973 the flow of oil was curtailed as a bargaining mechanism in the Arab-Israeli conflict. This action appears to have brought to an abrupt and decisive end the era of cheap fossil fuel energy that we have enjoyed since World War II. Our goal for energy, to be realizable, must now be stated in more modest terms, namely a supply of energy that is sufficient for our real needs at equitable prices with acceptable environmental consequences. The question that we address here is, How is this goal to be realized?

Many nations have now declared a policy of the pursuit of "energy independence." Because of the vast international network of production, transportation, and processing that now exists, this may be an essentially impossible goal, but at least it is a sensible direction for policy. The alternate routes to national energy independence are clear: since we have been consuming more but producing less, we must now produce more or consume less. Neither avenue alone will allow the goal to be reached; both must be followed.

Energy Conservation

The highest priority and urgency must now be assigned to a vigorous program of energy conservation. Because energy has been so cheap, we have become accustomed to using it very wastefully; if we examine where our energy has been going, much of it piles up in the attic, on the exhaust pipe, and through the window. The energy that we waste contributes nothing to our standard of living.

The residential sector consumes about a quarter of our energy use. As much as 30 percent of this energy can be saved if we will adopt relatively simple measures such as insulation of adequate thickness, heating our houses a few degrees cooler during the day, using clock timers to turn off the heat at night, and reducing the use of air conditioners. These measures cannot be stimulated completely on economic grounds at present, because the absolute saving in monetary terms is not great. Tax incentives and altered utility rate structures, introduced through legislation, will undoubtedly be required, and we encourage consideration of these measures at the earliest time. Familiarity may also be motivated to practice conservation measures at home if they can be made to realize that they may save an amount of energy equivalent to the fuel needed to operate the family automobile for a substantial period, in some cases as much as a year.

In the transportation sector, the automobile is one of our most wasteful energy consumers, especially in the United States where it consumes over one-third of all the liquid fuel used. What kind of old had to be pulled by 500 horses? Yet, that is what many motorists have become accustomed to. Both legislative and social incentives will be required in order to reduce the present situation, but it is the very existence of tomorrow that guarantee the saving of tomorrow. There are many options open here, and we should pursue all of them: smaller and lighter cars, smaller and radically redesigned engines, optimization of vehicle design for efficiency than for power, increased durability, and reduced speed limits. An industry that for years has defined "efficiency" in terms of production costs rather than energy use cannot be expected to pursue these changes without external incentives, therefore consumer preference must be shifted by means of legislation that has real economic impact. Such legislation need not depress the lets affluent of automobile ownership, but rather should transform energy and resource wastefulness into an expenditure luxury.

Airplanes too are wasteful users of energy, especially for short journeys, in comparison to rail travel. This problem is especially severe in the United States where the railways have practically vanished. Appropriate government action can reverse this situation, and this action must be taken now.

In the industrial sector, many of our manufacturing processes have been extremely wasteful of energy, because of its low cost in the past. Industry is, however, very cost conscious, and this situation can be expected to correct itself as energy costs rise. We must examine carefully our increasingly energy-intensive industries to be certain that the overall benefit and need of these processes and products, otherwise, less energy-intensive substitutes should be found.
It has been uneconomic in the past to mine fuels efficiently, and in some cases we leave over half of the fuel in the ground. There is room for much improvement here in the area of secondary recovery, some of which will be stimulated as the value of recovered fuels rises. We must also counter the increasing tendency toward becoming "throw-away" societies and move toward becoming "recycled" societies. A recycle society is a less energy-intensive society, and is also, obviously, resource conserving.

All of these measures, and more, must be taken to reduce as much as possible our wasteful use of energy. However, we must also produce more energy if we are to meet our short-term needs without excessive reliance on imports or the imposition of fuel rationing.

Increasing Energy Supply

In most of the western world the only alternative energy technology that is likely to produce substantial amounts of energy in the near future is nuclear fission. In the United States there is the additional option of coal burning because a large coal reserve exists in the western part of that country.

We favor the orderly expansion of nuclear fission power during the next decade, and we note that several countries, notably France and Japan, have already adopted policies of rapid expansion of nuclear power. The United States and the Soviet Union too are committed to its development, but at a somewhat slower pace relative to coal use.

The environmental impact of nuclear power has been under intensive study and is the subject of much debate. We should like to state our view of this important question. It is generally agreed that in routine operation, nuclear plants are very safe, with emissions of radiation that are negligible from a public health point of view. However, the possibility does exist, although very remote, of a catastrophic failure that would endanger the lives of many people. We urge that a higher level of effort be mounted to reduce this possibility as far as is humanly attainable. We are aware that a simple accident of semi-serious nature might provoke widespread negative public reaction, which could prejudice the entire future of nuclear development.

The question of safe storage of nuclear waste materials has not been completely solved, and we must solve it. Since some of these materials persist for tens of thousands of years, our storage systems must indeed be "permanent." If we choose to will to unborn generations the legacy of standing guard involuntary over the wastes of our generation, we are obliged to develop systems that are less vulnerable than the present liquid storage tanks. An important improvement would be to solidification of radioactive wastes by incorporating them in a special glass in combination with deep underground storage. A great priority should be given to research aimed at improving the safety of storage of radioactive wastes.

The anticipated increase in the use of nuclear energy during the next 10 to 15 years, based mostly on reactors of the type that use "burned" only about 1 percent of the uranium fuel, will lead to a serious depletion of the rich ore that is presently used. An alternative option that is capable of using the fuel much more efficiently is the so-called "breeder" reactor, which converts more than 50 percent of the initial uranium fuel. Use of the breeder reactor would ensure the availability of economical uranium fuel for an indefinite period. Considering the success of the first industrial prototypes, it appears likely that the construction of large competitive breeders could start in 10 years. However, the operation of such breeders raises new safety questions, essentially because of the very large amounts of concentrated plutonium involved in their fuel cycle, and there has developed a strong opposition, principally in the United States, against their development. Whether or not this opposition is well founded, it may succeed, and the development of other types of reactors that use uranium more efficiently than the present ones should be accelerated. There are already in operation some experimental high-temperature gas-cooled reactors which, because of their higher thermonuclear efficiency, use about 30 percent less uranium than conventional reactors. The best substitute to the breeder reactor is the Canadian heavy water moderated reactor, whose industrial success is now well established. This reactor utilizes uranium twice as efficiently as conventional reactors and has a considerable advantage over all other types of reactors in that it operates economically without any reprocessing of spent fuel; this means that the production of concentrated plutonium can be avoided. The possibility of a criminal diversion of this source of plutonium for clandestine fabrication of simple nuclear explosives would thus be eliminated.

In the western United States coal is an important energy option for the near-term future, with an amount available for at least one century and considerably longer with prudential use. There are, however, serious environmental problems associated with the combustion of coal, problems which, although less dramatic, are more certain in terms of human disease than those of nuclear power. These problems must be reduced in order for the environmental consequences of coal burning to reach an acceptable level. The problems with coal refer principally to its sulfur content, and a variety of techniques must be developed for the removal of the sulfur pollutant. These include stack gas cleaning, catalytic techniques for coal conversion, sulfur removal, and on-line low-BTU gasification processes. Somewhat further into the future will be the possibility for direct liquidification and gasification of coal at the mine—processes that may someday be done underground with minimal environmental impact—which would provide fuel not only for electric power generation but also for transportation uses.

We wish to emphasize the great importance of research, both basic and applied, in bringing forth these important developments. It is essential for both government and industry to support and pursue cooperatively the large amounts of effort required to ensure their success.

The Long-Term Future

Looking to the longer term future we recognize that the period of fossil fuel use is but a brief moment in the long history of mankind, and we must
prepare for the day when this era is behind us. There are, fortunately, a variety of technological options that are available to us, and it is of the utmost urgency that we pursue the research necessary for their development, without delay. These options include geothermal energy, solar energy in its many forms, and nuclear fusion. They are indeed long-range options which can have only very limited impact in the near future; however, if we do not get on with the job of developing them, we will not have them when we need them much more than we do today.

Geothermal Energy

Geothermal energy, which has been referred to as "nature's own steam turbine," can provide an important source of energy in regions of the world associated with volcanic or seismic activity. The resource is composed essentially of "hot spots" in the earth's crust that have been thrust up near to the surface as the result of volcanic or seismic events (although not through the surface, which would have resulted in loss of the 'heat'). Three kinds of geothermal sources may be operationally distinguished: dry steam, hot water, and hot dry rock. These three sources are, respectively, more abundant but also progressively more difficult to utilize. In the case of dry steam, deposits have been found in Larderello, Italy; in Geysers, California; and in Wairakei, New Zealand, and these are presently being used to produce just over 1000 MW of electric power. However, the occurrence of the steam resource is very limited, so that the potential utilization may be only 2 or 3 times that of the present.

The extent of the hot water geothermal resource, in the temperature range >150°C, is many times larger than that of dry steam, and it is estimated that as much as 80,000 MW of electric power could be generated in the western United States alone from geothermal hot water. There are many problems associated with this development, for instance, corrosion of equipment due to the high salt content, estimation of location and lifetime of deposits, and environmental problems such as subsidence or earthquakes triggered by the removal of the subsurface water. Much research and development is required to solve these problems.

Hot dry rock at reasonable depths below the earth's surface represents a large source of energy, as much as 400,000 MW equivalent in the United States alone, but we do not know at present how to extract and use this heat. A long-range research and development effort must be mounted to investigate ways to drill economically into hot rock areas and to utilize water or other fluids, pumped in and out, in order to make practical use of this energy.

Solar Energy

Although solar energy is not, as sometimes claimed, unlimited in amount, it is unlimited in time and will be a viable resource for as long as our sun exists. An appreciation of the extent of this resource can be gained by the example: the power density of the solar flux, on the average, is about 250 W/m². Put another way, if this energy could be converted to electricity with 5 percent efficiency (a not unreasonable figure), about 0.5 percent of the continental land area of the United States would suffice to produce the present level of that country's electrical power. This may seem like a lot of land, but it is small compared with the amount of land, 17 percent, that is used in the United States for another form of solar energy conversion—agriculture.

A variety of applications of solar energy can be developed and we urge a large and broad program of research devoted to these developments. Applications range from the heating and cooling of individual buildings, to large-scale production of electricity, even to the generation of synthetic fuels such as methane and hydrogen.

Some solar technologies, such as water heating, are already reasonably well developed and in widespread use in countries such as Australia, Israel, Japan, and South Africa. Systems for small-scale electrical generation have been built, but only a limited number of systems are being built, and the high costs of the systems are likely to be lower than those of fossil fuels because of the lower fuel costs. Therefore, economic and institutional incentives should be developed so that the higher first cost of solar systems does not remain an impediment to their widespread implementation.

In the area of large-scale generation by solar energy, very little research has been done, and we urge that programs in this area be initiated without delay. The availability of these systems is of course greatest in the arid regions, but it is also greater than is usually believed. Two basic techniques can be employed: solar thermal and photovoltaic. Solar thermal systems can be used for process heat, and this heat can be converted to electrical power by conventional methods. The heat can be collected either by a distributed collector system or by a central focusing tower approach. There are many technological barriers to be overcome before solar thermal conversion can become a practical technology; such systems would have to be used in clusters of components required in large numbers and the high failure rates of existing materials to be effective in all operating environments involved. Photovoltaic systems are currently the least advanced of the solar systems and can be converted into electrical energy without the heat-integrated step. Photovoltaic systems, such as those employed in space applications, are far too expensive for terrestrial application, with cost per installed kilowatt-hour as much as 100 times too high. In this area real breakthroughs in materials design are required, and it is of the utmost importance that research into the basic solar-cell properties of photovoltaic materials be accelerated so that low-cost direct conversion devices can eventually be commercialized.

The development of bioconversion technologies represents another prom-
The next generation of large experimental facilities of this type, which are now in the final design stage in the United States, in Western Europe, and in the Soviet Union, may bring the proof within the decade of the physical feasibility of controlled fusion. A similar success appears also to be possible with the second approach, the sudden compression and heating by very powerful laser beams of pellets made of a frozen mixture of deuterium and tritium. This method is now the basis of a large research program in the United States.

Even if the scientific basis of controlled fusion is demonstrated in the near future, tremendous technical problems will have to be solved before it becomes possible to design and build a practical nuclear fusion reactor. The materials problems, for example, are enormous, and the creation of the requisite new materials may take decades. The costs of the first fusion bolters will probably be prohibitive, and many more years will elapse before controlled fusion becomes competitive with fossil, nuclear, or solar energy. Nonetheless, it is extremely important that research into fusion be pursued vigorously, for without an intense long-term effort we would have no hope to succeed with this technology, which could be of crucial importance for mankind.

We are advocating here the development of a variety of energy options for the future. The range of options must be kept open for many years; it is far too early to specify which technology will be most appropriate under the variety of circumstances and situations that will obtain in tomorrow's world. These energy options must also be continuously assessed so that each society can make the most appropriate choices among them as the developments proceed.

**LONG-TERM FORECAST OF ENERGY CONSUMPTION IN THE WORLD**

It is often considered, at least as a desirable and feasible objective, that in the not-too-distant future all the inhabitants of the earth should enjoy a similar standard of living, implying an equal annual energy consumption per capita. This is completely unrealistic; in any predictable future there will remain considerable differences between the consumption of energy per capita in the different economic regions of the world: it is even out of the question that within 20 or 30 years the consumption of energy per capita in the presently less developed countries might attain a value comparable to that existing 30 years ago in the United States.

The per capita consumption of energy in Western Europe is now about one-third of that in North America, and in the poorer underdeveloped nations, it is about one-eighth of that in Western Europe. Even if economic growth were to be slower in North America as much as possible without disrupting the social order, and at the same time exponential growth were to be maintained in the developing countries, there would remain at the end of the century a very large gap in the per capita energy consumption (and that of raw materials) between the United States and, let us say, India. On such an assumption (overly optimistic, to be sure) by the year 2000 the per
capita energy consumption might have increased by as little as 20 percent in the United States, but would not be more than one-half of that in Western Europe and one-sixth of that in the less developed nations.

We believe that energy consumption per capita must essentially tend toward a constant value, but this will happen at different points in time and at very different levels in the various regions of the world. We hope that this stabilization will take place by the middle of the next century, when the total world population will also stabilize at around 12 to 15 billion inhabitants.

The large remaining disparity in average energy consumption among different countries may appear to be unjust, but it is not more unjust than the disparity between individual incomes in any country, and if the smallest average energy consumption is not then too low, this disparity between nations would not imply that life is much more pleasant or meaningful in the nations where the consumption of energy is the highest.

In the overall perspective, the development of the last 25 years is characterized in part by impressive achievements in agriculture, fisheries, and technology. However, by and large, the waterfalls fail in the tactical sphere. An overall strategy has been and is lacking, and we have been alienating ourselves from the stark realities of the globe.

The key elements of a new global strategy which is indispensable for the survival of mankind and to the future of civilization must include the following:

Worldwide drastic steps must be instituted immediately to slow down the population increase. The urbanization drive must be brought under control. A privileged minority of less than one-third of mankind can no longer be allowed to consume two-thirds to three-fourths of what world agriculture and fisheries yield. World trade with food and food must be revamped according to new models. Food crops must gradually replace feed crops. Animal production must be tied to a system of waste recycling and feed products channelled to direct human consumption (Soybean mixtures with cereals stand out as a prime example). Large scale efforts must be initiated to control the losses and spoilage both before and after harvest and to achieve a more rational utilization especially of milk (now exhibiting a diversion of no less than 5 million metric tons), fish, soybeans, and bean plant protein. Rational long-range storage of staple foods for emergency situations needs to be organized on a regional basis. Less capital- and energy-demanding techniques and procedures must be introduced in agriculture and fisheries, as well as in food processing and distribution. A comprehensive accounting is called for which evaluates our measures from a management standpoint and how they size up from a truly economical point of view. Energy considerations have to be entered into such evaluations, primarily as to agricultural techniques, fertilizers, and irrigation. Capital outlays from the bank of nature's resources in soils, water, forest, and minerals must be accounted for.

We find ourselves in the labor pains of a new world order. Valid programs cannot be attained by adding up the world's eye view of 170 individual nations. The world is poorly served by unilateral decisions whether they are made in Brussels, Brasilia, Moscow, Seoul, or Washington.

A more adequate terminology has to be developed for fundamental concepts such as self-sufficiency, trade balance, surplus, and supplementary stocks. The flow of energy and raw materials must in a completely new

* Address to Group Reporter 2.
MANKIND, ITS NUMBERS, HEALTH, AND FAMILY ARRANGEMENTS: GROUP REPORT 3

Emily H. Mood,* Carl E. Taylor,^ Lorenzo K. Y. Ng,^ Rollin D. Houchkina, Richard A. Prindle, Stacey B. Day, and Annette Druven

The interactions between population, health, and economic development are multifaceted and complex. In the broad perspective of environment and society in transition, considerations of population growth and numbers must be viewed in the context of social justice that embraces an inclusive concern for man as man—the health, well-being, and quality of life of each individual. Inherent in such a view is the acknowledgment that population growth or numbers are not in themselves a "problem," but become one, however, if the alleviation of disease and the promotion of health through new scientific approaches lead to unchecked growth and to dislocation in the real economy and ecology of man and environment. Such dislocations are becoming increasingly recognized. Accelerated environmental deterioration and pollution, malnutrition, intrusiveness physical and psychological stress, excessive utilization of physical resources—these are but a few of the scenarios that many have come to accept as the common lot of man.

We must ask of ourselves, how does it happen that revolutionary improvements in human condition may result in greater evil, that through conceptualization man continues to live in the paradoxical predicament of potential abundance and the exponential threats of disaster?

The implications are clear that this dilemma cannot remain unchecked. The urgency and importance of the tasks in developing and implementing strategies for dealing with problems associated with unplanned population growth and for improving health, well-being, and the satisfaction of family or other emerging life arrangements are great. Too little attention is directed as yet to the establishment of a comprehensive network of institutions—transnational, national, regional, and local—specialized for dealing with these problems. The "population policies and strategies" that must be developed should be contextually relevant to the individual governments as well as responsive to the collective needs of man. Conservative conventional wisdoms as well as parochial interests appear to impede the discovery of common interests and common aspirations. Current and future problems will not be resolved by simplistic or universal solutions. The growing interdependence of our planetary life must be perceived in ways that enable us to maximize diversity, freedom of choice, and the quality of life for all.

ANALYSIS OF THE SITUATION

Interrelationships, Numbers, and Needs

The "population problem" is, in reality, a set of problems relating the balance between numbers, structure, and distribution of the population to

* Chairperson.
^ Supporting.
quantity, availability, and distribution of goods and services. The imbalance between population and resources may be real or imagined, annoying or critical, and subjectively or objectively quantifiable. Perceived imbalance in one society may not be recognized in another, or may be compensated by more advantageous relationships in another sector. Thus, "trade-offs" can exist resulting in increasing complexity in identifying and quantifying the "population problem." As noted earlier, the vantage point of transnational, national, and local overview may greatly influence perception of the "problem" and the interrelationships.

Relation to the Biosphere

The biosphere, herein intended to represent all the environmental influences and resources impinging on man except his own social order, is a finite object, the components of which represent actual or potential constraints on the growth of the population.

The component most discussed has been food. Many would admit that local shortages, crop failures, and malnutrition have contributed to malnutrition and famine. Even as the national and regional level such occurrences have been observed. On a global basis debate still reigns, but few will deny that doubling the population in a generation or less may well lead to even more critical imbalances.

Water is another critical component. Essential for life to the individual directly, it is also essential for food production and other crops, manufacture and production, and frequently energy production and distribution. Again, the quantities available are finite. Local shortages have long existed and are recognized. Very recently weather modifications, over-grazing, and other factors have contributed to droughts throughout whole countries and regions. Doubling population, of necessity adding to demand through increased food production, including domestic animals, coupled with further pollution consequent to greater utilization of fertilizers, increasing energy demands, etc., can only hasten the time of critical imbalance.

Density of persons upon the land is presently a matter of subjective evaluation. Short of absurd commentaries and projections of the populace standing on each other's shoulders, it can be shown that very high densities can be achieved. These high-density situations exist very frequently in the highly developed nations where possible disadvantages may be compensated for by relative abundance of other components (food, water, goods, and services). Such densities may now be intolerable or even possible in the less-developed areas of the world.

Recent political maneuvers have increased recognition of energy requirements as another potential constraint on population growth. The first necessity in modernization of agriculture is energy. For every calorie of food energy produced by modern high technology agriculture, 2 to 3 of a calorie of fuel is required. This issue, along with problems of availability of natural resources, is discussed at length elsewhere in this monograph. Suffice it to say that the exponential growth of population, along with a nearly exponential rate of consumption in certain regions of the world, cannot long endure.

Relation to Social Organization

The growing population and its growing demands appear to have placed growing pressures on social organization and its institutions. On a global basis, rather than increasing linkages, communication, and a sense of common purpose, there has occurred a growing fragmentation, disruption, polarization, and proliferation of overlapping and competing institutions. If this is not as a result of, it certainly is a concomitant of the recent period of population growth.

Evidence is rapidly accruing of increasing tensions in political systems as growth places still more demands on institutional services. Expectations have risen dramatically while essentially unchanged political structures struggle to meet demand.

Violence, terrorism, and other symptoms have appeared, leading some to speculate that overcrowding is a factor. Although some laboratory studies of experimental animals suggest a possible relationship between population density and social pathology, it is evident that other factors, including deteriorating services, unfulfilled hopes, and distributional disparities, also influence this situation.

Concurrently, cultural values appear to change as the old order falls in response to the expanding numbers and demands. An apparent loss of affect and increasing callousness evolve as disappointment, frustrations, crises, and catastrophes occur and are communicated.

Problem Areas

Motivational Forces in Human Reproduction

Many complex motivational forces are inherent in the field of reproduction and family organization. Some of these are understandable, while others have been given little attention or study. In particular, the importance of women as vital participants in this whole picture has been neglected. Inferences in many differing cultures is acceptance of the female as the nurturing force in the tribe, the race, or the national group. In this it is based on biology but in addition it is reflected in the almost universal drive recognized emotionally, if not intellectually, by citizens as well, to illustrate women that they complete their destiny as human beings if and when they are able to nurture, produce, nurture, care, and love another human being. In another section of this volume a prominent contemporary psychiatrist, Dr. Lawrence Freedman, links the primal chorus of birth and the subsequent supportive care of the infant to its lack to the multiple forms of violence prevalent in most cultures. An eminent psychologist, Carl Jung, believes that the desire to perpetuate the race is evident in both men and women and serves to link them to the future, to immortality, and to the infinite.
Overall motivational drives may be more evident in the female than in the male and are reflected often in sexual behavior. These forces are responsible to date for the continuation of the human race. Thanks to the more recent contributions of the medical sciences, human life has been so extended to make continuing fertility a problem with transglobal implications.

The economically more affluent nations are attempting to assess and prescribe measures for dealing with unregulated fertility in a variety of ways. These include: (1) development of methods to eliminate conception; (2) furnishing of services to make these methods available to women and to men; (3) offering mechanical intervention below the fetus is visibly if preventive measures have been unavailable or failed; (4) making education available in the anatomy, physiology, and psychology of sex; (5) permitting changes of attitude toward the potential contribution to society of women, which are reflected in equality in education, job opportunity, and economic independence; (6) bringing recognition that equality of status and occupation between men and women may serve as a substitute in some measure for repeated childbirth; (7) revising and lessening the pro-natalist pressures within cultural patterns evident in certain religious, political, and nationalistic approaches.

These approaches, together with increases of many types in economic development and comfort of living, have been reflected in a demonstrable reduction of the birth rate in the more developed nations. There is some evidence to indicate that approaches used by the affluent nations, which reflect an increase in health and quality of life for women, men, and children, are becoming acceptable to developing or nationally oriented countries. If so, the men and women of these nations may then reflect less economic need for numbers of offspring and a greater desire for a new quality of life for themselves and their children.

**Balancing Liberty and Control**

Certain limitations in human systems, or in our abilities, restrict our capacities to deal effectively with these systems. It is only realistic to expect that population changes within a society will, similar to economic changes, be complex results of subgroups of people behaving differently, only partly overlapping, responses to stimuli and trends incompletely and oppositely perceived. In the multifactorial system of population growth only a few of many variables can be assigned quantitative significance, and we are obliged to rely upon anticipatory analyses and essentially integrated judgments. These need to be based upon the experience of medical, psychological, and social workers, preferably with experience gained within the particular subgroups involved. Such analyses have long been available for various areas, but they need to be continually updated, made for other areas, and, especially, to take increasingly into account the impact of rapidly changing social and economic expectations.

As another limitation, man has been endowed in his evolution with certain physiological self-protective mechanisms, which limit and control his individual responses and are also operative in human group responses. We recognize but do not understand such effects as those of war, famine, or pestilence upon birth rates. More specifically, man as a political and social agent responding to crises also tends to respond linearly when faced with an exponentially increasing threat; that is, man makes simple stage-routine reparative gestures, after the fact, and points at the symptom more often than the cause. In his evolution, survival value and some self-rejecting ability (or "homeostasis") were probably furnished to man by diminishing his response to increasing threats. However, some dangers in the modern world—exhaustion, depletion, or pollution of human as well as physical resources—have already revealed the inadequacy of merely linear repair.

We must avoid the tendency merely to turn down the heat control when the home is already in the grip of a spreading fire.

Another innate limitation of human response is the self-protective habitation to a warning that remains peripheral. Just as the individual "learns to live with" a headache and even ignores it, he has an inbuilt tendency to become callous or hardened, to respond less and less, as an individual or a society, to a warning—even when that danger is increasing. There are known physiological facts that moderate or inhibit these responses to simple physical stimuli. Only in some similar way can we understand our relative "adaptability" or lessened response to tragic circumstances as they are repeated—whether as famine, bombings, or bloodshed in distant lands, or only as increasing exposure to the needs of the poor, either in the village marketplace or in our privileged daily mail.

**Group Report 3**

Any provision for self-regulation within the social order will involve the transmission of recommendations or regulations, arrived at in some concert in one group, to persons or groups that necessarily will have a smaller part in the establishment of those regulations. It is surely one of the oldest experiences of society that control always involves placing some limits or definitions upon liberty. But the liberties potentially infringed in a society's need to regulate birth, care, and education of its children are perhaps uniquely sensitive to mankind's other inbuilt self-protective instincts and mechanisms.

Society itself, apart from government, sets numerous customs, constraints, and controls affecting family life. We may detect these at several levels in our present world between supranational and national groups, national/minority, men/women, or collective/personal levels.

Thus the individual will generally be the target of a considerable number of explicit and implicit restraints and sanctions affecting his biological life, some of which he perceives as natural and others as imposed. Whether he will react to a newly propounded recommendation, or especially a supranational one, as an inevitable infringement of his liberty may be a profound, delicate, and intensely personal question. In general, his reaction can be predicted by the outsider only on the basis of a thorough apprehension of all other forces impinging upon his motivation. It must also be...
recognized that in such personal reactions one can have different opinions at different times—a basis for a certain degree of susceptibility to emotional manipulation from without, for which hopefully reliable information and education may serve as an antidote.

Trend to Conformity

Under increasing population growth and increasing technology the impotence of individual and diversity are fast surrendering to society and conformity. Does "society" mean everybody? And does "everybody" have equal say in changing direction, control, content, and purpose of life? In this sense technology has an ominous implication of treating people as a commodity—a "quality" that may not benefit future life. In a certain sense technology "proposes" people—it can increase productivity, efficiency, and lower-production costs if it can produce more of people without increasing cost. To this degree technology can be alienating in some situations. For quality of life men and women must assert technology so that technology does not control them (even though technology is man-made). In this sense there is an apparent conflict between man and technology, one feature of which will affect quality of life. Some difference will, and perhaps should, result in individual initiative and an individual refusal to permit conditions of life to become unhealthily detuning.

Finally, the world is a pluralistic society. We do not yet have a concept of universal morality understood by all men. Ethically and morally, until we can arrive at a universal morality, we have a responsibility to try to understand perspectives of ethics other than our own. Ethics might reasonably be expected not to do responsibly for all humanity. In such areas as this, unbiased agencies, starting with a hostile beginning, might endeavor to commence problem solving.

Population Composition

Population composition in numbers will be a determinant of all other policies—economic growth, energy disposal, quality of life, political stability, health, education, and welfare programs. Not recorded as easily visible, but of great importance, are attitudes toward death and survival patterns now and to be projected for the year 2050, as well as fundamental problems in the biology of aging. Human senescence brings in its own questions and answers. Survivors per 100,000 live births from various life tables for selected countries (India, Mexico, Japan, and New Zealand) show an increasing longevity from 1921-1934. The span of life has been lengthened, and age at death, as of 1974, commonly occurs by the ninth decade of life (90-100). Convincingly biological research may make an ultimate age of 120 not impossible. What is germane is not, however, length of life in years but quality of life in senescence, and societal needs and composition variables through age group from youth to senior citizens. Equally, rate of doubling population, types of population, and zones of population are to be analyzed. Problems such as demands for the necessity right to determine one's own death ( euthanasia), abortion policies, and population limitation by social or political pressure are forefront. Techniques such as artificial insemination, sperm banking, genetic enzyme analysis, antisense fluid research, surrogate motherhood, control in such characteristics as rate of offspring, and elimination of genetic defects by manipulative genetic techniques introduce new potentials that need urgent consideration. The applications of such techniques introduce a whole new imperative into the decision-making process.

Equally, such possibilities as "cloning" (the growing of twins or multiple images of an organism with the vital whole biological character of its original—i.e., with "copies" identical in mind, maker, and man—might be grown from the nucleus of an adult cell of the organism) could introduce an entirely new evolutionary concept in possible genetic options for future populations. Planning and decision-making in many of these emerging fields are foreseen as an issue of priority in the realm of numbers in the not too distant future.

Recommendations

Knowledge Gaps

Twentieth century technological man has in many ways become so aware of his "strength" that he is in danger of ignoring his "weakness." After approximately 2 million years or so of evolution, we still are to ourselves largely unknown. A better understanding of man and his behavior is fundamental to our efforts to develop strategies that seek to optimize the quality of life for psychosocial man as well as to maximize the survival of biological man. Our endeavors to learn more about ourselves and our behavior should not be just a haphazard accumulation of facts and figures. It must be guided by a skill informed by some values based upon the recognition that we are a single species. Anything short of this would not suffice.

At an operational and pragmatic level we continue to live in a world where human reproduction is still largely a matter of personal choice. This desire and motivation, both conscious and unconscious, have largely been overlooked. It is essential to know urgently more of the motivations factors and the social incentives that shape families and ways to limit their size consistent with individual and collective needs. The rate of expectation in motivation, particularly as it relates to the developing countries, needs to be understood.

As the research levels there is a continuing need for improvements in contraceptive technology and for more effective dissemination thereof. Such efforts should be pursued in the framework consistent with freedom of access to birth control techniques guided by personal values informed by concern for others.

The medical profession is now beginning to realize its obligation to prevent genetic counseling and to gain essential parents a responsible estimate of their chances of having children with a normal expectation of a satisfactory life.
Values and Attitude Alterations

In considering alteration, or in attempting actual alteration, of values, attitudes, and behavior, particularly at the grass roots level, it is crucial to understand the fundamental norms of the community as well as of the individual. Personnel should be required to have specific firsthand acquaintance with the social outlooks, needs, and motives characteristic of a community before introducing concepts or expertise derived from distant and different populations.

It is imperative to be aware that altered behavior can result in considerable personal sacrifice (i.e., social ostracism, labor temporary or permanently). This must be faced realistically and assistance given in diminishing adverse effects.

A common obstacle to altering values, attitudes, and behavior is the idea or fact that parental norms are being attacked. Where it is possible, something in the previous pattern similar to the attitude being altered may be used as a bridging device (examples: courage, change, sharing, migrations, and sense of adventure as applied to any new transition of attitude). Sometimes it is necessary to bypass the obvious motivation in order to find a better method.

Careful training must be given in anticipation of the event wherein the altered attitude will be tested. Time lags between training and experience must be taken into account. Fluctuations in attitude and partial return of old patterning must be given constant consideration. Sustaining new attitudes can be reinforced by training individuals or groups with new values to share with both individuals and groups. These "trainers" now become a new cadre of teachers—perhaps with a greater understanding of persons to be retained. Flexibility and ingenuity in the trainer are essential. Concealment is picked up intuitively and is an impenetrable barrier. Immediate, external, and positive responses cannot be expected.

Mechanisms of Communication

The communications area emphasizes development of the bases and dynamics of knowledge and research in the field of numbers with which we are concerned. Four major subareas must be embraced in presenting problems and in the nature of population considerations: (1) Intercultural communication—a focus internally on the awareness of the problem and on the related processes of thinking, feeling, and behavior related to this field—is necessary. (2) A focus on communication between two or more persons, and on the cases of agreement and understanding between them, is needed, such as that between male and female, husband and wife, family and counselor, civic group and local civic unit, local control and state control, state and federal (or national), and national and transnational relationships. (3) Small group communications effectively setting patterns are needed; i.e., a focus on understanding of goals, objectives, and resource utilization and utilization as pertain to problems of fertility planning, mortality statistics, aging and tranquility, economics, family, and social change as they may interrelate. (4) Those communication facts are aided by media, which involves research and development in the use and impact of media in population communication, education, and research. Within the provinces of media are: (a) communications techniques that refer to the planning and development of the effectiveness of various approaches to media in the communication process; (b) instructional technology in which the major interest is in the utilization of media to enhance and complement established instructional procedures; (c) the programming and production of teaching "packages" that may be utilized as help in overcoming "population problems," and (d) the evaluation of media programs to provide a basis for judging their effectiveness and for further developments in this area.

Other dimensions include education and training programs by which optimal transfer of information to learners is achieved. A dimension must be allowed to provide assistance to teachers in the sequencing of elements and in devising use of media in consumer education so that ultimately individual members of the world population may enter into a more cooperative and collaborative process of obtaining a quality of life through wise planning of population numbers. Responsibility for this communication program is shared by many interdependent agencies—health, education, and welfare; public health; social and cultural planning, economic, governmental (local, urban, state, and federal); and international (supranational) agencies.

The Institutional and Organizational Structures

Institutions and organizations, both national and international, must bear the responsibility of providing the framework for the establishment of guides and criteria, ordering priorities, providing services, including education, devising systems of fertility regulation, and evaluating outcome in terms of optimizing the quality of life.

The primary responsibility of the local institutions and agencies, the provision of services to people. Following guidelines and established priorities, implementation of activity should be undertaken, with monitoring carried out to assure maximum effect and efficiency. The local institutions, as the interface with the individual, bear the additional responsibility of assisting involvement and communication.

National institutions and organizations vary considerably in scope, capability, political influence, and operational capacity. Nevertheless, some national authority must take responsibility for establishing national criteria, issuing administrative coordination and implementation of plans, and ensuring evaluation of activities and programs. To the extent that such national authority can draw upon international assistance, and within its boundaries, learned bodies and societies, private groups, or others, including the community, it is encouraged to do so. As capability increases and involvement broadens, the authority should provide assistance, leadership, and support to local activities.
committee recommends that the need for fertility control be recognized in conjunction with mortality control.

As discussed earlier, a conflict arises between assurance of equal rights and the problem of control and maintenance of cultural and individual diversity and variety. The committee believes, however, that basic minimum components of the quality of life may be imposed, if necessary, while preserving this diversity.

Reference
PRIORITY IN EDUCATION, PUBLIC INFORMATION, AND USE OF BASIC KNOWLEDGE: GROUP REPORT 4


We interpreted our brief to mean that we should suggest priorities in action, rather than in the subjects of information, since the main priority needs were being considered by other committees. However, these groups of problems for which solutions are a prerequisite of world order and proper use of the environment are not specifically included in other committees, and we bring them forward here for discussion: (1) Arms control including cessation of manufacture of nuclear, chemical and biological weapons. (2) Problems of climatic change. (3) Inclusion of damage-minimizing measures at the design stage of new industrial complexes and provision for continuous improvement as techniques change.

AIMS

The broad aim is to create all over the world an awareness of and ability to respond to changes in world and local systems caused by man's interaction with the natural environment by the inconsistencies between cultures and by changes in climate which may be outside human control. At first there will be only nuclei of people with this awareness, but the long-term aim is to establish a broad awareness throughout all communities. These people will need to have faith in the ability of people to explore and analyze their physical and social surroundings and confidence in the possibility of learning to use knowledge in order to work with nature (using the word in its nineteenth century sense) rather than against it.

Within this broad aim there are others, some of which are mentioned in the sections on "Means." The most definitive of these are support for the establishment of a multidisciplinary United Nations University; the creation of a profession of "Environmental Doctors," and the training of programs to create the necessary attitudes and awareness in children.

We have divided our proposals into sections for convenient reference, and also because some of the subjects require expansion into one or more sections, we also include addenda to this effort.

To Whom Addressed:

(1) All in authority, governments, especially member states of the Security Council.
(2) Educators and educational organizations where these exist.
(3) Private foundations.

* Also drawn from discussions which included Lloyd D. Motz, Ausilia Pecri, and Peter S. Theodor.

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(4) Voluntary organizations.
(5) Unspecified (Because unknown) potentially aware groups which could constitute themselves if the knowledge were made available.

By Whom Disseminated:

(1) All national and international groups with specialized knowledge, such as WHO, FAO, and the World Meteorological Service, on a continuous monitoring basis. The new International Referral Service in Geneva would be important on environmental matters; the International Radiological Protection Service could make its information available in more easily assimilable forms.
(2) These with relevant expertise in various disciplines, and eventually the multidisciplinary teams of "environment doctors."*
(3) Universities and similar institutions.
(4) Ministries of education.
(5) The media.

What:

(1) Information on encounters, conventional, nuclear, chemical, and biological in forms that would be easily comprehended even by the illiterate and semiliterate.
(2) Information on the relationship between population, resources, use of energy and environment, stressing, especially in countries not yet industrialized, the possibility of managing industrialization so that the damage is controlled, permanent damage is minimized, and the lives of all people enhanced, instead of pursuing the path trodden by Europe, America, and now Japan, whereby a few benefited enormously, many became richer, but with heavy penalties in terms of health and environment, and the natural environment became irreparably damaged.
(3) Information on the problem of aggression (see addendum).
(4) Vocational, practical, and cultural education appropriate to local situations and changing over time.
(5) Information on the effects of climatic change on agriculture, and of agriculture on climatic change, in order to avoid or ameliorate probable continuation of drought in the belt between 30th latitude north and south, with attendant famine and possibly unrest.
(6) Information on population control.
(7) Ways of conserving energy, reusing, recycling, and reclaiming materials, reducing obsolescence.

The United Nations University could institute courses of study on: reduction of armaments; development of energizing nations; and new sources of energy—"forests" solar, wind pumps; and development without degradation.

By Whom Known:

(1) By the fullest use of all available written, material, transmitted sound and vision, meetings, and seminars.
(2) By establishing appropriate schools in developing countries.

(3) By sending persons with relevant expertise and appropriate “awareness” to emerging countries, in order that they may rapidly develop their own capability to select the various technological “packages” most suited to their requirements. Participating multidisciplinary teams might be set up by GINEP to perform this role.

(4) By maximum use of newly available means of communication (see separate Annex) and preparation of video tapes and radio tapes in many different languages.

(5) By ensuring that as many children as possible receive the kind of early experience which will enable them to grow up into the adult with the necessary awareness, sensitivity, and confidence (see separate Annex).

(6) The World Academy of Arts and Science should pass a resolution on the United Nations University and should announce this in a press release.

(7) The NYAS conference should send letters to other institutions all over the world calling for support.

(8) Pressure should be brought to bear, by ourselves and the organizations to which we belong, to get our respective governments to give immediate support to the United Nations University, which will set up its headquarters in 1974 and urgently requires $200 million. Its first 3 to 4 years will be critical in determining whether or not it will be able to achieve its purpose.

(9) Use of fiscal incentives and disincentives both to facilitate various aspects of the educative process and to encourage or discourage behavior conducive to the commonwealth as perceived by each community for itself.

(10) The creation of an international problem-oriented organ of information combining the resources, audience, and perspectives of UNESCO “Counsel,” WHO “World Health,” FAO “Crops” and others, into the widely distributed centers of masses on world problems.

(11) The creation of video tape packages in a greater number of languages than is the case, and with images appropriate to the recipients.

(12) Holding of one or more “sensitivity” per year (perhaps on a regional basis) in which ideas and experiences could be presented, discussed, and exchanged.

(13) The establishment of an international center for the exchange of information on social change.

When

The Next 5–10 Years:

(1) Establish or identify nuclei of aware people in all countries.

(2) Set up 40 experimental child education programs in about 20 countries.

(3) Exert pressure for funds for the United Nations University, especially by members of Security Council.

(4) Begin training of “environment doctor” teams.

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(5) Begin preparation of information packages on environmental, pollution, and population, resources, and environment.

10–20 Years:

(1) Facilitate conscious diffusion of awareness in communities.

(2) Have 10 per cent of children in at least 5 advanced countries and 20 emerging countries in educational programs of the kind outlined.

(3) Have 50 schools training about 5000 graduates to be included in “environment doctors” training.

(4) Introduce medical incentives.

In twenty or fifty years appropriate child, adult, and environmental training institutes should be established in all developed countries and at least 20 emerging countries.

Cautions

Because the kind of awareness we think desirable appears to be more evident in the developed countries, there is a danger that it will be imposed on other countries, rather than allowed to become grafted into their cultures. Somehow provision must be made for indigenous cultures to evolve in ways appropriate to a more industrialized society in which to exist, or, in certain rare cases (Amerindians in Brazil, Kalahari Bushmen), to be enabled to pursue their own ways of life in areas protected from this development.

There is also the evidence danger that because Europe and America achieved industrialization and development first, European and American lifestyles may become regarded as more advanced than those of other countries. People need to feel that their own culture is just as valid, and to know that development in Jutkow certainly, and America jointly, grew out of an existing culture, some of which was adopted, some discarded, and some preserved. The different qualities of life in various European countries derive partly from the preservation of different aspects of these preceding cultures. This survival of cultural identity need not be confused with aggressive nationalism, but is something invaluable which maintains the diversity and thus prosperity for survival of mankind.

It is important also to avoid the raising of aspiration beyond the possibility of fulfillment, as, for instance, has happened in some countries which have raised standards in schools more appropriate to developed countries. It is also necessary to stamp out the notion that development/improvement necessarily means replacing the consumption pattern and life styles of American and Western Europe, and to preserve belief in the desirability of independence and self-sufficiency.

There is implicit danger too, in the potential “half-life” of formal education, which has been growing progressively shorter. Formal education must include the transmission of concepts and attitudes which will allow self education by experience to continue throughout life, and in addition opportunities for formal education in later life should be made available as widely as possible.
VIOLENCE*

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An inventory of scientific knowledge concerning violence which contributes to public policy must acknowledge and transcend confusions of definition, contradictions of history, and ambiguities of lower animal homologies and of primitive man's analogies.

The science of violence can be applied to public policy only through insight into law and the relationship of internal and international violence on war and the stages of civilization. It must range from aggressive drives to the technique of violence; it must draw upon psychology, physiology, and psychiatry as well as upon the social and behavioral sciences.

The literature concerning rage, aggression, violence, assassination, terror, gorilla warfare, rebellion, revolution, and war reveals remarkable diversity of opinion. Some authorities assert that we are genetically predisposed to violence; others, equally eminent, see men as peaceable beasts whose herds must be disbanded and reorganized and whose shepherds, if they are to cease butting each other, must be replaced.* To avoid any scientists whose theories and observations coordinate the phylogenetically predisposing and the ontogenetically reinforcing, achieving a synthesis of both.**

In the past 12-month period, approximately 650 articles were written and published in scientific journals on the subject of aggression. Conflict resolution, legal, exhortatory articles on war, terrorism, assassination, and personal violence increase this literature by the thousands (see References). However, this explosion of rhetoric concerning this most violent of man's preoccupations attests to an extraordinarily rapid expansion of interest, not new information. When one-quarter century ago I began my study of aggression and violence, all the literature available published within the previous decade was less than 1 percent of these figures, but they contained nearly as much information.** Over 25 years, 25 million deaths and 25 wars later, we are scarcely more informed concerning these matters than we were at the close of World War II. I have decided, therefore, to append a generous bibliography of this outpouring but to confine this essay to the research and clinical experience which has come to me at first hand.

On the cover of Life for January 1950, was the picture of a smiling mother holding an infant. "Childbirth Without Fear" was the caption. During her pregnancy she had learned to exercise her body; she had practiced the procedures of childbirth, had discussed the gestation with her husband and with similar couples, and had spent 10 hours of parturient labor in her

* Addendum to Group Report 4.
husband's company. She delivered her child without showing fear, without screaming rage or threatening violence. She was conscious and happy.  

For the first time in an American hospital, pregnant women were not treated like sick beasts, pampered through their pain, tolerated or silenced with drugs when their anxiety yielded to rage or through anger gave way to pain as they protested the fearful ordeal of Eve. This mother sucked and expressed her child as soon as it was born instead of hours later after both had recovered from the anesthesia, surgical intervention—modern obstetrics.

Yet for that newborn child, so for the millions of newly born every year on this planet, birth was a painful, twisting passage of the large skull (grown to accommodate an enormous brain) through a tight and bony pelvis. From this first separation, this sudden extraction from a warm, dark sea of amniotic fluid to the cold, bright amphitheater of gasping for air, leaving its below of rage which evoked the satisfied sigh of misunderstanding relief from the hydrant. That child would be 25 years old now. As a girl we can guess that she has been spared most of the group violence of this quarter century. But the violence of her arrival, her traumatic separation, and her first socially adaptive bow—our obliviousness to that primal trauma—still affects her in ways she does not know, and we can only suspect.

So fascinated was I, as a young psychiatrist, by this biologically primitive, phylogenetically imposed, psychologically fundamental experience of childbirth, that I began a study of phylogeny, borrowing from the anthropologists, the paleontologists, the ethnologists and through participation in the research of the comparative psychologists while training myself as a psychoanalyst.

For me, the incidents of fate, love, class, geography, and climate assembled his unique genetic matrix. His prolonged gestation, his incapacity after birth to survive without adult care for one quarter of his life span, requiring the physical and affective care of adults, at first female (casually aided by a male), who fed him and created the micro world which he saw, heard, felt, suffered, enjoyed, imitated and rebelled against, so form for him the human macro world into which he emerged. During that prolonged period of profound dependence, the deepest of human emotions, both love and hate, necessarily became focused upon those first representatives of his species. He learned love when he looked, nurtured, and loved him. He learned fear, pain, and hate when they deprived, frustrate, or punished him. From that early experience of separations he discovered that isolation from other humans was the most painful of experiences and that there was no greater pleasure than that gained through the acceptance by significant others. Always after was the underlying fear of abandonment, of loneliness, of not behaving properly. Appropriate acts could be defined only in terms of acceptance or rejection, of similarity or of difference.

Intrigued by the implications of this age-old, but freshly won knowledge, I made controlled experiments in cooperation with my colleague, Rauvald. We studied anxious, aggressive, and sexual behavior in the Rhesus Macaque.  

See also the references in the text.
struck with the observation that among our men the horror of difference within our own group exceeded the intensity of the rejection of the captured enemy. For example, the prevalent attitude toward the sexually deviant person from our army, who was a fellow in arms, was far greater than the rejection meted out against the foreign "enemy."

Peace declared, I joined the faculties of the Medical School and the Law School of Yale University and studied the violent offender from both perspectives. In 1963, the President of the United States, John F. Kennedy, was assassinated. I tried to understand the assassin as a critical variant of the violent attacker whom I had heard of in the expression of the most intimate form of destructive interaction between anonymous figures. I was struck with the extraordinary realization that in his confrontation between the anonymous figure of the assassin, who came from out of "nowhere" to inflict a lethal blow upon the most honored leader in the world's most powerful nation I was seeing the same elements of intimacy, of love, of hate, of isolation, which in the assassin's perspective was similar to the attacker whose victim shared his obscurity. Each was found to be similar in early background, the qualities of his mothering, and the absence or distortions of his fathering. The social and psychic mechanisms by which that assassin was deprived of self-esteem, of self-love, of self-appropriation, of identification with the existent group which approved of him, and of which he could reciprocally approve, were very similar.

In all these seemingly disparate sets of observations, I had discovered remarkable similarities. Genetically inbred, developmentally learned, inwardly experienced, outwardly manifested, they for generations, cons, millennia, have led groups of men to war on other groups of men.

From the biologically imposed dependence upon crucial others, each learned pathos, anxiety, the druggan of loneliness. Within each was seared the penalties of difference, and the hope of rewards for belonging to a group. Each needed to be loved by and to love a leading figure. Without these bonds there was a feeling of being hated, despised and, worse, overlooked. With this comes the need for the love, the esteem and the companionship which permit one to exist and to accept oneself.

Violence, the complex sometimes cunning maneuvers by which the insulted and the injured may strike out, may break that hated mirror in which they see their own distorted visages. By assault they destroy the image of disdained and disdain reflected in the eyes of the other, the stranger.

But what, we ask, distinguishes the violent man who destroys another obscure figure of hate and love or one who chooses to destroy a vastly powerful and celebrated political figure? The answer is a complex process of politicization through which the sense of failure is overcome by attaching it to the social and the political system of which one is an outcast, a hated and hating shred. But if these two brief summaries describe the assassin and the terrorist, what do these have in common with the tens of millions of ordinary citizens who, at a command of a leader, will, as soldiers, fight the enemies of their country and risk their lives and who return to obscurity, to necessity, to poverty, to imprisonment?

It is an unhappy reflection that ordinary men will kill on command without excessive pain to themselves. In this sense, they are the assassins whom we may fear or despise, who, made of the same stuff, Cenrecht found the ordinaryness of the terrorist more terrifying than his murderous disposition.

I have labeled this field of study, to which I have devoted a large part of my professional life, the study of politicism, the study of specters of the
community. That word has two parts: polls, the nation state, and mass - the upstarts. It is a dynamic and ever present tension. But we know that the conditions exist whereby the human animal, whether by distortions within his group or because of conflicts between his group and others, has the propensity to become a killer, we know as well that the vast, powerful, overwhelming and persistent preference is to remain an accepted member of the polls.

Our research policy, like our diplomatic policy, as we approach the end of this century must be to ascertain with greater precision, and to create with vastly increased efficiency the conditions under which the great masses of human beings and their poll-live out their lives as fulfilled members of a planetary polls.14

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and test them, and how to use his intelligence in understanding the world and himself and in solving his problems.

The development of faith and confidence in our own human intelligence conflicts with faith in tribal gods and beliefs in the teachings of tradition. They give children a conception of a fixed world of wise men who know all the answers, thus failing to emphasize the necessity for worldwide cooperation in working out new ways of dealing constructively with world problems.

Fortunately, curiosity is characteristic of children, and their drive to find out and explain things can be a powerful motive for carrying on inquiry and finding that they themselves can develop better and better explanations as they approach problems from different perspectives and increase their own experiences with the phenomena about which they are curious. The positive reinforcement of children's efforts to understand, combined with guidance in ways of learning, can contribute strongly to building this faith in human intelligence.

A third focus for early education is on the interpretation and enjoyment of human relationships. Most children are negatively conditioned so that they expect and seek a very few elements in their relations with other human beings. They do, of course, learn to expect from parents and friends help in gratifying physical needs and opportunities to participate with limited roles in social life. However, on the negative side, they expect aggression, rebuffs, or aloofness from most of the others with whom they come in contact. By the time they are young adults, their social relationships are greatly disencumbered both in the variety of people with whom they have meaningful relations and in the range of human interaction in which they participate. Along with exploring the wider world, children need to be positively conditioned to seek out new persons from different backgrounds and to be involved in an increasingly wider range of relationships. A world society requires citizens who participate with others in a wide range of situations, not because they feel it a duty but because they find satisfaction in a common life shared with others throughout the world.

To appreciate a multicultural and multivocal society, children need to have experiences with persons from other backgrounds and whose hierarchies of values are different. They need help in playing various roles in their relations with others, they need help in understanding other customs and practices, other beliefs, and values, and they need to see parents, friends, and other teachers enjoying interactions with others without losing their own identities in these experiences.

The purpose of early education in the area of human relationships is not to give children the belief that the people of other groups and nations are model angels wholly to be loved but rather to help them perceive as accurately as they can what human beings from many backgrounds are like. They have strengths and weaknesses and characteristics to be admired and others to be deplored. Most are interesting and friendly and can be helpful. However, they are not all alike, and in their variety, they have to be under-

* Addendum to Group Report 4.
PRIORITIES FOR IMPROVING THE WORLD STRUCTURE OF PUBLIC ORDER: GROUP REPORT 3

Myers S. McDougal,¹ Ian Schneider, Walter Isard, Karl Deutsch, Robert Triffin, Richard H. Nobe, Michael Reisman, Sir George Caffin, and Peter S. Thacher

We commence with the facts of global community; the level of interchange and interdependence has reached the point where decisions taken in any part of the world have impact on all other parts. The maintenance of such a variegated and interdependent community requires a degree of organization and inclusive compromise which will require revision of the archaic notion of state sovereignty and new structures.

The most basic decisions of any community are the "constitutional" decisions, those which establish and maintain the structure of the community's decision-making process itself. From the perspective of the scientific observer, the preferred constitutional decision process of any community is one which strengthens that community and maintains or improves its ecological and social environment, endows the common interests of its members, and fulfills a variety of procedural demands. There have been few instances in the history of our species when men and women of rational and humane vision have had the power to conceive a constitutional congress and to reorganize the constitutional process of their community in accord with common interests. This reality is as unlikely now as before. But this does not make an "exercise in normative" formulation futile. Every current choice with global ramifications has, in fact, constitutional impact; its wisdom can be evaluated in terms of its contribution to an improved structure of world decision. Hence the utility of a group of scholars considering the recommend world constitutional policy.

At the most general level, we would recommend that the world constitutive process produce decisions rationally designed to realize the common interests of mankind. More specifically, the process should:

—provide for the widest possible participation, with restrictions only on grounds of competency or irresponsibility;

—assure that decisions are taken from perspectives of common rather than special interest;

—make wide access to organized as well as unorganized groups, with an appropriate balance maintained between regional and centralized decision-making;

—reinforce authority and effective power in a quantity sufficient to make constitutive decisions effective;

—encourage persuasion rather than coercive techniques for decision-making, but develop an institutional adequacy for coercion when world common interests require it.

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Priorities for Public Order of the Environment*  
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By the environment we refer to the whole comprehensive ecosystem of man's larger earth-space community. It is the more specific geopolitical unitings or interdependences of this comprehensive system which make it a single shareable, and necessarily shared, resource. What is true about interdependences in the enjoyment of the atmosphere, the oceans, the air space and interzone, drainage basins, and land masses when considered separately is equally true of the indivisible whole which they comprise.

From the standpoint of an observer, identifying with the whole of mankind rather than with some single parochial community, we can see that the peoples of the world share certain common interests in the protection and appropriately conserving use of their most comprehensive environment. These common interests are both inclusive and exclusive. The exclusive interests of peoples in the protection and conservation of the environment extend beyond the mere stem of their interests in all the great component shareable resources, in the healthy functioning of the earth-space environment as a whole, including even the exclusively controlled land masses. The exclusive interests of particular communities relate to the healthy functioning of their own internal social processes, affected as they are by the larger ecosystem.

A principal task of global decision process, including both transnational and national processes, is to protect and accommodate these inclusive and exclusive interests of peoples and to reject all claims of special interests that are destructive of common interests. In an independent global social process, people apply institutions to resources for the protection of values.

By "priorities" we understand reference to perspectives about common interests. In rational conception, priorities must, accordingly, refer both to internities in demanded values and to expectations about alternative decision processes which can be made to secure such values. Since every value and the decision processes by which it is secured are interdependencies with all other values and the decision processes by which they are secured, any estimate of priorities must be extensive and instrumental within particular contexts. The important perspective must be a demand to grapple with the "fig. blazing, muting confusion" about us at any point at which it can be made manageable.

It is increasingly recognized today that there are environmental dimensions, just as there are human rights dimensions, in all the authoritative decisions that are taken in all our communities, from local to global. The

* Addendum to Group Report 5.
most urgent task confronting observers concerned with improving the
public order of the environment is, accordingly, that of bringing a more
realistic and comprehensive intelligence about the environment to bear
upon the making of all these decisions.

In the context of the contemporary spatiation and exhaustion of re-
sources, accelerating population growth, and increasing technological
potentials for destruction, the mere injection of a more relevant intelligence
about the environment into routine decision making is not, however, enough to
clarify and assert the common interests of peoples. If mere survival, much
less optimum order, is to be secured, more positive and dynamic programs
must be shaped for the better protection and more advantageous use of
the whole earth-space environment in all its components: atmosphere,
ecosys, air space, outer space, polar areas, drainage basins, and land masses.

For provisional identification of some potential priorities, we make
systematic reference both to certain features of the process by which peoples
enjoy their environment and to varying phases of the processes of authori-
tive decision by which they seek to secure this enjoyment.

PRIORITY IN MANAGING USE OF THE ENVIRONMENT

Allocation of Resources
The atmosphere, the climate and weather, the oceans, the air space and
outer space, and the various international rivers, seas, and waterways
should, because of their importance to all, be maintained as shared re-
sources under inclusive competence, as free as possible of exclusive com-
petition or dominance. In particular, at the upcoming Conference on
the law of the sea every effort should be made to reject all monopolistic claims
over resources that have hitherto been shared.

Regulation of Enjoyment

Resources Exclusively Enjoyed
The emerging customary norm that every community is responsible to
all others individually and collectively for injurious use of the great share-
able resources that comprise the environment should be communicated and
commodified in all public media. The prohibitions of the 1963
Test Ban Treaty should, then, be recognized as extending customary
expectations to all participants, even non-signatories.

Resources Exclusively Enjoyed
As an implementation of accepted norms imposing responsibility upon
states for exclusive resources such as atmosphere and marine pollution,
disposal of atomic waste, supranational rights and so on, states and the gen-
eral community should design measures for the prevention and deterrence
of such activities and for rehabilitation and reconstruction. The recent
Convention for the Prevention of Marine Pollution from Land Based
Sources should be expanded to include airborne sources and extended to

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protect the oceans and seas as a whole. The time is also ripe for multilateral
weather and climate modification agreements.

Facilitating Productive and Harmonious Enjoyment

Resources Inclusively Enjoyed
Visible organized regimes for high seas fisheries and for exploitation of
mined resources—with a minimum of interference with the other inclusive
uses of transportation, communication, and scientific inquiry—are urgently
required.

Resources Exclusively Enjoyed
The most immediate need is for adequate supply of information and full
recognition of the duty to consult with other states concerning activities
likely to affect them. Beyond this, technical data and other relevant in-
formation should also be supplied to some established international body,
logically the International Referral Service (IRS) to be established by UNEP
in regard to proposed means of enjoyment of exclusive resources which
affect the regime for the common enjoyment of inclusive resources.

Planning and Development

Resources Exclusively Enjoyed
The most urgent need is for overall organizational arrangements to
integrate intelligence, planning, and promotional activities with respect to
all the varying components and features of earth-space environment. The
Governing Council of UNEP is, to some extent, charged with these func-
tions, but it has not been endowed with the capabilities for their continuous
performance.

Resources Exclusively Enjoyed
Comprehensive planning and development is needed in all countries at
all levels—from local, to metropolitan, to drainage basins, to larger and
ultimately national and transnational levels. Many countries already have
environmental agencies or ministries for overseeing and managing the re-
sources they enjoy exclusively, and the status and performance of these
bodies should be improved. Whatever the institutional architecture, the
function of planning and development needs to be provided by govern-
ments with respect to all environmental variables. Cooperative planning
for exclusive resources—as it illustrated by the Conference Exposition on
Human Settlements—is useful, but it is also essential that responsibility
be delegated to and assumed by continuing organizations which can im-
plement the policies by actually carrying out the planned development.

It is, for example, important to make the concept of the working en-
vironment an integral part of the general human environment. By extending
the concept of the working environment to include all aspects of the work
situation, both inside and outside the workplace, ILO activities in this
field may become relevant to global environmental problems. The entire
problem of relationship of environmental protection and development
implies many employment aspects, for which policy recommendations
must be devised. Environmental policies with significant employment
effects include the management of natural resources and human settle-
ments, i.e., the distribution of populations between rural and urban settle-
ments in relation to the employment opportunities and the quality of life.

People in Relation to Resources

The laws of states concerning nationality and the movement of peoples
require drastic revision toward the freedom of choice of individuals and a
more rational relation of peoples to resources. It is overwhelmingly im-
portant that the general community devise incentives compatible with the
values of human dignity to decelerate the growth in numbers of people.

Priorities in Management of the World Constitutive Process

Intelligence

At the present time there is no global, interregional, and inadequate
national planning for the long-term future. In implementation of the plan-
ing and development tasks already indicated, "Earthwatch" or some equiva-
lent should be expanded into a comprehensive environmental in-
telligence function for the entire earth-space community. Appropriate
ancillary institutions should be created at every community level, and these
should be given the facilities and access necessary to fulfill and effective
performance.

Promotion

The promotion function might be more explicitly located in the struc-
tures of international governmental organization, and emphasis might be
placed upon specially organized public interest groups backed by charitable
foundations. Scientists, social scientists, lawyers, and others must become
concerned advocates and mobilize support among effective elites for appro-
riate environmental policies. Every channel, both public and private,
should be employed to take advantage of the immense potentialities of
contemporary mass communication.

Prescription

Greater use should be made of the United Nations General Assembly,
of delegations of competence to appropriate specialized and regional
agencies, and of procedures comparable to those employed by the ILO in
the clarification and promulgation of the urgently required prescriptions
for the environment. We recommend, further, that some expert body com-
parable to the International Law Commission be established to engage in
the continuous clarification and recommendation of prescriptions appro-
riate for all community levels. The tremendous importance of the ex-

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perceptions about lawfulness created by habitual, cooperative activity might
also be more explicitly recognized.

Innovation

States might become more willing to represent public interest groups and
environmental causes, nongovernmental groups and individuals might be
given increasing access to transnational arenas of authority, and special
ombudsmen or equivalent might be made competent to defend inclusive
interests.

Application

Facilities and procedures of the International Court of Justice could be
improved, and other methods of dispute settlement (negotiation, good
offices, mediation, conciliation, arbitration, and administration) could
be tailored more readily to give greater effect to environmental consid-
érations in the rendering of decisions.

In a relatively decentralized world, the role of the nation-state in the
application of inclusive standards would appear inescapable.

Termination

Procedures comparable to those employed in prescription might be em-
ployed to ameliorate the special costs of environmental protection for
particular states, such as states in process of modernization.

Appraisal

The institutions employed for the intelligence function might be adapted
to more effective evaluation of how the whole process of authori-
tative decision in relation to the environment is working. This is a function for
which private universities, foundations, and scholars have an especial
responsibility.

In a more particular specification of priorities, cutting across what has
been recommended above, it was noted by Mr. Peter Thacher that at the
second sitting of the UNEP Governing Council (Nairobi, 11–22 March) it
was decided to select specific areas of concentration (identified priority
areas, see report of first session) and had further specified the criteria for
the continuing process of selection of areas of concentration.

Insofar as the Fund Programme is concerned, that is to say, that part
of the overall VA Environment Programme which draws support from the
Environment Fund, a number of specific proposals for future action were
approved, and allocations decided, under the following headings (which
are shown as an indication of the scope and priorities of the program):

1. Priority subject areas
   1.1 Human settlements, human health, habitat and well-being
   1.2 Human health and well-being
2. Land, water and "desertification"
2.1 Ecosystems
2.2 Soils
2.3 Water
3. Trade, economics, technology, and transfer of technology
3.1 Trade and economics
3.2 Environmentally sound technologies and their international transfer
4. Occurs
4.1 Marine pollution
4.2 Conservation and protection of living aquatic resources
5. Consequences of nature, wildlife and genetic resources
5.1 Plants, animals, and endangered species
5.2 Ecosystem, sites, and samples
5.3 Genetic resources
6. Energy

II. Functional tasks
1. Environmental assessment: Earthwatch
1.1 Global environment monitoring system (GEMS)
1.2 International referral system (IRS)
2. Environmental management
2.1 Integrated planning and management methods
3. Supporting measures: information, education, training, and technical assistance
3.1 Information
3.2 Education and training
3.3 Technical assistance

III. Future development of the programs
1. "Outer limits"
2. National disasters
3. Particular environmental problems of specific industries
4. Ecodestruction
5. Development of the international law of the environment
6. Eutrophication
7. Comprehensive theory of comparative risk

Among other actions noted with interest was the recommendation that the United Nations General Assembly establish a voluntary International Habitat and Human Settlements Foundation, with initial support from the Environment Fund, having as its primary purpose the strengthening of national environmental programs relating to human settlements particularly in the developing countries, through the provision of seed capital and the extension of the necessary technical and financial assistance to permit an effective mobilization of domestic resources for human habitation and environment design and improvement of human settlements.

WORLD ORDER PRIORITIES

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During this century, we have passed through three cycles of approaches toward greater world community and of retreat from it. Between 1900 and 1913 the "one" world of that time was held together by market forces, the gold standard, international trade and finance, mass migrations, a common middle class subsistence, and the context of the nations for colonial empire, power, and prestige. This world collapsed in the shambles of World War I and the revolutions that followed it in many countries.

What followed was a world of many nations, increasing nationalizations, restrictive labor and immigration policies, economic protectionism, and with the coming of the Great Depression, an array of currency controls, trade quotas, and the like, all in the service of nationalist striving for state controls of economic life. However, this divided world collapsed once more, in World War II, and in the upheavals and regime changes that followed it in many places.

After World War II, it was tried once more to put the world together, this time in considerable part through international agreements, institutions, and organizations. Far beyond the pioneering but fickle efforts of the old League of Nations, the new organizations—the United Nations, the International Monetary Fund, the World Food and Agriculture Organization, and many others, as well as an expanded array of private multinational corporations—helped governments to coordinate their actions more effectively. There followed two decades of great economic prosperity, widespread industrialization and urbanization, health improvements and population growth, and large technological changes. Plans for regional integration in Europe, Latin America, and elsewhere seemed to promise further progress toward "one world" once more.

This development stopped, or slowed down, critically, once again at some time in the early 1960's. The institutions, the ideas, and the political practices and controls of the late 1940's and the 1950's no longer were adequate, so it seemed, to cope with the burden of the vastly enlarged transactions, ecological and social problems, and political demands which generations of growth had generated. Once again, governments and people have been turning to their national perspectives, and once again they have relegated world cooperation to second place.

We feel that we cannot afford another decade of neglect of world problems. The accumulated effect of these neglected problems may produce catastrophes even larger than those of the past. Most of the priority con-

* Addendum to Group Report 5.
WORLD ORDER PRIORITIES*

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* Addendum to Group Report 5.
Public Order and World Regions

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The issues of social welfare, justice, and preservation and enhancement of the environment, as they pertain to world regions, are fundamentally questions of distribution and production—distribution of income, resources, productive plant and equipment, infrastructure (including health and educational facilities), and opportunity to enjoy the environment.

For the purpose of this conference, it is useful to concentrate on the problems of the environment, broadly conceived. Any approach to the solution of environmental problems must begin with a recognition that our present government and nongovernmental institutions are inadequate. In order to sharpen our thinking on directions for improvement of the world public order, we shall posit, in fact, we consider absolutely essential, a strong world unit directing and serving a system of world regions. Such a world unit would exist in a newly constituted UN or a restructured United Nations, which was greatly strengthened in power. In particular, there are specific requirements for the viability of such a unit. We are not in a position to enumerate all of these, but at the minimum, these requirements should cover: (1) tax power; (2) establishment of reserve funds for designated welfare-development purposes; and (3) full regulatory power and control of the seas.

Sir George Catlin has suggested that poverty, pollution, population, and peace are fundamental issues—as indeed they were at our Rome conference some years ago. These issues pose some of the basic trade-offs that must be involved in the establishment of healthy and compatible policies for a system of world regions. These trade-offs between world and regional goals can be specifically posed by considering the general problem of environmental management.

Some scholars might consider that the first step in developing policy would be to look at the problems from a global standpoint. At this level, we might ask, by how much should world economic development be limited in order to improve the quality of the environment? A trade-off would then be established between the material goods that enter into the Gross World Product account and the quality of the world environment, as measured perhaps by the inverse of the level of pollution generated.

Ironically, we recognize that simply setting limits on total world emissions is insufficient. Attention must also be focused on the distribution of pollution to each region of the world, since population, resources, and industry are by no means distributed evenly over space. Our standards

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must thus explicitly set constraints on allowable pollution levels for each region of the world. In setting these limits, we would need to consider the different industrial densities and mix, the population distribution and the resource scarcity of each region.

Constraints must be set not only on the pollution generated by region, but also on the pollution concentration that comes to be resident in different parts of the world, since diffusion processes often spread pollution generated in one place to other parts of the world.

Establishing limits on the levels of pollution in each region of the world will entail setting constraints on rates of industrial growth in each region, maximum per capita consumption levels in each region, and even perhaps population growth—constraints which are likely to create sharp conflicts between nations and world regions.

Other questions that will have to be determined include: the extent of the world’s income redistribution powers and/or taxing powers, the extent of its involvement in social welfare programs; and the extent of its involvement in regional development programs.

In addition to all of these issues, there is another question which concerns the extent to which centralization of environmental management. This comes up most forcefully when we recognize that there are common problems that are associated with common ecological systems, whatever the geographical location of the nations involved. For example, the arid regions have common ecosystems, and thus common problems; they form a natural basis for regionalization or decentralization of policy. In other cases, environmental regulations need to be organized around geographically contiguous regions, as is the example of the nations surrounding the Baltic Sea. Obviously, the existence of common problems does not preclude the possibility of a diversity of solutions for the several regions.

In still other cases, as with mercury pollution, for example, regulation will have to take place at the world level, since the extraterritorial go beyond regional boundaries.

Whatever the case, however, there is a clear need for environmental management that goes beyond the national level—environmental management that can only be undertaken by an empowered world unit directing and responsive to the needs of each region and nation in its system.

PART III. THE CONFERENCE DINNER

OPENING REMARKS

Boris Proel

The New York Academy of Sciences

World Academy of Art and Science

American Geographical Society

Excellencies, Presidents, Honored Guests, Dear Colleagues,

According to established customs, I should start my speech with one or two amusing stories, but instead I decided to read to you a very interesting excerpt, which was sent to me by a friend of mine a few days ago. I quote:

Why must we be so hot by internal conflicts? Our leaders place personal ambitions before national guidance.

We are watched by sneaky bacteriologists who envy our wealth. The government seems to be controlled by secret societies who preach strange doctrines.

Our elected candidates must endlessly substantiate slogans for good judgment and phrases for deeds.

Some of our men in government treat our laws like fables, made to be climbed.

Profit has become our religion, expediency our law, greed our motivation.

Yet what good are profits when the value of our money grows steadily less?

We have reached the point where we pay more to be governed than we do to live.

Taxes may sorrow, workaholism grow shoddily, goods inferior, prices outrageous, politics more corrupt, but the only thing we feel most is boredom.

We cannot stand time on our hands.

Yet we demand shorter workhours and more time to be bored, an unwholesome cycle whereinh makes have replaced the truth.

Is it man’s fate always to muddle through, bog down periodically and rise briefly from his inertia?

Yes, we have everything—everything—except the most precious of all possessions—a collective unity, a common destiny.

It would seem we are surrendering our responsibilities and are indifferent to the quality of our leaders, opening the gates to infiltration by destroyers who pretend to champion the people but are actually political adventurers.

That was Sertorius Calpurnio, an olive oil merchant talking to his wife, Cornelia. The place was ancient Rome. The date was 49 B.C. Rome collapsed 14 years later in 476 A.D.

* * *

There is a very dangerous tendency in the world—people are becoming anti-science and anti-technology. This attitude has to be changed and not let to be polarized if we do not want to accelerate irreparable disastrous consequences.
The most outstanding feature of modern society is the acceleration of technological changes. These changes affect all aspects of our daily life and the man in the street has great difficulty in assessing the consequences of this impact. On the whole, it is the development of technologies based on scientific discoveries that produced the actual well-being of the populations of the western world. Of course, there are also negative effects of technological changes which call for a new way of behavior, in order to withstand the personal insecurity, social dislocation, and professional instability, as well as dangers of pollution, ecological disequilibrium, etc.

We know the problems? But nobody can claim to have definite answers. Anyway, there is no reason to be dismayed by technology or to reject it on the basis of anti-scientific feelings.

Alvin Martin Weinberg expressed it very well in the following sentences, and I quote:

For rationality and science there is no simple or cheap substitute. Should science die under the onslaught of the nihilists, it could be only a temporary defeat. This human rationality and human good sense will prevail in the long run we talk for granted. It is up to us members of the older scientific-technological establishment to persuade our younger junior scientists nihilists that ours is the cause of reason, and that in our arduously built scientific-technological tradition lies our best chance of ultimate survival.

* * *

Over the last few days, we, who have participated in the conference, have been trying to throw some light on key requirements facing the world community. We have been making our own contribution to the understanding of science in today's world.

We are most honored that Lord Ritchie-Calder has been able to join us this evening and that he has kindly agreed to give the after dinner address. It is difficult to decide which of Lord Ritchie-Calder's attributes to highlight on this occasion—his pioneering effort in science journalism, his academic work, or his numerous activities toward international cooperation.

As a science journalist, he has published over 30 books which include, *The Life Savers, The Story of the Pharmaceutical Revolution, Medicine and Man, Science in Our Lives, Living with the Atom, and How Long Have We Got*. His standing in this field was marked in 1961 by his being awarded the Kalngie Prize, the highest international award for the "Promotion of the common understanding of science."

As an academic, he has been Professor of International Relations at The University of Edinburgh, and is now visiting Professor of Technology at the Heriot-Watt University, Edinburgh. He is currently a Senior Fellow at the Center for the Study of Democratic Constitutions in Santa Barbara, and he is also a member of the General Council of the Open University of Great Britain.
Lewis Mumford in *Interpretations and Forecasts* and Gerard Piet in *The Acceleration of History* have sent us back to the uneasy predictions of Henry Adams, the American historian who outranged his classical contemporaries at the beginning of the century by producing "The Rule of Phase Applied to History." With informed insights into scientific developments including recognition of the portentous meaning of Bequerel's discovery of radioactivity, he plotted the phases of history and the sports produced by man's material achievements and related them to the Curve of Thought by which man has consciously handled such achievements. His History of Thought was in passage through three phases, each with a duration of years that was the inverse square of the duration of the preceding phase. He computed the path of history to the path of a comet which would pass its perihelion in 2025 A.D. and curve back on itself. His progressionism was pretty grim. He said:

According to my score of points and curves at the accelerated rate of progress since 1900 it will not need much another century to turn Thought upside down. Law in that one would disappear as a theory or a priori principle and give place to force. Monotony would become police. Exclusiveness would reach cosmic violence and disintegration would overcome integration.

He reckoned he was making generous allowances in his time scale of civilization when he estimated that 
the perihelion of the revolution would arrive by 2025. He did not live to see the atomic bomb but H. G. Wells did. You will remember that in *The Time Machine* which anticipated Adams, Wells had mankind turning back on itself in the space-time continuum. After the atom bomb Wells, with his co-geniusian pessimism, had persuaded himself that this idea was not fictional. In the year before his death he too used the analogy of the comet. He wrote:

Events now follow one another in an entirely unforeseen sequence. Processes which have reached the parallel for what we call Eternity swing off as a tangent from one another—just as the comet in its perihelion hangs in the heavens but for a season and then rushes away for ages and for ever.

If we do not like the doomsday interpretations of Adams and Wells we may find comfort in Jonas Salk's *Survival of the Wittest* and believe we are in transition from "Epoch A" to "Epoch B" from scoring purposeslessness in "Epoch A" to sexual utilitarian through improved quality of life in "Epoch B." As it is evident from the agonizing reappraisals at this conference whether we are in the tail of the comet or in the processes of epochal transition, we are in an uncomfortable predicament. What Adams called Thought

and what Salk calls Wisdom is a commodity in short supply. Historically we have come to the changes of phase produced by the discovery of natural forces, of the elements and the sources of energy and variously adjusted them to our material advantage. In the process we produced cultures, societies, and institutions. We internalized knowledge and dispersed it. We encouraged that natural curiosity which we call science and processed our arts and crafts into what we call technology. Now there is so much knowledge that we cannot cope with it effectively and so much technology that it tyrannizes us. We are suffering from consumption of the brain and from the sclerotic of our political societies. To paraphrase Adams: "Justice has given place to law enforcement. Public morality to corruption. With the nuclear bomb Homo sapiens, thinking man (or Homo fragilis, unthinking man) can veto the evolution of his species, and peoples and nations are buffeted by forces that they themselves created.

Environmentally, we all may be in a space capsule but economically, we are adrift in a balloon, helpless in the updrafts of inflation and being tossed hither and yon. The helplessness is not confined to politicians, to the economists, to the stockbrokers, to the workers, scurrying for higher wages, or to the shopkeepers coping with higher prices, in the so-called advanced countries. Inflation becomes starvation in the poor countries which we have starved up in our price system and made dependent on oil-driven pumps or tractors and oil-based fertilizers and pesticides. They now find themselves unable to get oil or, if they could, to pay the price. This is a satirical commentary on the "Green Revolution." The plantation breeders and the agronomists may have excelled in producing high-yielding grains and rice but the hungry will be choked if the indispensable irrigation water, fertilizers, and pesticides are not available.

In the acceleration of history, the pace quickened during World War II and afterwards. In the growing-up period of the war babies we have seen the Atomic Age, the Computer Age, the Space Age, and the Bionics Age in which we will manipulate the nature of man himself. Each is as epochal as the Bronze Age, the Iron Age, the Renaissance, and the industrial Revolution and all have occurred simultaneously. Man has stood on the moon and has looked back at the earth, that small planet, the limits of man's family era, within which billions of people now and the billions still to come have to continue to survive and get along together. No two places on it are distant from each other by more than a few hours by jet propulsion, a few minutes by intercontinental ballistic missiles and split seconds by radio. It has been reduced to a neighborhood, but as Adams foresaw, the material achievements have exceeded the management capacities of the human mind and human institutions.

The Neighborhood Council is the United Nations. In the hot embers of a world war a new organization was created but when the Charter was signed in San Francisco in June 1945 only four people could have known, but they did not understand, that they were legislating for a world that no longer existed. The four were Truman, Stalinists, Attlee, and Eden, who had been broiled about the atomic bomb which was to be exploded a
months later in the desert of New Mexico. They only knew it was a big test bomb, a thousand times more powerful than the chemical bomb, but it no one had told them about radiation and the giant effects and none of them (except the military, political, social, and psychological effects of the event) of a catastrophic weapon.

There was nothing in the provisions for the United Nations which would care for this or any other scientific eventuality. With great difficulty the "S" was incorporated into UNESCO—the United Nations Educational, Scientific and Cultural Organization—which had been conceived of as UNESCO—Education and Cultural Organization—in the thinking about which science had been treated as something to be taught in schoolrooms or reached laboratories or, with the grace and esteem of time, might qualify as culture. That it was the social and economic dynamic of our time and the byword of both education and culture was only reluctantly accepted.

In the parent organization, however, science did not get its place in the decision-making or the decision-taking. It still does not. As the scientist advances and the momentum given to them by the crash programs which recouped time intervals between discovery and application from centuries to decades, decades to years, and years to months became manifest, the United Nations has always had to improvise. The United Nations Atomic Energy Commission which might have produced international regulations and control of the military and peaceful uses of atomic energy ushered in the cull of the Cold War. Ten and 13 years later we had the United Nations conferences on the peaceful uses of atomic energy. The great value of these conferences was that they reduced secrecy and brought the scientists together in relatively free discussions, but their promises in developing countries of moderated costs and faster reactors to provide the energy to hasten them on their way to industrial prosperity have not been fulfilled.

Still did the powers sign the Charter in 1945 realize when communications would do in their empires—independence, yes, (that is what the Trusteeship Council was interested in) but not as fast as events proved. What a British Prime Minister cabled "the winds of change" were in fact eolic winds. Universal radio turned the aspirations of freedom into an active and irresistible force. Independence became epidemic. Whereas in 1945, the United Nations had 51 members, today it has 135 and most of the newcomers are fragrant in thrall empires. Telecommunication not only encouraged the aspirations of freedom but also the realization of rising expectations. The highly advanced countries boosted by radio of their great scientific achievements.

I have been with the Sherpas on the slopes of Everest as they listened to accounts of a nuclear powered submarine going under the icecaps of the North Pole. I have been in the heart of Africa where the radio antennas were relaxed by talking drums into the swamp forests of the Congo. I have been on the Andean plateau, where the disinterested priests of the Incas, under the huge chickens of the rocket launchers, were listening on transister radios to the astronauts gestating in space. I have been "moon-basing" in the snow-deserts of the Arctic with Eskimos who curted Geiger counters on their dog-sleds on their way to their trap lines to look for uranium and battery radios to listen to the prices on the Montreal metal market to see whether it was worthwhile to loot for uranium. Everywhere, but everywhere, people were talking about the wonders of science.

This revolution of expectations encouraged people to believe that science and technology would provide answers which would transform their lives—feed the hungry, cure the sick, and liberate the poor from the degradation of poverty.

Now midway to the year 2000, when there is enough overkill in the nuclear arsenals to provide a hundred tons of TNT equivalent for every man, woman, and child on earth, when men have broken the gravitational forces of the planet, stood on the Moon, and sent inquisitive instruments into orbit around Mars and Venus and to Jupiter, when electronic instruments have excelled, for specific purposes, the human senses and surpassed the sensory capacity of the human brain; when organs can be transplanted in intensive-care units—when such things have been spectacularly demonstrated, the weight of two thirds of the world's people has not improved. Proportionately, it has worsened. For one thing there are more people to share the misery. For every hour of the human race, there are three more mouths to be fed—and precariously in the less developed countries.

This is not due to a great orgy of production. Couples are having more children: more children are surviving the deadly hazards of childbirth, infancy, and childhood to make and to multiply. The span of life (still short in poor countries in comparison to the rich countries) has increased. Medical science, when it can be applied in public health situations, has curbed the mass killer disease. Even while we see what has been happening in the Sahel, north of the Sahara, it is still possible to claim that globally there is enough food for everyone, but we cannot even get the heads out of the rubbish and the new concern about protein is a reminder that feeding means more than just appeasing hunger—it means providing food suitable for well being, and there is certainly not enough nourishment to go around. For another thing, the drift to towns is increasing urban squatter and urban violence. Unemployment is increasing and with it deprivation and denial of human dignity. After years of trying to increase educational opportunity the literacy rate has dropped but the number of illiterates in the world, by addition and multiplication, is increased. It is obvious that the developing countries are struggling up a down escalator. And, what is more, through the technology of communications, the people know it and want it. Disenchantment with science and technology and distrust of their solutions have set in.

While the developing countries are denied genuine economic growth to achieve their social purposes, developed countries are now embarrassed by the social problems which unexamined productivity has produced. Preoccupation with GNP (gross national product), that dubious index of material wealth, has increased dissemblance and alienated the younger generation who see it greed and debasement of the quality of life. Industrial unrest has been generated by lack of job satisfaction. To tell
We need more than intergovernmental Oversight which are blinkered by national sovereignty, more than International institutions, like UNESCO, and more than transnational traffic which is the future-faire of Ideas. We need a global view and a global concern.

And that raises, rightly, the question whether a global science policy would impose constraints on, or control science and technology; I, for one, am not going along with a moratorium on scientific research or the curtailment of natural curiosity. But I suggest that a case can be made for establishing wise priorities in the technological use of scientific knowledge and, in terms of professional responsibility, for offering cautions about trends in science that are raising profound ethical questions.

We saw the salutary influence which the non-governmental organizations had in exposing the complicity of governments and bringing about UNESCO. As a solace for his pessimism, H. G. Wells produced his "New World Order." I believe that this week this conference has been, a time-phase removed, reviving that requirement of a new world order. We can accept the simplicity of the Brotherhood of man, the common heritage of mankind, and the commonwealth of science—-and they are nonetheless valid because they are simple axioms. But we have now science generated factors which are implosive—impinging on a globe which is itself finite, the earth man looks as from the moon. They are global because their management is beyond the competence of any nation, or nations, however highly advanced. Nor can they be tempered by adding up the sum of national policy sciences as at present conceived.

We are living with the problems of nuclear power—no longer at the discretion of the superpowers playing strip poker in the SALT talks; of overpopulation; of shortages of food necessary for human well-being, and environmental determinism due to the proliferation of technology in the recent past. We are facing, in a future more imminent than most people recognize, the implications of new technologies—of global weather modification; of the extension of sensory detection of the earth's resources from satellites; of mining the ocean bed for minerals, in ignorance of the effects of the ecosystem; of highly sophisticated computers for data services and surveillance of our private lives; of direct broadcasting into the home from transmitters in space; and of genetic engineering changing human nature itself. They will all have their impact before the year 2000 and the international machinery or even the international morality to regulate and ensure their proper use does not effectively exist.

We should consider not only how to improve intergovernmental machinery but the role of non-governmental organizations, of the universities, of the scientific cosmopolitan movements like Pugwash and PAXM in Marburg of cooperative research institutes of "centers of excellence," and how, if desirable, such elements could be articulated in a "global science policy." What would be the appropriate body or harmonized bodies from which such a global science policy will emanate? How
CONCLUDING NOTE

Boris Pregel, Harold D. Laswell and John McNale

The Second International Conference on Environment and Society in Transition carried the integration of knowledge and policy a long step forward by focusing upon World Priorities. Policy is an act of stepping into the future, and future events are "estimated" rather than "known." As the members of the Conference emphasized at every meeting of a working group and at every plenum, the policy implications of knowledge are matters of judgment. If judgments are to be other than capricious and arbitrary an act of judgment must be disciplined by procedures that include the contextual consideration of norms, facts, and estimated futures.

The Conference is part of an institution building process in which both the American Division of the World Academy of Art and Science (WAAS) and the New York Academy of Sciences are engaged. The task is to establish close and continuing relations between scientific and professional knowledge and action by public authorities. Where scientists and professionals can assert themselves as citizens (as well as officials), the responsibility of academies, universities, and research institutes is especially important. It is essential and appropriate to report regularly on world priorities, and in this way to provide a well-thought out map for the consideration of all concerned.

It has become increasingly clear that if our judgments of priority are to be based on realistic assumptions, they must be made in the context of an inclusive, selective, and provisional map of the past, present, and future of environment and society. Further, it is evident that the probable realization of world policy is improved when they evolve in the course of a program that includes an informed review and appraisal of public policy in a wide range of fields.

Judgments of priority are an exception to the principle that a decent regard for the opinion of others is an important element in a collective process of decision. Weights must be ascribed to the judgments expressed by individual scientists in reply to private questions about their ranking of world priorities. In preparation for the Second International Conference we therefore gathered replies to questionnaires circulated to a preliminary sample of scientists and professionals in many countries. It is important to continue and to improve surveys of this kind, which should be sponsored by organizations that decide to issue revised priority recommendations from time to time.

As scientific, professional, and official bodies take more regular responsibility for the choice of policy priorities, they will be challenged to identify the basic assumptions on which they proceed in reference to the preferred quality of life. Members of the Conference called attention to the point that an authoritative preliminary effort has been made to define the appro...
private norms for the world community in the Universal Declaration of Human Rights, which outlines some implications of the overarching goal of human dignity. (The specifications of a model of human indignity can be found in Riss programs for non-Aryans.)

Contemporary speculations are actively engaged in selecting and utilizing at least partial indicators of the quality of life. Exercises of this kind are indispensable means of translating the ambiguities of prove into explicit references to society and environment.

The policy papers that were prepared by the working groups of the Conferences may be reclassified in various ways in order to emphasize important considerations of objective and tactics. For example:

1. Policy priorities related to world institutions.
   A. Policies designed to speed up the dissemination and maintenance of a realistic common map of world institutions, population and environment. The mapping process is intended to enable all who would play a useful part in policy formation and execution at both official and unofficial levels to keep their own assumptions under review.
   B. Policies designed to achieve a more responsible framework of world public order.
   C. Policies designed to foster selective development and to reduce inequalities between and within countries.

2. Policy priorities relating to world population and environment.
   A. The balancing of food requirements and population size is a priority problem in both immediate and long-run perspective.
   B. A comprehensive system of priorities is necessary if world policies toward environment are to be coherent and cumulatively effective.
   C. Priorities toward energy sources and arrangements aimed at abundant energy without waste.

Many suggestions by Conference members were intended to encourage next steps toward strengthening the impact of knowledge institutions on public policy. Academies, universities, and institutes do not at present use a common channel to report their activities at the several phases of public policy. It would be useful to obtain from these institutions in a routine way a publishable accounts of their policy initiatives (and effects). A simple questionnaire like the following indicates what is meant:

Has your organization publicly proposed a list of “world policy priorities” or of “national policy priorities”? Was the report at your own initiative, or at the request of an official agency?

Has your organization published a report on “world policy goals” or “national policy goals”?

Has your organization published “reviews” or “recommendations”

Concluding Note

Concerning national or international policy toward environment (or toward any chosen sector of public affairs)? Are any of the above in prospect during the coming year?

The Conference perceives each of its activities, and those of similar organizations, as steps toward realizing the aspirations expressed by Lord Ritchie-Calder toward “Mankind’s Second Chance.”