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ENVIRONMENT AND SOCIETY IN TRANSITION: WORLD PRIORITIES

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American Division of the World Academy of Art and Science
The New York Academy of Sciences
New York, New York
1975

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E. Energy

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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 developments, 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 concisely reviewed by outstanding contributors to the physical, biological, and cultural realms of knowledge. These developments were weighed in terms of their current and prospective impacts 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 First 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 recommended 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.

For many participants the arrangements of 1970 and 1974 were novel and even disturbing. We must express our admiration for the smoothness with which nearly everyone adapted to the situation. We appreciate the generosity of spirit that made it possible for so many members to congratulate the Conference organizers on the format.

INAUGURATION OF THE CONFERENCE

Boris Pregel

The New York Academy of Sciences
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 panel 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 imaginary, 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 present world difficulty. 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 underlined 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 a steady rate. For the immediate purpose of this report we have processed approximately 700 returns from 72 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 continuing 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(s) and/or add others. *The second question* called for the ranking, on a 1 to 5 scale, of policy priorities, considered in world perspective, of some 25 priority topics—ranging from atmosphere and noise, the clarification of value norms to vulcanism and water supply. Respondents could also add three other topics as desired and were asked to give additional discursive 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	9%
2. Economics	9%
3. Medicine	8%
4. Biology	7%
5. Political science	7%
6. Psychology	5%
7. History	4%
8. Earth sciences	4%
9. Engineering	4%
10. Philosophy	4%
11. Law	4%
12. Arts	5%
13. Biochemistry	3%
14. Anthropology	3%
15. Literature	3%
16. Biophysics	2%
17. Chemistry	2%
18. Oceanography	2%
19. Physics	2%
20. Linguistics	2%
21. Atmospheric sciences	2%
22. Cybernetics	2%
23. Space sciences	2%
24. Mathematics	1%
25. Ecology—Environment*	1%
26. Education*	1%
27. Agriculture*	1%
28. Astronomy	1%
29. Communications*	1%
30. Planning and Development*	1%
31. Management*	0%
32. Demography*	0%

* 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	22%
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 aggregated profiles of choices for various fields.

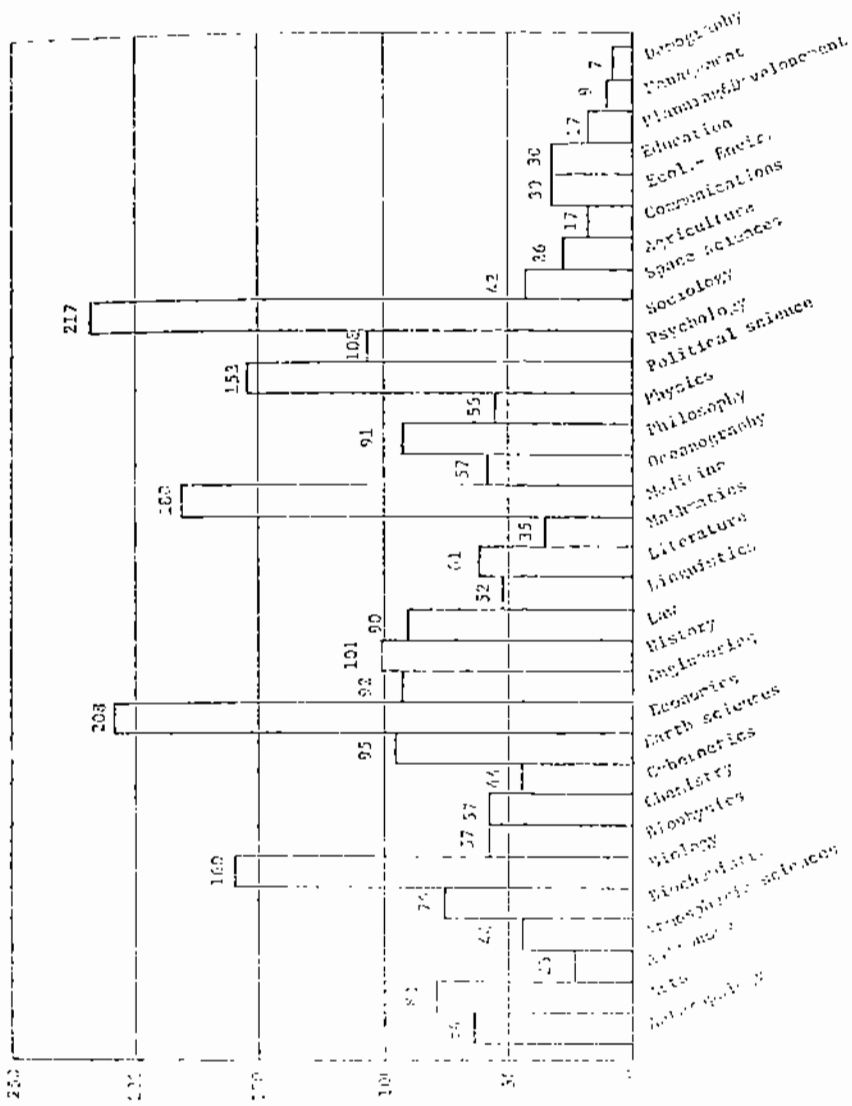

FIGURE 1. Fields of Interest (Note: Respondents (708) could choose 1 to 6, inclusive, fields of interest.)

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 in the highest categories—and outer space exploration and vulcanism allocated lowest priorities.

1. Education
2. Energy development and use
3. Food supply and distribution
4. Health and medical care
5. Population numbers and distribution
6. Mobilization of public participation and support in decision processes
7. Income distribution and consumption (including leisure)
8. Water supply and distribution
9. Public communication and information
10. Social discrimination and non-discrimination
11. Control of violent and non-violent coercion
12. Clarification of value norms
13. Atmosphere and noise
14. Family structure and relations
15. Planning and appraisal functions
16. Cultivation of science
17. Forests
18. Provision of civil and criminal justice
19. Human genetics
20. Metals and minerals
21. Climate and weather
22. Seabed
23. Cultivation of expressive arts
24. Ecology—Environment*
25. Outer space exploration and utilization
26. Vulcanism (including earthquakes)

* This was not a listed priority but added in "other" category.

As with fields of interest these may be regrouped and compared as percentages of the overall response. In the case of priorities, however, it may also be useful to retain the topic subdivisions as the grouping is more arbitrary.

Social/Economic/Political 38%

Clarification of value norms
Control of violent and nonviolent coercion
Income distribution and consumption (including leisure)
Mobilization of public participation and support in decision processes
Planning and appraisal functions
Provision of civil and criminal justice
Public communication and information
Social discrimination and nondiscrimination

Materials/Resources/Energy 19%

Energy use and development
Forests
Metals and minerals
Outer space exploration and utilization
Seabed Vulcanism (including earthquakes)

Behavioral/Health 23%

Family structure and relations
Food supply and distribution
Health and medical care
Human genetics
Population numbers and distribution

Arts/Humanities 14%

Cultivation of expressive arts
Cultivation of science
Education

Environment/Earth Science 7%

Atmosphere and noise
Climate and weather
Water supply and distribution
Ecology/Environment

It may be noted, of course, that the regrouping of the priorities, although useful in suggesting the strong emphases 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 each rank up six priorities.

Correlation of Fields of Interest with Priorities

Although little systematic correlation could be carried out, due to the variability of response incident on 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 as indicated field with health and medical care. One hundred thirty-two out of 180 respondents noting medicine as major field 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 accorded to vulcanism (including earthquakes) even among those respondents living in earthquake prone areas such as Japan and Central and South America.

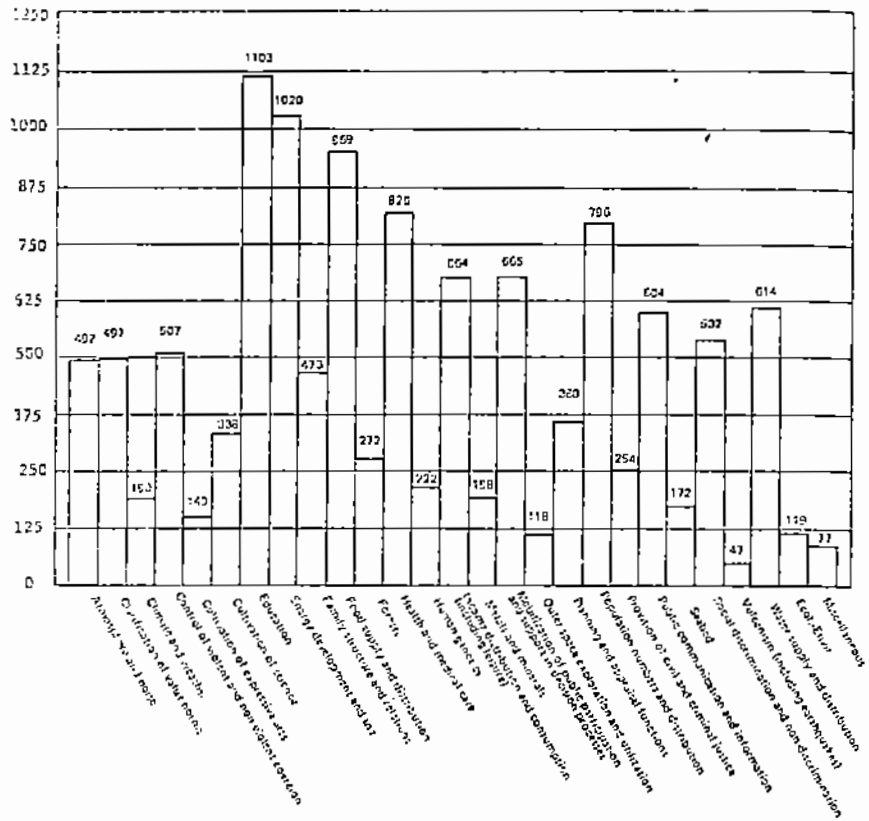

FIGURE 2. Priorities as allocated (Note: Respondents (708) could choose 1–6, inclusive, priorities.)

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 concerns.

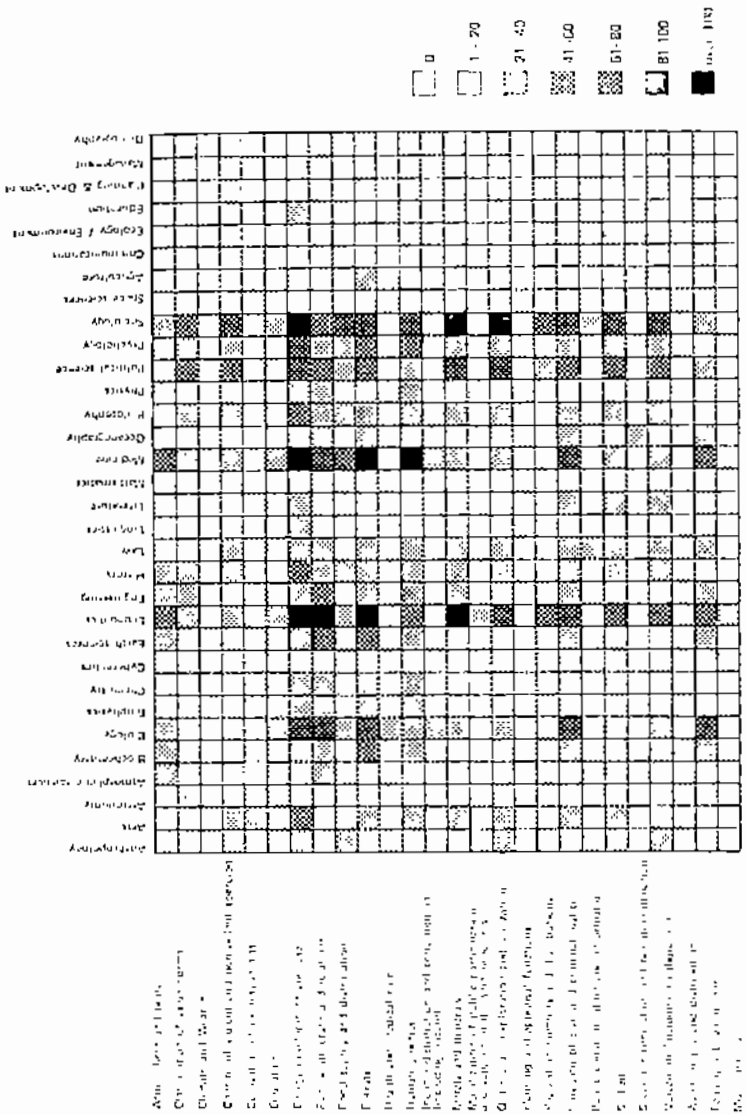

FIGURE 3. Frequency distribution matrix of priorities/fields of interest.

Geographical Distribution of Respondents

As noted earlier, the 708 returns processed were from 72 countries. Since the "cut off" date for preparing this interim report, the overall response has gone 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*

United Kingdom	101	Switzerland	51
USA	100	Netherlands	49
France	86	Germany	22
Belgium	66	Italy	22
		Canada	15

B. *Regionally grouped responses*

Latin America (including South and Central America and West Indies)	48
Scandinavian group	41
Europe (*additional to* (*A*) but including Eastern Europe and USSR)	37
Asia (including India, Pakistan, Japan, Thailand, etc.)	30
Africa (South of the Sahara)	19
Middle East (including North African countries and Israel)	11
Southwest Pacific (including Singapore, Phillipines etc.)	10

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 Geomagnetic 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

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 poll 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, et cetera; (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 discursive 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-

quate for the larger purpose it was used for, we have been extremely gratified by the response and encouraged in the idea that such a survey conducted on a more complex and continuing basis might fulfill many useful purposes.

One purpose may be simply its questioning and alerting function as addressed to these 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—these functions of continuous appraisal, review, and assessment which may provide for the 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 Szalai 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 Lasswell. 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 Lasswell. Of course, if anything I say this morning does not make sense, it is not because of Professor Lasswell, 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 fortunate 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 retrain 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.

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 conceive 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 dissatisfactions 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 of Japan 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 ten 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 employment and quality of workers' lives; modes of consumption and distribution of income; material environment; violence and criminal behavior; family life; and social mobility and stratification.

It was rather interesting to find that, despite so much talk about the deterioration of life today, the quality of existence had *not* become worse in all of the areas we studied. In fact, in certain areas, it had actually improved! It is only in some areas that life has really become very bad.

The important thing to remember is that people are apt to become emotional when they look around at the current state of affairs and then think that the world is now coming to an end. In fact, one of the best sellers in Japan last year was entitled, *Japan Sinking*. This book sold very well—about three million copies. Unfortunately, it was not published by my company!

Our studies showed that there had been improvement in the area of health care. The Japanese have a longer life expectancy; there is medical security; and health care services are found in detached local communities as well as in cities. Furthermore, there has been improvement in the educational facilities in Japan.

As for quality of workers' lives, here too there has also been improvement. Workers now enjoy all sorts of recreational facilities. During the weekend, for example, they can study painting or writing, or engage in sports. Workers can now more easily select their work in relation to the kinds of preferences and skills that they have. Over the span of ten years improvements have been about two-fold according to our survey.

Study of leisure, which has of course expanded, shows the same thing. We discovered that at first people paid more attention to television to fill in their leisure time, but now their interests have become more diversified. Thus, there is greater spontaneity in enjoyment of life than there was previously.

With regard to consumption and income, the gap in distribution between the rich and poor has been narrowed not only in income, but also in property, resulting in a greater stability in life-style. Although people are worried about inflation, and facts show that they have more stake in the economic drive, they are not as worried about it as they used to be. So, here the question of what we mean by output comes up again. This involves objective indicators of what has happened. As we interviewed people, they told us somewhat different stories. Therefore, there is a gap between the subjective assessment of certain things and objectively perceived changes. This gap will be examined in our next report. We are aware of its importance, but so far, I do not think we have succeeded very well in assessing it.

Another area in which there has been improvement is family life. The growth rate increased for some time, but now it has stabilized; parent-child relationships have improved; and crime, except for delinquency, has decreased.

There has been greater social mobility recently in Japan, a fact that has been indicated by various studies. Lipset and Bendix of the University of California worked with us on a comparative study of social mobility since 1950. On the basis of that study, we found that in Japan during the span

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.

These findings indicate, then, that we need not take an unduly pessimistic attitude toward the societal 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 let 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 area in which there has been drastic decay is the spread of harmful materials such as gasoline by-product pollutants; these have multiplied thanks to the prosperity of Toyota and Datsun 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 of 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 oil 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. Under such 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 whole, must think and talk about the interests of their constituencies rather than about the future of mankind.

How can we expand the vision that political and intellectual leaders must have to achieve a new society so that it takes into account local interests as well? This is a very crucial question. During December and January, when the Arab nations announced that they were going to reduce their oil exports, some of us in Japan were quite upset. However, we realized that this was actually our cue to design a new way of living. During those critical months at the end of 1973 and the beginning of 1974, people became quite serious and thought more deeply about the importance of man, about themselves, about individuals, and about mankind. I believe that we should become neither too pessimistic nor too optimistic about the future. Man is able to learn under difficult circumstances, and the problems we are faced with now afford us a golden opportunity to learn.

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 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 grossly 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 $20{,}000^{th}$.

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 combinatorial 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. The

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 Lasswell. 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 at the price of either a completely static view of the world or a jesuitical 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 dispensed 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 tour 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 macro- or microeconomists.

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 astrologers and palmists, and a group of less honest

economists and stock-market analysts. I suppose that as a member of the Commission of the Year 2000 I am probably one of the earlier entrants into the new type of futurist business, which has been growing far faster than the astrologers'.

It is my belief that the Commission for the Year 2000 and most of its members had a reasonably healthy and balanced understanding as to what they were doing. To a great extent, I believe that they knew that they could have influence in raising the questions of who plans, who listens, who cares, and if they did no more than to bring these questions to the consciousness of different parts of society, the Commission would have served a valuable purpose.

After the Commission for the Year 2000, and to some extent before it, the followers of the computer had already arisen. We had a proliferation of the simulators and the grand simulators. The simulators and the grand simulators can be split into two major tribal groups.

The first is the "business as usual" simulators. This includes those who take care of the large macroeconomic models. Included also are respectable counsellors to the governments, those who are card-carrying professors at acceptable universities and belong to most of the right associations. The other major tribe has as its prime members the prophets of doom, and global forecasters. These simulators include the Club of Rome, the Forrester school, and several others.

The payoffs to the "business as usual" simulators are fairly straightforward and are measured in terms of promotions, grants, memberships in academies, and even in personal profit. However, it is much more difficult to specify the payoffs to global forecasters. If, as I noted with the Commission for the Year 2000, we were to regard their role in terms of social propaganda, we could claim that they were successful and could extend this measure to the activities of the Club of Rome. When viewed in terms of public impact, the global forecasters and prophets of doom simulators have been extremely successful. Their books and articles have sold in the millions. They have reached a popular constituency and have caused much popular discussion.

It might be that the work represented by the Club of Rome, Herman Kahn's futures studies, Forrester's large-scale simulations, and others should be interpreted merely as devices to attract the attention of a broad spectrum of society to problems deemed important by their designers.

I believe, however, that it is important to find out if the growth of activity in the building of large-scale models has been motivated by other purposes. Do the large planning modelers wish to become central planners? Do they want some central political figure to say, "Give us your methods for this is the way we are going to run our economy or society"? Are they utopians or otherwise naive? Have they ever seen and understood the functioning of a large bureaucracy? Have they seen the differences in pressure and the nature of power that are manifested in a move from the cloisters or from the universities into the mainstream of a bureaucracy? Have they ever seen the hordes of chief petty officers, or majors and colonels

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 rather detailed study of a considerable amount of work on simulation 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 cameraman and every newspaperman and his brother to wherever 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 depths 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, opens up new dimensions for "rationalizing man."

I personally believe that future-planning is of extreme importance and that the correct size for 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 resolved.

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 to his own account as the economy changes.

In contrast, the futures-planner may best serve his society as a generator of self-defeating prophecies. 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.

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 being tried out. Let me say briefly that I have been responsible with others for launching a set of ideas about the development of developing countries in the seventies, known as the Second Development Decade, and this was accepted by all governments in the session of 24 October 1970. We have since 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 so little real implementation of this strategy has taken place. This second complex of problems might well be indicated for brevity's sake as the problems raised by the Club of Rome and by the Meadows' Report. Even though I am fully aware of the fact that there are many possible things to criticize in the Meadows' Report, I think that, nevertheless, it has had the great virtue of bringing into focus 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 reconciliation 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 connotation in Mr. Strong'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 reconciliation.

If I were to take over some of the terminology that Mr. Shubik gave in his admirable exposé 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 indicative plan and would really inspire a number of politicians towards 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.

What I am going to talk about briefly is typically not 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 where the main bottleneck is. I have started working with and am having great use for Dr. McHale'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 exercises, my impression was that this fadded 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 ethologists, 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, technicians, technologists, geologists, and sociologists up to a point, and on the other hand, the ethologist. 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 even been strengthened for some time, but consistently the small group that I indicated of ethologists 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 a 4 percent annual 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 act—is that the sort of problem that they see is very complicated. The current stage of their

research is not yet far enough advanced to give anything like world estimates as to, for instance, which parts of arable land should be untouched in order to provide some sort of breeding place or, at least, a place where the necessary diversity of genes can be maintained. I am speaking, of course, as a non-expert on these things now, and I hope I do not misrepresent the case. It seems to be necessary to look at the vulnerability of the new species that we now rely upon for the green revolution which has become apparent from time to time already. In no way, it seems at least, are others able to criticize our figures in what we would call a constructive way. We economists are not afraid of working with world figures when needed. Therefore, the figures that I present should be seen only as a challenge, mainly to our colleagues from ethology or biology, in the hope that, ultimately, improved knowledge will help us to decide.

In the second part of my paper, you will find the actual figures that are the consequence of what in the first part I took as the assumptions for what I called framework of observation and production development over about 40 years of time starting in 1970, and finishing in 2012. Do not laugh at the exactness, that is simply for technical reasons. It is easier to take a 42-year period than a 40-year period. It is not meant to be taken literally, of course.

You have seen the assumptions. The assumptions are extremely imposing and I presume that most of you would agree with me that they are asking far more than can be expected to be attained. To repeat, for instance, my assumption is that we succeed in getting the population of the developed countries back on the 1970 level by the year 2012. You will understand, of course, what that implies. The second assumption is that for the developing countries we are not that strict, but we assume that by the final year, they will have reached the point of zero population growth gradually from their 2.7 percent now.

The third assumption is that we will slow down the development of the rich countries to about half what it is now, ending up with, at least in material production, zero growth. The fourth assumption is that we should, nevertheless, somewhat accelerate development of developing countries. I think 5 percent annual increase in per capita income is an example. Why do I choose here something that seems to be against the tendencies of the other three assumptions? It is because I am as much impressed, as most development economists are, with the tremendous poverty that we can hardly imagine which is part of the developing world. I believe that if we do not follow strong policy here, we will ourselves be victims later on.

One thing that I introduced here as a measure to find out how to proceed is to compare the 10 percent richest to the 10 percent poorest. The stable nations that I considered were the United States, France, and Germany. I found that the ratio in income per capita between the 10 percent richest regions and the 10 percent poorest in these countries is below 2 to 3. It would therefore seem that these countries are not in any trouble due to difference between regions.

The exercise that I have documented in my second half showed that we can, if we follow the working hypothesis that I formulated, hope for a ratio

of 2 to 3, between the 10 percent poorest countries of the world and the 10 percent richest and that would still mean less integration than we have now in well-integrated countries. It depends, of course, on the feeling that you have about how much integration the world will need 40 years from now. But to me it seems that the very quick development of every technological aspect of our lives will probably make it imperative that we achieve some sort of world integration if we do not want to avoid being the victims of very great upheavals.

I may have been slightly too pessimistic in that respect. One might change the figures somewhat, of course. The most difficult thing that still confronts us is that even with the almost impossible effort that I describe as my working hypothesis, we still arrive at a figure for agricultural production about 3 times the present level, and that means a 3 percent annual increase. This 3 percent annual increase certainly has not been achieved so far. Between 1956 and 1966 it was 2.7 percent, and then after that it was almost at a standstill. The only other comparison I could make is that at the time the FAO still believed in the worthwhile plan it had made itself for the 20-year period, 1965 to 1985, they indeed accepted the possibility of a rate of growth of agriculture of 4 percent per annum. So, in that respect I am slightly on the safe side, but not according to my friends the ecologists. They probably will doubt very much whether an increase in production of that size will be possible.

If I compare my attempt with a few competing attempts, and there are a few very interesting ones and in many respects better ones than the one I present, then these various alternatives all require much higher agricultural production 40 years from now than my set of assumptions does. I quote two examples. One is not public and therefore I will not go into detail about it, but it is a piece of research. The other one which has been published already is the one which was presented to the Population Association annual meeting a couple of weeks ago in this same city by Messrs. Maxwell and Brown. It is a very interesting piece of work although it seems that they are more realistic with regard to their population forecasts or assumptions than with regard to their assumptions about production. They first of all arrive at a higher agricultural production than you would derive from my paper, and then they seem to consider that it is still possible 40 years from now to have a ratio of incomes per capita between the rich countries and poor countries of about 10 to 1, which I cannot believe.

Given these introductory remarks, it may be better now to turn to my summary.

* * *

SUMMARY

Theory

Assigning priorities is identical with drawing up an optimal (perhaps only indicative) plan on how to allocate available resources. Optimality can only 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 far 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-to-do. Severe limits are set to 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) leeway can be hoped for because of our expanding research and inventiveness.

With many strategic data on these matters still lacking, only a prescientific (intuitive) judgement can be given. For the time being this author ventures 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.

* * *

The prescientific (intuitive) judgement I presented in the Summary works out as follows. With the use of the World Bank 1973 "Trends in Developing Countries," but correcting by the Balassa 5% rule (completed with a correction for very low incomes by multiplying them by 1.6), Table I is obtained.

Considering the 10 percent richest countries (measured by population)

TABLE 1
POPULATION, INCOME PER CAPITA, AND TOTAL INCOME FOR DEVELOPED (D) AND DEVELOPING (U) COUNTRIES, AND TOTALS (T) 1970 AND 2012

Year	Population (millions)			Income per Capita (1970 $ purchasing power)		Total Income (billions $)		
	D	U	T	D	U	D	U	T
1970	1089	2588	3677	3700	320	4030	830	4860
2012	1089	4835	5924	7400	2560	8060	12400	20460

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 at 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. Ester Boserup, 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.), where these ratios (between the richest and the poorest decile) amount to 1.8, 1.7, and 1.5,

TABLE 2
INCOMES PER CAPITA ($ OF 1970 IN SENSE EXPLAINED) OF RICHEST AND POOREST 10 PERCENT POPULATION COUNTRIES

Year	Richest	Poorest	Ratio
1970	4400	136	32
2012	8200	1060	7.7

TABLE 2A
INCOMES PER CAPITA, CORRECTED FURTHER

Year	Richest	Poorest	Ratio
1970	3300	275	12
2012	6200	2000	3.1

respectively. For a less stable community such as Italy I find 2.1 and for the six 1969 EEC 3.2. (Deciles refer to regions, not to persons.)

My demographic assumptions imply, according to some information provided to me by the Netherlands Interuniversity Demographic Institute, that for the Netherlands an immediate switching to 1.6 children for the generations born after 1944 should materialize. For a number of more important countries the switch will probably be less drastic.

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 an attempt at reconciliation of the following challenges:

(1) take seriously the need to attain much more stable world social and political tensions between rich and poor countries;
(2) take seriously the threats of pollution, especially of the oceans, by a continued 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 that purpose.

The main intent of my paper is to invite alternatives.

PRIORITIES IN THE FIELD OF ENERGY: RESEARCH AND DEVELOPMENT

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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 industrialized 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 industrialized "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 rationing of energy in all its forms (electricity, gas, gasoline, fuel oil) or the launching of a large program of construction of electronuclear plants. However, any effective

rationing 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 unwise to try such rationing and unrealistic to believe in its success. In these countries of Western Europe there is indeed no choice, and many large electronuclear plants will be constructed during the next decade; the same is true for Japan also. 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, all of the Westinghouse 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 1.5 billion dollars and should start producing enriched uranium in 1978.

In the United States the situation is different because of the existence of very large reserves of coal easily workable and of a reserve of oil in shales which is much larger than all the Arab oil reserves but is still untapped because 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 replanting the extended areas laid 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 dioxide, all new plants burning coal or heavy fuel oil should be equipped with rather expensive devices for desulfurization 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

a fraction of the public opinion which has a somewhat mystical fear of the spread of radioactivity that might result from a major, very improbable accident in a nuclear plant, it is certain that many such plants will be constructed in the United States, in the near future, because the electricity they will produce will be, in most locations, much cheaper than the electricity produced by a power plant burning any fossil fuel.

Priorities for Action

On the whole, taking into account the fact that an electronuclear plant requires a larger investment than a conventional power plant, the industrialized nations will have to invest on a very large scale during the coming years to face the immediate consequences of the energy crisis and consequently the funds available for developing new sources of energy will be rather small. Choosing the right priorities is very important; I think that during the next 8 or 10 years the effort of research and development should be increased on short-term projects, giving good hope of easing, in the near future, the energy shortage or its increased cost.

We have seen that the first unavoidable consequence of the energy crisis will be the construction in the industrialized nations of many more large electronuclear plants. From the point of view of air pollution in normal operation this is a very good thing, but it is difficult to estimate the consequences of a major accident that might occur in one of these numerous plants. The public opinion because of its insidious nature is certainly overestimating the risk involved. Nevertheless and in spite of the many safety features already incorporated in the nuclear plants, which render infinitesimal the chance of a major accident, a new and important effort should be made to increase the safety of operation of nuclear plants. It is nonsense to ask for an absolute safety, but if the number of nuclear power plants that will be constructed during the next 10 years is about two times larger than previously expected, an important effort should be made to try to divide by two the already very small probability of a major accident occurring in such a plant, even if the cost of more safety increases the cost of production of electricity by as much as 20 percent.

The large unavoidable increase in the use of nuclear energy during the next 10 to 15 years, based mostly on reactors of the American B or P W R type, which "burn" by fission only about 1 percent of the initial uranium introduced in their fuel cycle, will lead before the end of the century to a complete exhaustion of the rather rich ore bearing now worked, and consequently to an important increase of the price of uranium. This shows the importance of developing the fast neutron breeder reactor which uses eventually more than 50 percent of the initial uranium after converting its inert part, the isotope ^{238}U, into plutonium. If a large number of breeder reactors are not in operation before the year 2000, nuclear energy will become much more expensive. When we consider the success of the first industrial prototypes, especially the French one, it appears very likely that technically the construction of large competitive breeders could start 10 years

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 B W R 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 B W R 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 fabrication 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 requiring 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 face 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 ionized

gas jet into electricity by magnetodynamics should be intensified, now that the high price of fuel oil would justify the estimated supplementary investment.

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 unequipped 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 satisfy 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 mountainous 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 10,000 kW-h with a total efficiency of more than 90 percent, 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 300 kg, would be sufficient to propel a medium size car over a distance of 200 miles at a speed of 60 mph, and the reloading might take only 5 min. The industrial development, on a large scale, of such electric automobiles, that might take 15 to 20 years, would save much gasoline and would eliminate 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 temperatures below 1000°C. This may become the best way to store, to transport (by pipelines), and to distribute the energy produced in large high temperature nuclear reactors. The storage of hydrogen by absorption, under moderate pressure, on special porous metals may even lead to the possibility of using it as motor fuel, thus avoiding most of the pollution due to exhaust gases.

Geothermic 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, within depths accessible by drilling, of porous rocks impregnated with fossil hot water. In some volcanic regions wells, some hundred meters deep, may deliver steam at sufficiently high temperature and pressure for feeding turbines and producing electric power. It is the case, notably, at Larderello in Tuscany, where units of a total electrical output of 400 MW have been in operation for many years, and in California. In other regions it is only hot water that can be pumped even from rather deep wells, and the best use that can be made of such hot water is to heat houses or buildings. For instance, in the Parisian region a few wells, drilled for oil prospecting, reaching sandy rocks of the Jurassic age at a depth of 1000 m, deliver hot water at a temperature of 70°C that is used for heating a group of 1500 apartments. Even water at a lower temperature could be used with the help of heat pumps, if some progress is made in their construction, lowering sufficiently their cost.

Great technological efforts, mostly in drilling and geophysical prospecting, remain to be done in order to profit on a large scale by such geothermic energies, which will probably become of importance only for exceptional regions, but may nevertheless represent a few percent of the world total energy supply near the end of the century.

Solar Energy

In spite of the enormous amount of energy received by the earth 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 photoelectric 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 photocells, before a distant future. Nevertheless, research on solar photocells should be increased because the conversion of sunlight into electricity 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 most part of India.

The direct use of solar energy in 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 experiments 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 involved 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 bombs. 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 useful but nasty elements like plutonium.

The conditions necessary to achieve controlled fusion are extremely difficult to fulfill. The most arduous problem is the confinement, away from any wall, of an extremely hot (more than 50 million degrees) 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 Artzimovitch. The next generation of large experimental facilities of this type, which are now in the final designing stage 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 fission 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 fission 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 as little as 20 percent in the United States, but will not be more than one-half in Western Europe and one-sixth in the underdeveloped nations what 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 then, from the economic point of view, 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 eventuality that the safety of operation of such breeders, including their fuel cycle, could not be convincingly ascertained 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 photocells should be increased because they could be used, if they are sufficiently improved, in medium sized installations which might be very useful for isolated villages in underdeveloped 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 economical success in this field before at least 50 years.

THE SCOPE OF THE CONFERENCE: POSTCONFERENCE OBJECTIVES

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INTRODUCTION

Before the conference separates 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 emphatic endorsement in its conclusions 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.

How is mutual trust to be achieved and sustained? What *distinctive* contributions can scientists and professionals make to their fellow citizens? A partial answer is that they can *offer periodic commentary on what has been done or left undone* by the institutions of public order. They can also *propose more adequate goals and strategies*. Periodic reviews and appraisals of public policy can perform a valuable function in the United States and in every body politic where private persons and associations are sufficiently free to report the truth as they see it without fear of retaliation. Reviews and appraisals are distinctive in several ways:

They are *voluntary* and at their best are independent of pressure from Big Government or Big Monopoly.

They draw on the *best available knowledge*. A basis is provided for judging present and prospective policy alternatives.

They *diminish intellectual fragmentation* by utilizing comprehensive maps of man and environment and by relating specific problems to the context where they occur.

After the 1970 Conference steps were taken to gain experience by initiating and executing *Public Policy toward Environment 1973: A Review and Appraisal* (*Annals of The New York Academy of Sciences*, Vol. 216, published May 18, 1973). Twenty panels of specialists prepared short chapters on their sectors of competence. Developments in the United States were put in the perspective of world trends.

The present Conference is intended to carry the Academy's strategy some steps further. As you have noticed, the procedure of this gathering differs radically from the model of a Conference whose principal feature is the reading of lengthy papers followed by brief discussion. Our model is a congregation of small working groups whose separate task is to prepare one or more documents designed to influence post-Conference activities, not only of the Academy, but of any number of official and unofficial groups and organizations.

Obviously such documents are not the only desirable outcomes of our week together. We do not overlook the importance of personal friendship and intellectual stimulation. These, too, will have post-Conference consequences favorable to a more adequate structure of World Order.

The documents will guide The Academy's activities at the post-Conference phase. In common with all problems, thinking about a world policy problem involves five intellectual tasks:

The clarification of *goals*;

The description of *trends*;

The analysis of factors that *condition* the direction and intensity of trends;

The *projection* of future developments; and

The invention, evaluation, and selection of policy *alternatives* designed to optimalize goal values.

The committees are involved with matters of method and substance. The expectation is that the committee on priorities will provide us with a document that clarifies the theory of world priorities. Some of the problems of

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 is 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 professionals in drafting 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 relating 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 *life quality* or *life style*, postulates must be made about the size of population. Does one assume zero growth or a specific level of acceleration or stabilization by 1994?

Further, if 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?

Under 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 intentions are to concentrate on sectors of special importance and to invite the committees to examine priority questions within the sectors. The interdisciplinary character of each group will speed up effective eventual communication among committees, regardless of their separate starting points. The committee on world energy, for example, will of necessity deal with levels of resources and technology. It will judge the probable impact of organizational and legal structures, and also of public perspectives and behaviors. A corresponding range of tissues 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 *appraisal* of policy structures and actions to date;
The gathering, processing and supplying of *intelligence* to decision makers; and
The *promotion* of public action.

The committee 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 parochial 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 appraisals of public policy toward one or more 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 adapting conceptions such as a social planetarium to 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 leviathan of power to swallow society, or, reversely, of permitting

private monopolists or anarchistic forces to paralyze public order. Menacing imbalances between government and society are not invariably associated with either socialistic 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 most likely to succeed when it proceeds in two relatively independent parallel channels. The probability that a public order can stay "honest" is improved when the civic order is well-informed and active. Therefore, a 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. The reviews would develop attentive constituencies among government agencies, mass 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.

I. Earth and Space

Space
Air
Climate and weather
Water
Seabed
Earthquakes
Fossil energy
Nuclear and other energy
Minerals and metals

II. 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
Respect
Government, law, politics
Morals, religion
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 monopolistic 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 polities whose private and semiprivate academies and societies have a record of occasional participation in recommending or appraising public policy. They may be willing to recognize the opportunities and dangers of the time and to redouble their efforts in these directions.

In countries where the scientific and professional establishment is short handed 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 one 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 times we have witnessed the rapid growth of official and private agencies that give prominence to one or another feature of the decision process. "Future" societies are a case in point. The "projection" of coming

developments is one of the five problem-solving tasks mentioned above (the others: goals, trends, conditions, alternatives). The Academy's initiative may very well induce some "future" organizations to broaden their scope to include more features of the policy process.

Another contemporary trend among instructional 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, agriculture, architecture and 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 justifiably achieves recognition as a profession. The capacity to *serve clients* is not the sole test, whether we look at the old professions, such as medicine and law, or think of more recent candidates. It is necessary to add *capability in evaluating 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 appraisers 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 formulated. Goals and principles may be somewhat obscure, contradictory or confused; legal prescriptions and procedures may be missing or inept; organizational structures may be in flux; technologies may be underdeveloped, obsolescent, or in debate; public support may be ineffectively 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 margin of uncertainty is wider than a 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 initiate the work of some panels. Suggested improvements are invited.

a. *Goals* of public policy. What are the objectives of public policy toward that portion of the environment with which the Panel is concerned? When were these goals formulated? What form was used (i.e., were they part of treatises, statutes, ordinances, administrative regulations, etc.)?

b. *Criteria* of public policy. What criteria are relevant to the problem of reviewing the adequacy of policy formulation and performance? What criteria have already been recognized by public authorities as pertinent? For instance, consider the clarity and comprehensiveness of public policy. How clearly are objectives specified in reference to use, conservation, waste, pollution, and the distribution of burden and benefit? Are the lines of responsible authority precise or vague?

c. *Positive and negative achievement.* Have the technologies applied or encouraged been the most adequate? Have organizational structures acted in full cognizance of their responsibilities and have they been provided with the legal authority and the monetary and other assets required to operate effectively? Have the relevant authorities actively mobilized the public and group interests necessary to initiate and support what needs doing?

d. *Optimum proposals.* Each Panel is encouraged to indicate and assess possible alternatives in technological, organizational, legal, and support-mobilizing terms. Attention is directed to the assigning of priorities to component objectives and strategies.

Whatever the jurisdiction with which a Review Panel is chiefly concerned, the Panel is reminded to take account of policy formation in the largest international arena. Reviews and appraisals are needed at every level—national, transnational, and subnational. The latter includes provinces, districts, and metropolitan and rural contexts. Scientific and professional societies are ultimately involved in all. Parallel appraisals can be developed until they provide increasingly satisfactory samples of world trends and conditions and of the impacts attributable to policies that were either initiated by the scientific community or by others.

Since reports are directed to a larger and more diversified audience than a purely technical group, it is advisable to keep the reports short and, when feasible, to intensify their effect by employing multimedia technique. These requirements do not rule out technical appendices or impede the cooperative development of systems of data gathering, processing, storing, and retrieval. Through coming years they can be expected to become more complete, precise, and dependable.

As scientific and professional societies gain experience and expertness they will be able to carry their preparatory work to whatever level of minuteness seems rewarding. A critical issue is whether the data at the disposal of associations in the civic order will be substantially identical with what is available to the government. In view of security and privacy considerations, it is agreed that some limits are properly imposed on the access of private individuals and organizations to government information and on the access of officials and official agencies to civic organizations and individuals.

A further point concerns collaborators. Previous references may seem to imply that specialists should work solely with fellow professionals, officials, 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 Planetarium and Other Techniques

We mentioned a second strategy of Academy action in the post-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 zones* have outrun 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 consolidation 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 socialisms. Racism cuts across a potential identification with man. Even the media of mass communication 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-correcting 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 arrangement 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-

torial 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, vivid, and policy-oriented image of the whole.*

Selectivity is the key. The challenge is to sustain a contextual sense despite the avalanche of detail involved in an inclusive panorama of man's past, present, and future. Each committee of this Conference is invited to offer provisional 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 conceptions 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 broadcasts to relatively permanent local exhibits? Such documents as the Universal Declaration of Human Rights can be given tentative, not dogmatic interpretations. They relate to every value-institution sector of human life (to the shaping and sharing of power, enlightenment, 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 concerned with government, law, and politics; the communications revolutions; 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 sanguine scenarios should be chosen? What are the recommended sectors and indicators?

Alternatives. In the light of assumptions about priorities what policy problems should be proposed for universal presentation? How can the categories employed at the Conference be adapted to the purpose (e.g., assumptions 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 parochial constraints will modify social planetarium content in many situations. Nevertheless it is probable that enough convergence of view has already occurred to warrant the claim that much can be done to achieve a widened and deepened 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 bodies. Under the guidance of local panels (who, among other sources, evaluate suggestions and materials from elsewhere) exhibits can present a concise version of the whole.

The social planetarium conception can also be applied on a huge and highly differentiated scale, realigning 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 culture of exhibition." It will be feasible to take more effective advantage of occasional fairs and exhibits and to make sure that they are planned in ways that permanently enrich the community.

It is important to recognize that the social planetarium technique can be applied at inter-village levels, as well as at great national, metropolitan, and regional centers. World cities 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 enlisted 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 University* 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 affirmatively and communicated 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 those 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 too comprehensive to be confined to a single structure. It welcomes initiatives under official, semi-official, or private auspices and looks forward to cooperative projects and arrangements among them.

Another feature of the Academy's approach to the creation of world

university structures has been the encouragement of *multiple-centers* with *distinctive though interconnected functions*. The *primary units* in a chain of centers may be university departments, schools or institutes, or government bureaus or private institutes. The essential requisites are high scientific and professional quality conjoined with concern for the policy implications of knowledge. The Academy has taken initiatives for an expanded and selective program.

Closely related to university centers are the plans for World Academy *Fellows* who want to focus on policy questions and would benefit by intensive exposure to the relevant specialists. The Fellows would sometimes become involved in *travelling seminars* that stimulate critical discussion among diversified groups and institutions.

For questions of particular importance the Academy has the mechanism of a selected *World Commission* at its disposal. Of course the Academy will continue to adapt the *Conference* to its purposes.

Man's Paradoxical Predicament

The preceding pages have dealt in such detail with "ways and means" that it may seem that we have lost interest in examining our conception of man's predicament. Without pretending to speak for the Academy as a whole, it may be worthwhile to characterize some of the principal features of the global situation as these features have been analyzed in many previous discussions.

The predicament is obvious. If we have made fantastic progress in knowing and managing nature we have made remarkably less progress in knowing and managing culture. Thousands of qualified scientists have been telling their fellow men about the perilous significance of nuclear energy and biological knowledge if knowledge is turned to destructive purposes. Nonetheless, the peoples of the Earth continue to live in a divided and militant world in which the institutions of public order are too weak to arouse and sustain confidence in peaceful and beneficient change. The underlying expectation of violence and the institution of war continue to permeate the world community.

We ask again: How can these things be? How does it happen that man continues to live in the paradoxical predicament of potential abundance and threatened disaster?

Consider the institution of war in relation to other institutions in the world community as a mutually sustaining system. If the war system were not supported by socioeconomic systems, and if socioeconomic systems were not supported by the war system, the institution of war would long since have withered away.

The analysis emphasizes the situation-by-situation structure of the institution of war. It affirms that the individual actors in these situations expect to be better off, in terms of all their value preferences, by performing the usual operations than they would be by acting otherwise. The continuation of the war pattern, in common with the perpetuation of any mode of behavior, is a function of the net advantages expected to be obtained in specific circumstances. It does not necessarily signify a favorable overall disposition toward the institution itself. Nor does it presuppose awareness of the connection between many specific situations and the overall network of war-sustaining 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 earlier 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 sufficiently grand scale to transform the fundamental perspectives and operating techniques of world public order.

Elites 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 empowered. 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 branches to resist. Is it any wonder that a statesman may decide that political suicide contributes neither to his career nor to the fundamental reconstruction to which he may be personally devoted?

The political elites of the globe are trapped by the internal and external process 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 ethical 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 parochial locus of innovation.*

Many philosophical, jurisprudential, and theological doctrines invoke 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 expediencies, at least, will put the fruits of knowledge at the disposal of national societies and hence 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 net value indulgences afforded them by national settings. Note 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 proximate 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* images 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 incessantly 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 nations, and especially to foreign perspectives. Giant states that engage in forced modernization (e.g., the Soviet Union and Red China) are especially nationalistic, anti-local, and anti-international.

The significance of the self-reference effect and the monopoly of attention

paid to national events is underlined 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 comment (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

Clues to the preservation of the divided and militant structure of world affairs 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 symbol-system in the name of which power was seized in revolutionary France included "life, liberty 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 sometimes a deliberate strategy, as in the case of the Nazis in Germany who were a self-proclaimed party of "workers" and "socialists." By emphasizing the "national" identity opposition was mobilized against acknowledging the primacy of the Russian Center of self-styled "world revolution." The "racist" theme was a political innovation that helped to differentiate the Nazis from the Marxists. Similarly the Marxist emphasis on "economic" categories played a role in functionally differentiating Marxist movements from the "moralism" and "legalism" of French-influenced political ideologies.

Up to the present the 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.

Symbol 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. In 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 particular pattern. Every other element may become a target of partial incorporation or rejection. The operational practices of "Bolshevism" went 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 control 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 *minimum self-modification*. Hence the strategy of restriction by partial incorporation plays a conspicuous role in perpetuating the imbalances and the diversities that aid in maintaining a divided and militant 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 a single nuclear 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 assets 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 "synchronic" 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 invite 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 aroused youth (and other groups) and their concurrent withdrawal of support from independent, separatist, nation-centered institutions. Sudden collective seizures 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 authoritative and controlling system of optimum public order. Such a development would provide the support necessary to permit power elites to expect more advantages from arresting 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 appraisal and planning of changes in the world community context:

I. The Oligarchic Model. The power centers of the world arena adhere to development policies at home and abroad that depend on high levels of investment in resource-luxuriant technologies, in this way heightening commitments to wealth and power. In a world that emphasizes 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). In 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.

II. The Participatory Model. The demand for selective development increases the pressure for investment in intermediate, resource-parsimonious technology that minimally disrupts the distribution of population and intensifies demand for the pluralization of values. Excessive concern with that culminates in expressive acts that are parsimonious in 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-edit 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 less to foretell events than to forestall or to expedite their occurrence.

The "developmental construct" 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.

B. Framework of World Public Order

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 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 flames, no less than nation states, preserve a form more enduring than their substance only by drawing on the milieu and discarding into it. Their total physical capacity is limited by what they can thus metabolize, and they perish unless intakes balance outflows. 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."

Allied to these are 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.

Insofar as any human system acknowledges any purpose other than to survive and to grow, a new field of policy making emerges, regulated by what I will call functional criteria. All our countries anxiously 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 increasing) extent they concern themselves with similar indices in other countries and for the world as a whole, partly because external disasters may have internal 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 areas of threat show current standards unattained 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 promises and threats, as in the earlier ones, is bound to be more than we can meet, choice is 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 interest (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 discontinutiy because it is generated by a dialectical process. More attention will probably be paid to areas which current policies neglected or handled unsuccessfully. 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 terms of trade, may change the relative importance of different fields merely by requiring a radical relocation 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 unstable—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 alerts 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 model 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 1963[1] 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, merely to understand 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 squalor." 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 interconnected 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 minimum number of values which cannot be ignored in deciding what results count as costs or benefits.
3. 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.
4. Identify points of diminishing or increasing return in pursuit of alternative possible policies.
5. Identify elements of risk and uncertainty, their possible range and relative importance, and their relation to various time horizons.

6. Identify relevant time relations, notably the lead times and fructifying times of various possible courses of action, and their relation to the time horizons beyond which crucial elements of risk and uncertainty defy estimation.

This kind of policy analysis is in my view of great although limited value. It will not of itself give one best answer or even any answer to the question of what the new policy should be. But it will so redefine the situation that policy makers and their constituents can identify both the facts and the values which cannot be ignored when estimating the multiple, disparate, and conflicting costs and benefits which will flow from any solution. It is, of course, the function of the planner to minimize these conflicts and to find ways of realizing so far as possible values which at first seem inconsistent. But choice there must be. A policy, like any other work of art, depends on exclusion of whatever is inconsistent with what it is designed to realize.

In calculating cost and benefit, Western minds have been so long accustomed to expressing all in a common money of account that they find it difficult to understand how the mind compares disparates and weighs imponderables. Because we manifestly do so, the paradox must lie in the way we choose to express it. Nonetheless, it demands much closer attention. I will not burden this note with my views on the ways in which areas of human interaction come to be regarded as regulable by human control and develop and change the operative standards by which this control is regulated (this is manifestly a historical process on which I have written at length elsewhere[2]), nor will I repeat here my views about the ways in which disputes are resolved between rival criteria fighting for realization in conditions which make them competitive or conflicting. I will only repeat my conviction that policy making is not like playing chess. It cannot be reduced to calculation, not because (as in chess) the calculations would be too complex, but because in chess, the rules of the game and the meaning of success are unalterable data, while in managing human affairs at any level from the personal to the planetary, the rules of the game and the nature of success are precisely what have to be decided.

Notes and References

1. The Buchanan Report. Traffic in Towns. 1963. London. H.M.S.O.
2. The most recent of these are: Values, norms and policies, (Policy Sci. 4: No. 1, March 1973); Motivation theory—a cybernetic contribution (Policy Sci. 18: No. 4, July 1973); and Policy Making in Local Government (Local Government Studies, February 1974).

NEGOTIATING A WORLD MONETARY ORDER

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INTRODUCTION

Let me first reassure you! I do not intend to bore or puzzle you with an abstruse discussion of the esoteric issues involved in international monetary negotiations. I cannot avoid saying a few words first about the substance of these discussions, but the bulk of my remarks will center on an attempted explanation 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 illustrates the extreme opposites 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. Confining myself to the more recent past, however, I would like to point out the truly revolutionary—and hopefully germinal—reform adopted in 1969, under the aegis of the Fund, i.e., the creation of a new international monetary instrument, barbarously christened "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 agreement rather than abandoned, as in the past, to the irrelevant hazards of gold production minus private absorption of gold by industry, the arts, the dentists, the hoarders and the speculators, and/or the unpredictable balance-of-payments deficits of a dominant power (primarily Britain until 1931, and the United States after World War II) whose currency—legally, but not necessarily effectively convertible into gold metal at a fixed and unchanging price—was in fact universally used and accepted in international payments.

Ten years of marathon negotiations on international monetary reform had indeed elicited a large intellectual consensus, among the officials as well as the academics, on the need to anchor international monetary payments—although not, of course, domestic payments within each country's own borders—on an international monetary instrument patterned upon the SDR and issued to its members by the International Monetary Fund (IMF).

This international money would serve five purposes:

1. It would be the "numéraire"—or unit of account—serving as common denominator for national currencies. The exchange rates of national currencies into one another would be uniformly declared to the Fund, and readjusted when necessary, in terms of this common unit (Germany, for instance, communicated to the IMF, in June of last year, a central rate of 3.21979 German marks per SDR).

2. It would serve also as an "exchange guarantee" for all claims and debts expressed in this common international unit, and particularly for the claims or debts accumulated by each country toward the IMF. One could anticipate that many private transactors would, in the future, wish to protect themselves against exchange risks by denominating in the same manner a growing portion of their international lending and borrowing transactions, especially in a world in which exchange rates were becoming subject to more and more frequent changes.

3. The IMF money would become the main—if not exclusive—*means of international payment* and reserve accumulation for all national monetary authorities.

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

5. Finally, the IMF would earmark the lending potential derived by it from world reserve growth to help finance *collectively agreed objectives*, such as the offsetting of disrupting 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 partially 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 committed 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 irrevocable 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 decentralized IMF, enabling it to discharge more efficiently and realistically the 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 irritatingly 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 tend, 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 widely —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 "snake" limiting the maximum range of fluctuation of seven European currencies (the German mark, the Dutch guilder, the Belgian and the Luxembourg franc, the Danish and the Norwegian krone, 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 academics dogmatically devoted either to free market forces or to national sovereignty, or, bizarrely and contradictorily, 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 "sovereignly" 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.

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 competitive 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 legitimately 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 interference is universal, irrespective of the free market dogmas loudly, but ineffectually, 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 elicit larger international inflows, or outflows, of capital, depending on the circumstances of the moment.

This free-for-all exercise of "national 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 engulfs 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 defection 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 unviable 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 con-

vertibility by the United States was not only illegal. It deprived the international monetary system of the keystone—the gold-convertible dollar—in which the Bretton Woods commitments were defined and implemented in practice by all participating countries.

A foredoomed 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 only (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 margins 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 negotiators themselves.

Unavoidable clashes of national interests account only in part for this dismal record of unconscionable delays. As, or more, important, are the inherent defects of negotiating techniques and habits that make it unnecessarily difficult to reach concrete agreements, even on points that have rallied a large intellectual consensus among all the parties concerned. A keen awareness of these shortcomings, and possible remedies, might well prove as essential at this stage to the success of future negotiations—in this field and in others—as the intellectual exploration of the issues under debate.

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

1. First and foremost, is the fact that continued failure to agree may be far more damaging to the national interest of every participating country than the partial compromises 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,[1] 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 in payments deficit or surplus," (p. 12) and one of the conclusions that "the U. S. interest is served by an increase in its ability to devalue the dollar" (p. 21).

Realistic as this approach may be as a description of prevailing negotiating procedures, it seems to me to be a most obvious prescription for ensuring the failure of international negotiations and for perpetuating a monetary chaos profoundly detrimental to the national interests of the United States as well as of other countries.

The types of agreement that will appear to serve best the temporary interests of countries in deficit will obviously be the reverse of those favored by, and acceptable to, countries in surplus. Since the deficits of some are matched by the surpluses of others, agreement will clearly be impossible as long as such a criterion is adhered to by all the negotiators. It calls to mind the time-hallowed maxim that one should negotiate only from a position of relative strength, thus advising the countries deeming themselves to be in a position of relative weakness to leave the negotiating table!

It is, moreover, a well established fact that countries, or rather their ephemeral governments, are prone to misjudge the long-term interests of their people, to determine them on the basis of totally unwarranted extrapolations of current, but reversible, trends, or even to subordinate them to blatantly selfish electoral considerations. The temptation to bend to passing fads and private lobbies is often irresistible for our so-called "leaders." As a French saying goes: "I am their leader; therefore, I must follow them!"

An illuminating and generally recognized—ex post—example of such misinterpretation of national interests is the rejection, at the end of the war, of the Keynes plan by the American officialdom in favor of the White plan. We were then in surplus and apparently expected such surpluses to last forever, or for a very long time indeed. We refused, therefore, to *lend* money, and accumulate monetary reserves, through an International Monetary Fund or Clearing Union, and were led instead to giving away for good, under the Marshall plan, billions of dollars that we would otherwise have accumulated as "monetary reserves" and found invaluable, indeed, for the financing of the huge deficits which we encurred for more than 20 years, beginning in 1950.

Examples could be multiplied of "national negotiating positions" that blocked agreement at one point, only to be totally reversed within a few years or even months. We adamantly opposed as "utopian" and potentially disastrous, in September 1962, the proposal for the creation of a new kind of international reserve asset to supplement—or replace—gold and national currency balances (primarily dollars). We were soon, however, to become the major proponent of such a new reserve asset, but agreement was delayed by our initial insistence on a worldwide IMF solution, while the French and the other countries of the European Community insisted on a "Composite Reserve Unit" (CRU, for short) created and managed by only a restricted group of countries with a strong sense of financial responsibility. As the debate dragged on, the French and their European partners switched from their CRU proposal to the IMF solution, while we switched ourselves from

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 intangibility of the $35 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 national, 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, in daily contact with one another and with the OEEC Secretariat. They met in various technical committees to debate all 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 these committees. The Ministers themselves would meet in Paris, at 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 Minister the embarrassment of finding himself in a

minority in these Ministerial debates. Continuous personal contacts in Paris fostered a gradual *interpenetration* 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 tepid 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 readers.

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 *interpenetration* of national policy decisions, at the highest as well as at the intermediate levels, as contrasted to the more modest role that can be realistically assigned at this stage to the international staff of the Fund.

3. One of the major handicaps to be surmounted is 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 other 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 objections to a proposed national decision still under debate, so as to be able to report to his own Government the unfavorable reactions—and damaging retaliation—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 obdurate controversies between subordinate authorities. In practice, however, every effort is made to reach an acceptable consensus without having to invoke the arbitration of an overburdened 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 at 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 obdurately 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, bureaucracies, 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 the role that independent experts may play, at times, in exploring 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.

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 election, or re-election, depends upon it. All too often, however, they tend to become good forecasters—or even psychiatrists—rather than good advisers. They center their advice on what they guess the politicians will accept and take as their premise that politics 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 correctives" à la Brazilian. 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 abdicate their true profession when they mute their "first-best" advice as irrelevant and useless 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 past 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 last war.

The most promising path for the future is the one summarized under "Progress" above, and on which a large consensus had finally 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 unconsciously, by the activities of individual traders, business firms, banks, etc., and are for a long time unperceived 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 long smouldering 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 as unchangeable and as the "foundation for present and future arrangements." They were "fixed exchange rates" and the established price of gold, i.e., $35 per ounce. The two major changes that have effectively turned the previous system upside down are, of course, the exact opposite of these official forecasts and prescriptions: the daily floating of exchange rates and the gyrations of gold prices, totally unrelated to any of the "official" prices of $35, $38, and $42.22 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 unpredictable deficits of any "reserve-center" country or countries. What is most needed at this stage is an agonizing reappraisal and reorientation of the negotiating techniques that have led us to the present impasse. The stress should be placed on modest, but urgent first 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. Witteveen, and endorsed at the last Ministerial meeting of the Committee of XX in Rome. It offers, at least, a slight hope that we may soon resume our march 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 meanders have been fully charted.

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THE QUESTION OF ECONOMIC GROWTH IN A FINITE WORLD

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The first thing to ask is whether the question in the title is meaningful. The central issue is of course one that has been raised by several writers in the past few years and perhaps less conspicuously by the MIT study group under Professor Dennis Meadows whose book *The Limits to Growth* has been widely accepted by those who consider that the study is sufficiently accurate to be a useful representation of the real world, as a demonstration that the finite character of the real world means that continued economic growth is impossible. As will emerge, I disagree not merely with the way in which that study was carried out but I also consider the chief conclusion to be valid. My position is that the constraints on social change, of which economic growth is a part, are in principle no different now from what they have been in the past and that the most serious constraints stem not from the finiteness of raw materials or other natural resources such as land but from the difficulty of effecting social transformations whose desirability is beyond dispute. But I do of course agree that several important contemporary problems—population growth, for example—present themselves in the guise of problems of physical scarcity.

Some preliminary points may help to show that I am not seeking to dismiss the question but rather to answer it in what I think is a more useful way than that, for example, of Meadows.

First, it is important that the concept of finiteness is a relative one. The bushmen of the Kalahari Desert are known to consider that the world stops not far beyond the limits of their hunting grounds. The long history of exploration from the Phoenicians on has been accompanied by a steady increase of the extension of the supposed boundaries of the finite world. It is tempting to suppose that the world is now fully accessible, but a little reflexion will show that this is far from true. The issue is not whether there are undiscovered rivers in the Amazon basin, or undiscovered resources of some kind in the Antarctic, for these would make no qualitative difference to the resources that modern societies have at their disposal, but whether it is the case that the scientific exploration of the outer skin of the Earth in the past few decades and improvements of the technologies of exploitation have enormously increased the capacity of human beings to survive. It is my belief that the improvement of our understanding and of technology have more than kept pace with some of the contemporary threats to survival or even wellbeing.

It is worth remembering that when Adlai Stevenson first introduced the metaphor of Spaceship Earth in 1964, he was talking principally of the threat of nuclear war. Many later commentaries on the problem of this

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 depend 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 resources 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 test, 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 in 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 passing, I should acknowledge that the latest versions 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 each resource is arithmetically fixed in advance. For the life of me I cannot understand why this oversimple 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 in a real sense increased the accessible resources of the Earth. Nuclear power is another; schemes for extracting aluminium from clay (already practiced by the Russians) yet another.

The use of the land is another illustrative case of how the arithmetical 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 after all only a means to an end—food production. And the experience of the past half century, in Europe more particularly 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 accompaniments of modern agriculture are undesirable in themselves; they occasion awkward social changes in countries such as India or entail the risks of the large-scale use of pesticides, and there is room for argument on these points.

For what it is worth, I consider that there may be an element of impropriety in Western regret at the development of mercantile institutions in Indian agriculture when we, in Europe at least, still teach schoolchildren of the benefits of the agricultural revolution. Then the pesticide problem is exaggerated and is in any case avoidable with known technology. The essential point is that the finite supply of land is not a limitation of food production. If a society such as India has failed to control the birth rate, it may find itself beset by unwelcome social changes, but that is not a surprising conclusion.

There is, I recognize, a danger that what I have said about the way in which the finiteness of the real world is modified by continuing technological change will be interpreted as a declaration that technological change can be counted on to resolve all the problems of scarcity that arise in the future. But my case is more moderate than that. 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 restraints already practiced; 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 suggest that questions like these should not be studied).

This leaves, I know, the question of what happens in the long run, but I will return to that 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 pretends that Gross National

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 illiberal transfer of economic resources from the poor to the rich in some communities. At the same time, there are some reasons for believing that statistically the 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 no 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 way 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 that, in the context of Western society, expenditures that people think they desire are desirable, at least in the sense that they are democratic.

One fallacy common to computer modellers and to those who assume that economic growth is inherently desirable is the assumption that economic growth can take place without qualitative change. The computer modellers 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 unwanted 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 will 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, cottage industries were replaced by factories. Elsewhere, economic growth took the form of entirely new industries: railways, chemicals, road transport flight, and (since the Industrial Revolution continues) 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 of the demands made on the content of the 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 I have in mind. It seems to me that one must acknowledge that there is a wide range of social opportunities to be wrung 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.

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 untouched 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 inescapable that the political process should throw up untidy mixtures 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 technical. First, it seems to me that if governments wish prudently to manage the natural resources at their command, they must let economic forces exert their full influence. To say this is not to imply a blind faith in the mechanism of the market, which plainly is an inefficient way of distributing resources where land development is concerned, but it is anomalous that most 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 pipe-free Alaska as well) without substantial cost. These practices are wasteful, partly because they encourage the use of relatively scarce materials (natural gas, for example), partly because they discourage the use that might be made of plentiful materials to everybody's disadvantage but with harmful consequences for foreign trade as well, and partly because they help to cultivate that frame of mind to which politicians and voters are drawn which leads them to believe 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 illustrative 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 steelworks for the pollution that he causes, and 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 these 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 costing 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.

One 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 seemly, 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-finiteness 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 matter 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

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 for 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 assiduously neglected to do what they might have done to help.

There remains the question of what happens to all countries, developed and developing, in the long run. I said earlier that I am not asserting that technology can be counted on to solve all problems, and it would in any case be rash to trust to luck in such a way. Nobody respects Mr. Micawber. 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 in 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 at least as far in advance as some of the recent warnings of global disaster stemming from the supposed finiteness of the world.

Underlying this imponderable is the question of how our society should determine its attitude towards posterity. 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—are 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 inherent. We know from our experience that it is harder to create beneficent 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 hoard 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 command 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 creature and moulder of his environment, which gives him physical sustenance and affords him the opportunity for intellectual, moral, social and spiritual growth. In the long and tortuous evolution of the human race on this planet a 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—even the right to life itself.
>
> Declaration of the United Nations Conference on the Human Environment, preamble.

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 ecological unities 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 sharability of the oceans, the atmosphere, the air space and enfolding outerspace, 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 di-section of the seamless web of existence and resulting in evermore precise but highly specialized knowledge, has led to a new and unexpected vision of the total unity, continuity, and interdependence of the entire cosmos.[1]

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

> [T]he ecological way of seeing and comprehending envisages international politics as a *system of relationships* among *interdependent, earth-related communities* that share with one another an *increasingly crowded planet* that offers *finite* and *exhaustible* quantities of basic essentials of human well-being and existence.[2]

The most urgent need confronting us today is that of securing new and more precise scientific knowledge about the different unities and interdependences of our most comprehensive environment. With an increase in such knowledge, we might be able to devise more effective remedial measures both better to 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:[3] 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 his") was sponsored by the International Fellowship of Reconciliation (IFRC) 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 at elite and mass levels, environmental demands on the world decision process are becoming more comprehensive and more fully perceptive.

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 these 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 infusing 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—atmosphere, oceans, air space, land masses, and so on—are required if common interest in survival and optimum order is to be served.

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 interrrelated, intellectual tasks, including:

(1) the detailed specification, in their context of causes and consequences, of the more important problems arising from man's contemporary interaction 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 Constitutive 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 famework 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,[4] as the very convocation 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 200 specific recommendations for future international activities.[5] 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 (composed of a Governing Council for Environment Programmes, a small Secretariat with an Executive Director, the Environment Fund, and an Environment Co-ordination Board).[6] Supportive efforts are also being undertaken by a whole host of international organizations—governmental and nongovernmental, specialized and nonspecialized, 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 policy alternatives before authoritative decision-makers has also been weak. Most importantly, there has been a relative absence of the centralized performance of the prescribing and applying functions in relation to international en-

vironmental law. It is small wonder that overall public order of the environment has suffered.

The Continuing Problems

The problems we observe are, in sum, the continuing destructive impacts upon and spoliation of the environment and continuing unplanned exhaustion of resources, with loss of potential gains. The world's population increases at an alarmingly accelerating rate, with cumulative new demand 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 concentric, 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 rejecting 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 violative of the conditions of interdependence, imposing unnecessary harm upon others.

Within common interests, as contraposed to special, a distinction must be taken between inclusive interests and exclusive interests. By *inclusive* we refer to interests in activities that have significant transnational 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 high 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 oceans, 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 unauthorized 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-industrialized 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 (longer-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 optimalization of the shaping and sharing 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. . . .[7]

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.[8]

If we can believe the explications, 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 hortatory recommendations will actually be made effective in decision outcomes.

Trends in Decision and Conditioning Factors

Claims in Relation to the Process of Use

The potentialities afforded by world constitutive process and inherited 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 perennial problems.

Allocation of Resources

It is a function of the global constitutive process to allocate resources between the inclusive and exclusive use and competence 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 stock 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 superjacent airspace, and the genetic, aesthetic, and cultural resources within these areas.[9] 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

(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 competence 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 resource 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, inadvertent or deliberate, 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 Injurious Use

Resources inclusively enjoyed. With regard to resources inclusively enjoyed, many international agreements have been reached on means for controlling their injurious 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 1958 Geneva Convention on the High Seas provide that "[e]very State shall draw up regulations to prevent pollution of the seas" from discharge of oil and dumping of radioactive waste, respectively.[16] The 1954 International Convention for the Prevention of Pollution of the Sea by Oil (amended in 1962 and 1969)[17] prohibits the intentional 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[18] and the 1962 Convention on the Liability of Operators of Nuclear Ships[19] deal with and limit the liability of shipowners for damage caused by their vessels.

More recent treaties speak in stricter 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)[20] and International Convention on Civil Liability for Oil Pollution Damage ("Private Law" Convention)[21] 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 proportional 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 which 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,[22] also yet to come 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 $30 million.

Very recently, the 1972 Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft[23] 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[24] made similar black and grey lists applicable to all marine waters other than internal waters of states. The 1973 International Convention for the Prevention of Pollution from Ships[25] 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 seas by complementing it with a 1974 Convention for the Prevention of Marine Pollution from Land-Based Sources.[26]

The list of relevant conventions is long, and efforts at meaningful agreement are not limited to the oceans. The 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere in Outer Space and Under Water (the "Test Ban" Treaty),[27] while mostly a disarmament measure, also represents a very important environmental protection agreement. The 1967 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) provides that a state launching an object into space "shall be internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object,"[28] and the new 1972 Convention on International Liability for Damage Caused by Space Objects provides that a launching state "shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight."[29]

Resources exclusively enjoyed. With respect, on the other hand, to exclusive enjoyment of resources, the conferees 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.[30]

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 *Trail Smelter* arbitration, in which an international tribunal found Canada liable for fumes emanating from a smelter located in British Columbia and doing damage in the State of Washington.[31] The *Corfu Channel* case, in which the International Court of Justice held Albania responsible under international law for damage to British ships from mine explosions in Albanian territorial waters, is another example.[32] The third international judgment usually cited for its environmental implications is the *Lac Lanmoux* arbitration, where an international tribunal said that France would be strictly liable if, due to its hydroelectric utilization of a French lake, damage resulted to waters draining into Spain.[33]

Similar policies are expressed in the more general practice 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 its exclusive resource interests to assert the necessary and proportional force to avert the danger or to abate its effects.[34] In addition, in their various contiguous zones,[35] states exercise limited control over inclusive resources to prevent injury to particular exclusive in-

terests. Coastal states have also certain other rights of abatement beyond their national jurisdictional limits (as, for example, those specified in the IMCO "Public Law" Convention).[36] All these rights build upon the basic principle, already mentioned, of "impact territoriality."

The most significant feature of the Stockholm formulation in light of these precedents is that Principle 21 explicitly extends liability to cover "areas beyond the limits of national jurisdiction." The case law to date has been applied only narrowly for damage inflicted by one country or by its nationals on the rights, property, or territory of another country, its nationals, or activities. Customary concepts of "self-defense," "self-preservation," "security," "good neighborliness," and "contiguous zones" have also been defined in terms of a sovereign state "self." The new statement of international community expectations—by its explicit provision—applies to the *res communes* as well as the exclusive possessions of other states.

Facilitating Productive and Harmonious Use

Resources inclusively enjoyed. Facilitating productive use of inclusive resources has traditionally been expressed in terms jointly of conservation and apportionment. The early fisheries, pelagic sealing, and whaling conventions are examples of international agreements for these purposes.[37] Providing for the harmonious enjoyment in use of inclusive resources has required clarification of certain principles of jurisdiction and "rules of the road." Vessels, aircraft, and spacecraft are assimilated to their territory of registry (with certain exceptions where there is concurrent jurisdiction). As to the host of ancillary rules of conduct, maritime law has over the centuries developed a comprehensive regime for regulating navigation, safety, and other operational facets of use.[38] Similar regulatory regimes have more recently been adopted for parallel problems in the areas of international rivers, air transport, and space exploration through the operations of the Helsinki Rules,[39] the International Air Transport Association (IATA) and the Outer Space Treaty[40] and related United Nations space resolutions.

In the context of the current Law of the Sea negotiations, this order is being greatly enlarged in scope.[41] First, states are coming to realize the seriousness of the problem of overfishing and its adverse impact on world protein supply and economic livelihood. Conservation of the fish stocks is said to be a major impetus behind the many proposals for new fisheries regimes and "exclusive economic zones." A second concept gaining general support is that of maximum utilization (variously defined). Several of the fisheries proposals make specific provision for other states to share in fishing activities when a coastal state underutilizes the fisheries resources outside its territorial sea. Thirdly, issues of equitable allocation and problems of landlocked and other geographically disadvantaged states are having to be faced openly. Of some twenty-seven different resource proposals presented in the United Nations Committee on the Peaceful Uses of the Seabed and the Ocean Floor Beyond the Limits of National Jurisdiction (the "Seabeds Committee"), six deal essentially with the concerns of these geographically unfortunate states.[42]

Resources exclusively enjoyed. With respect to their exclusive resources, many states have gone farther 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,[43] 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 bird-watchers 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.[44] Similarly, the new 1973 Endangered Species Convention,[45] 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 inclusively enjoyed. Many of the most important resource use problems are associated with regional development and urbanization. Community planners have long advocated 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 land devoted to food production, land activities which pollute the oceans and atmosphere, weather 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.[46] Until quite recently, nevertheless, these functions have been given little attention by the world community, and only initial projects have been undertaken.

There have in the past been attempts at shared river basins planning and development. The 1909 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.[47] On a broader scale, the comprehensive efforts by many international

agencies of the United Nations Family to alleviate the drastic conditions caused by the draught in the Sahelian region in Africa and to improve the future prospects for the area is an unprecedented international custodianship enterprise.[45] Yet, as far as overall inclusive international planning and development of the resources of the shared 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 stated goals than others. The individual governmental ways and means are diverse. A hopeful collective initiative in terms of international cooperation for the planning and development of national or exclusive resources ought, however, to be noted. In the preparations for the 1975 Vancouver Conference-Exposition 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 their joint and separate benefit.[49]

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), of freedom of movement between communities (transnational migration)[50] and of control of numbers of people (population).[51]

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 find 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 amelioration of historic attitudes toward nationality can be seen in the contemporary human rights program. The Universal Declaration of Human Rights provides that, at 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." [52] Furthermore, the same condition is implicit in the broader proclamation in the U. N. Environment Declaration that "[m]an has the fundamental right to freedom, equality, and adequate conditions of life. . .." [53]

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. Freedom of movement between and among national communities is required for their effectuation.

Traditionally states have imposed severe limitations on international freedom of migration: in terms of immigration quotas, travel, and visa restrictions, on the one hand, and expatriation, deportation, and similar deprivations on the other. Such distressing precedents have been rejected in recent delineations of human rights, e.g., the Universal Declaration on Human Rights,[54] the International Covenant on Civil and Political Rights,[55] the European Convention on Human Rights,[56] and the American Convention on Human Rights.[57] Yet, one has only to think of the plights of Soviet Jews, Ugandan Asians, and American draft resisters to realize that the world community is still far from having achieved its stated objectives. The goal of a high degree of voluntarism in international affiliation, participation, and travel is far from having been reached.

Population. Thirdly, the matter of numbers and concentrations of people —the "population question"—is fundamental to international environmental policy-making. Population factors have to be approached both from the point of view of people as resources (human resources) and from that of people as molders of their own environment (human dignity). This raises urgent and contradictory policy considerations: on the one hand, people are an important base of power in the world community, but, on the other, no environmental measures in any dimension can be effective in the long term if the demographic explosion is not checked. At least to this extent, basic Malthusian doctrine remains as applicable as ever.

Until very recently population issues have been considered virtually exclusively within the decision-making competence of sovereign states. In the last decade or so, however, transnational efforts to control population growth and distribution have been inaugurated. They were at first narrowly limited to development assistance in the field of birth-control technology. However, with the growing imminence and clearer perceptions of impending global demographic crisis, international cooperation has been increasing steadily in scope and magnitude—culminating in the denomination of 1974 as World Population Year and the preparation for a World Population Conference in 1975.[58]

Claims in Relation to the Global Constitutive Process

General Conception

The contemporary global community, like its constituent national communities, maintains a comprehensive process of authoritative decision, in which elements of both authority and effective control are combined, for the protection and expansion of both minimum and optimum order. The "constitutive process" so maintained is comprised of all those decisions which characterize and identify the different authoritative decision-makers, specify and clarify basic community policies, establish appropriate structures of authority, allocate bases of power for sanctioning purposes, authorize procedures for making the different kinds of decisions, and secure the continuous performance of all the different types of decision functions (intelligence, promotion, prescription, invocation, application, termination, and appraisal) necessary to making and administering community policy. The "public order" decisions of the larger community, such as those that

protect or fail to protect the environment, emerge in continuous flow from this established process.

This conception of constitutive process is sharply to be distinguished from the oft-asserted, restrictive, two-tiered approach to global decision-making, which attempts to draw a sharp division between international law and national legal processes. Concise expression of this latter view was offered most authoritatively by the late Professor Lassa Oppenheim:

> International Law and Municipal Law are in fact two totally and essentially different bodies of law which have nothing in common except that they are both branches—but separate branches—of the tree of law. Of course it is possible for the Municipal Law of an individual state by custom or by statute to adopt rules of International Law as part of the law of the land, and then the respective rules of International Law become *ipso facta* rules of Municipal Law.[59]

Unhappily, this "two-tiered" approach has recently achieved resuscitation in the specific context of international environmental law:

> [T]he global and particular policy processes are not seen running side by side, one scoring here and one there. They are hierarchical rather than complementary. They are fused together to form a single two-tier process in which the understandings, apprehensions, and goals, continuously articulated, assessed and re-evaluated at the global level, are allowed to seep down to the second tier of the subsystems and gently civilize the harsh but unavoidable particular solutions to which individual states, pressed by technological flux, will increasingly resort.[60]

Similarly, the conception of a global constitutive process requires clear distinction from the other scholarly extreme: the so-called "monist theories" of international law. The clearest, brief exposition of these theories is perhaps that of Professor Josef Kunz:

> [A]ll the activity of the single States is regulated by the supraordinated law of Nations. The so-called "domestic affairs" of the single States are not the affairs which are *not* regulated by international law, but the affairs which a State, *under international law*, has the exclusive competence to regulate as it pleases.[61]

The most complete devotion to this monistic primacy of international law, unhappily, underwrites a rather futilitarian despair. Thus, Professor Richard Falk concludes:

> A world of sovereign states is unable to cope with endangered-planet problems .... Such a system exhibits only a modest capacity for international cooperation and coordination. The distribution of power and authority, as well as the organization of human effort, is over-whelmingly guided by the selfish drives of nations.[62]

Avoiding the Scylla of legalistic mysticism and Charybdis of academic fatalism, it may be possible to observe that people identify and interrelate, and make authoritative decisions, on multiple levels, from local to global or earth-space. Our presentation will be confined to brief descriptions of

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."[63] Earthwatch included functions divided into four categories: evaluation and review, research, monitoring, and information exchange. Of the 109 recommendations adopted by the Conference, Recommendations 25, 40, 23, and 27 had provisions pertinent to these four respective areas.[64] At 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 by the establishment of a "Global Environ Monitoring System" (GEMS).[65]

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 of the Council of Europe.[66] 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.[67]

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.[68] Finally, countless research and analysis efforts by private individuals and institutions contribute to the overall global fund of environmental intelligence.[69]

With all the recent proliferation of international environmental intelli-

gence 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." [70] 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 aborted "Principle 20" 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 reason to believe, that such information is needed to avoid the risk of significant adverse effects on the environment in areas beyond their national jurisdiction.[71]

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.[72]

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. Promotion (or recommendation) is the advocacy of general policy. It involves the formulation and propagation of demands and the mobilization of support for new enactments.

This function has been rather inadequately performed on the transnational 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.[73] 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." [74]

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 "NGO Declaration." In it they made recommendations on policy and action in regard to the Conference agenda and pledged, inter alia: separately to "mobilize support for the Stockholm decisions" and together to "mobiliz[e] joint pressure for environmental change." [75]

The Club of Rome, with its now famous study on *The Limits to Growth*,[76] is an example of an international organization which has developed high potential for transnational environmental promotion activities. The International Council of Scientific Unions, largely through the SCEP, SCOPE, and SMIC studies,[77] 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.[78] Finally, certain domestically based public interest groups are performing international environmental promotion functions.[79] 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 elites 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.

Prescription. Prescription 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 secretariats 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,[80] the International Convention for the Prevention of Pollution of the Seas by Oil (1954–1971),[81] the International Convention relating to Intervention on the High Seas in cases of Oil Pollution Casualties (1969),[82] the International Convention on Civil Liability for Oil Pollution Damage (1969),[83] the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (1971),[84] the Bonn Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil (1969),[85] the General Principles on Marine Pollution[86] and the Statement of Objectives on the same subject (1972),[87] the Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (1972),[88] the International Convention on the Prevention of Pollution from Ships (1973),[89] and the Convention for the Prevention of Marine Pollution from Land-Based Sources (1974).[90]

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 interdependences which are the most important conditioning factors of the policy-making process. Finally, there is a subsidiary trend toward increasing acknowledgement that, in the context of marine pollution, coastal states "have a particular interest in the management of area resources." [91]

Recent outcomes in prescription are, of course, not restricted to pollution and not restricted to the resources of the oceans. The "Test Ban" Treaty

(1963),[92] the "Outer Space" Treaty (1967),[93] and the draft Convention on Liability for Damage Caused by Space Objects (1971)[94] all embody prescriptions with relevance to the environmental protection and use of the atmosphere and biosphere. The new "World Heritage" [95] and "Endangered Species" [96] Conventions (1973), Convention on Fishing and Conservation of the Living Resources in the Baltic Sea (1973),[97] Agreement on the Conservation of Polar Bears (1973),[98] and a variety of other multi- and bilateral agreements are addressed to the positive goal of the wise use and preservation of environmental resources for future generations.

The central point is that these articulations of conceptions of prevailing law show both awareness of international environmental problems and a degree of willingness to do something about them. Clearly, if the inherited prescriptions about the protection of the environment are inadequate, the prescribing process itself offers few impediments to their being rendered more appropriate.

Invocation. Invocation is the provisional characterization of concrete circumstances in reference to prescriptions. In order to stimulate the application of community prescriptions, participants either must have the appropriate arenas open to them or find a surrogate or champion who does have access. The International Court of Justice (ICJ) is, for example, at present closed to individuals and nonstate entities,[99] but states often bring cases there in a representative capacity for such participants. Community members who would complain about the violation of prescriptions for environmental protection, nevertheless, are likely to confront formidable barriers to obtaining a hearing.

The overwhelming trend of decision has been to permit the state of nationality, and only the state of nationality, to protect individuals and corporate entities. Furthermore, states are still regarded as having an option as to whether or not they will protect their nationals, for international law imposes no duty on a state to do so. This law has been developed in such famous cases as *Nottebohm* (narrowly restricting state protection of individuals),[100] *Flegenheimer* (limiting state discretion as to who is its national for invocation purposes)[101] and *Barcelona Traction* (severely restricting competence to assert shareholders' interests in corporate affairs).[102] The net effect of these decisions is denial of protection in international arenas—of the minimum right to a hearing on the merits—to the individual and group interests concerned. Similarly, in the national arenas of many countries, public interest groups are incapacitated because of restrictive provisions on standing to sue.

Recent trends are not encouraging. Not only do the old limitations remain extant, but also recommendations in the context of the upcoming Law of the Sea Conference for a new specialized court (variously referred to as the Law of the Sea Court or International Maritime Court) and for a special fisheries commission again provide that only states would be parties to controversies to be resolved therein.[103]

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 Cases*, 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.[104] This vital matter is, therefore, now directly befor 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 put 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 appliers 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 1969 and 1971 IMCO Conventions,[105] such 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." [106]

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 "antipollution zone" [107] 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.[108] 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.

Unilateral assertions can, of course, be directly contrary to the policies of

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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 resistance 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[109] *Nuclear Tests* (concerning the legality under customary international law of nuclear tests in the atmosphere)[110] 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 prescribing function does not itself operate to terminate a great many old prescriptions. Comparable 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 interdependences with other areas of policy-making, it will often be necessary to ameliorate the costs of change and of selective impacts. The Helsinki Rules on the Uses of the Waters of International Rivers[111] 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 oceans 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 created under the new Law of the Sea Treaty.[112]

In sum, where *rebus sic stantibus*[113] 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,"[114] which reviewed the United Nations Development Programme, and the report by the Pearson Commission,[115] 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.[116] 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."[117]

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 able to entertain realistic expectations about the consequences of change.

Appraisal and Recommendations[119]

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 benefit for the greater shaping 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 ecosystemic. The Stockholm Conference was in some measure successful in developing the missing 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 deficiences 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 in world constitutive process.

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 oceans should be confined to a minimum, and, whatever the precise constitution of the new Seabeds Authority to deal with resources beyond the limits of national jurisdiction, it is essential that it both facilitate the widest shaping and sharing of the available values and protect 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 recommended interstate consultations for activities which carry a risk of effects on climate.[120] The Bangkok Conference on World Peace Through Law went further and proposed "establishment at the earliest possible date of a Convention on Weather Control."[121] 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 inadvertant and deliberate, which have effects or potential effects across national boundaries. We also recommend that some international agency, perhaps the World Meteorological Organization (WMO), be explicitly charged with undertaking inquiry and recommendation in this area.

Regulation of Enjoyment

Controlling Injurious Use

Resources inclusively enjoyed. Governments and all effective elites must cooperate to withstand the assertion of claims to uses 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, supertankers, icebreakers, deep-water ports, and seabed mining facilities. Multilateral solutions must be sought to problems of inclusive resources, and states individually as well as collectively must accept responsibility for the effective implementation of such solutions.

As far as the atmosphere is concerned, the 1963 Test Ban Treaty[122] forbids atmospheric testing of nuclear devices. Since then, such tests have repeatedly been condemned by the international community. Considering the dire environmental consequences, governments at the Stockholm Conference again resolved "[t]o condemn nuclear weapons tests, especially those carried out in the atmosphere."[123] France and China, nevertheless, refuse to accept such decisions, and Australia and New Zealand are now protesting recent French explosions in the *Nuclear Tests Cases*.[124] It should be recognized that the ban first stated by the 1963 Treaty has now crystallized in general community expectations to such an extent as to become part of customary international law, and both France and China should be prepared to live up to any such pronouncement by the World Court.

Resources exclusively enjoyed. Principle 21 of the Stockholm Declaration provides the equitable basis for a regime of regulation of enjoyment of resources exclusively enjoyed so as not to injure others or the common interests.[125] It should be understood to encompass responsibility in such areas as land-based sources of atmospheric and marine pollution, liability for weather modification activities within the jurisdiction and control of one state which could damage the environment of other states or the common environment, any similar effects of supersonic aircraft, disposal of radioactive wastes or nerve gas, and the whole range of new activities rendered possible by technological developments. The recent regional Convention for the Prevention of Marine Pollution from Land-Based Sources[126] should be extended to cover the oceans as a whole, and similar provisions should be made for enclosed and semienclosed seas, the time is also ripe for bilateral and multilateral weather modification agreements, and, as Canada has proposed to NATO's Committee on the Challenges of Modern Society, governments should undertake study of the effects of supersonic flight in the atmosphere.[127]

Facilitating Productive and Harmonious Enjoyment

Resources inclusively enjoyed. Of first priority in this area is the viable organization of a regime for the high seas fisheries and of the resources of the seabed to encourage their utmost exploitation for the benefit of the whole of humanity, including both present and future generations. Any extensions of exclusive competence, in the form of special functional "zones" or otherwise, should be with a minimum of damage to the remaining inclusive uses of the oceans—in particular, uses of transportation, communication, and scientific research.

Resources exclusively enjoyed. In light of the history of draft Principle 20,[125] 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 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 inclusively 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-space 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 unities and be organized in accordance with natural ecological subsystems rather than synthetic political agglomerations.

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 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-Exposition on Human Settlements[129]—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 *nationality* and *migration* of peoples is concerned. In the final analysis, however, neither this goal nor any other goal of environmental protection, preservation, and enhancement can be made realistic 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.[130] Positive educational and promotional efforts on the part of Zero 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 as possible with basic freedom of choice, might be given a fuller hearing.[131] It might be found preferable and possible for global decision-makers (rather than leaving the determination to the apocalyptic horsemen) 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 right 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 effectuation 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" [132] 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 biogeochemical conformation, 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,[133] but some sort of monitoring of 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 advice him on how best to contribute to the future development of international environmental law,[134] but this is only a very minor aspect of the overall function. Lawyers in general must accept the role of committed activists, 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*[135] and to evaluate its basic recommendation of "zero-growth" economic strategies in light of both natural and social conditioning factors.[136] 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,[137] and elsewhere, the decision should be that all presently inclusive resources are kept open to scientific inquiry, and sincere efforts should be made to extend freedom of information even to resources exclusively enjoyed insofar as necessary for comprehensive international policy-making.

Promotion

Lawyers, scientists, scholars, citizens, and others might become concerned advocates and mobilize support among effective elites, for appropriate environmental policies. One has only to think of the widespread demand for a moratorium on whaling, including its promulgation in Recommendation 33 of the Stockholm Action Plan, to recognize how little international public opinion alone did for the whales.[138] It is essential to supplement hortatory solicitations by mobilizing support within relevant arenas.

International public opinion, although insufficient in and of itself, is not inconsequential. Environmental advocates should be putting more energy and channelling more resources into the supportive activities of education, training, and public information. Due to the scope and expense characteristic of such campaigns, in our age of mass participation and mass thrust of communications technology, specially 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 of some other equivalent legal body (perhaps under the auspicies of UNEP) be commissioned to make studies—as the ILC once did on the law of the sea[139]—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 delegations 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 insofar as they have transnational reach (environmental, trade, development assistance, or otherwise).

Concerning particular substantive areas, marine environmental protection will be a major concern of the Law of the Sea Conference, and many agreements can be expected to evolve out of that umbrella exercise. International decision-making at the World Population Conference will deal with the most pressing international environmental issue 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 is also worthy of imminent consideration.

Invocation

The principle requirement for improvement of the invocation function is for nonofficial actors to be accorded greater access to relevant arenas. On the international plane, short of change in the Statute of the ICJ, this can be better achieved 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 ombudsman charged with invoking processes or intervening therein as representative of inclusive concerns when the common environment is threatened.[140] Whether this be the Executive Director of UNEP or some other individual or organization, the ombudsman 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 threats of radioactive contamination of the atmosphere in South Pacific areas.

The environmental role of nonstate appliers should also be enhanced. A special World Environment Court does not seem to be called for at this time. The ICJ can, however, be streamlined (through use of chambers, assessors, et cetera)[141] 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 problems in termination occur with respect to developing countries. At Stockholm it was repeatedly emphasized that in the developing countries most of the environmental problems are caused by underdevelopment.[142] The efforts of advanced industrial states to combat the ills caused by modern technological development should not, 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 upsurge of environmental concern in the world community. UNEP, however, has already begun appraisal of 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 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 policy-making.

The task of highest priority for all genuinely committed to a more appropriately conserving enjoyment of our most comprehensive environment, including all its great sharable 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 constitutive process 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 spoliation and destruction of necessarily shared resources and the woefully inadequate responding decisions by the contemporary global constitutive 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 lily pond: the lily plant doubles in size each day; if allowed to grow unchecked, it will cover the pond in 30 days, choking off all other forms of life in the water. So what happens?

> For a long time the lily plant seems small, and so you decide not to worry about cutting 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.[145]

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5. Report of the United Nations Conference on the Human Environment, U.N. Doc. A/Conf. 48/14, pp. 8–60 (1972) [hereinafter cited as Report].
6. *Ibid.*, p. 61. The United Nations General Assembly subsequently established UNEP by resolution 2997 (XXVII) of December 15, 1972, U.N. Doc. A/890 (1973). See also Hardy, The United Nations Environment Programme, 13 Natural Resources J. 235 (1973).
7. Report, p. 4.
8. *Supra* note 6.
9. For summaries of the regimes governing these resources, see Schneider, *supra* note 4, pp. 1661–1663, nn. 10–21. For comprehensive analysis of inclusive resources, see McDougal, M. & W. Burke, The Public Order of the Oceans (1962); McDougal, M., H. Lasswell & L. Vlasic, Law and Public Order in Space (1963).
10. See Convention on the Territorial Sea and the Contiguous Zone, *done* April 29, 1958, [1964]15 U.S.T. 1606, T.I.A.S. No. 5639, 516 U.N.T.S. 205, art. 24. See also McDougal & Burke, *supra* note 9, pp. 584–606.
11. See Report of the Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor Beyond the Limits of National Jurisdiction. See, e.g., the 1972 report, 27 U.N. GAOR Supp. 21, pp. 70, 73, 180, U.N. Doc. A/8721 (1972); the 1973 report, 28 U.N. GAOR Supp. 21, vol. 2, p. 4, vol. 3, pp. 1, 19, 23, 78, 87, 106, U.N. Doc. A/9021 (1973).
12. Working Paper on Special Considerations Regarding the Management of Anadromous Fishes and Highly Migratory Oceanic Fishes. *In* Seabeds Report (1973), *supra* note 11, vol. 3, p. 11.
13. Can. Rev. Stat. c. 47 (1969–1970), text in 9 Int. Legal Materials 543 (1970). See Beesley. Rights and responsibilities of arctic coastal states: The Canadian view, 3 J. Maritime L. & Commerce 1 (1971); Pharand, The Arctic waters in relation to Canada, *In* Canadian Perspectives, *supra* note 4, p. 434. *Cf.* Bilder, The Canadian Arctic waters pollution prevention act: New stresses on the law of the sea, 69 Mich. L. Rev. 1 (1970). But see Henkin, Arctic anti-pollution: Does Canada make—or break—international law?, 65 Am. J. Int. L. 131 (1971).
14. See Samuels, International control of weather modification activities: Peril or policy?, 13 Natural Resources J. 327 (1973); *idem.* Prospective international control of weather modification activities, 21 U. Toronto L. J. 222 (1971); Taubenfeld, Weather modification and control: Some international legal implications, 55 Calif. L. Rev. 493 (1967).
15. See SMIC, Man's Impact on Climate (1970).
16. *Done* April 29, 1958, [1962] 13 U.S.T. 2312, T.I.A.S. No. 5200, 450 U.N.T.S. 82.
17. *Done* May 12, 1954, [1961]12 U.S.T. 2989, T.I.A.S. No. 4900, 327 U.N.T.S. 3. Amendments *adopted* April 11, 1962, [1966] 2 U.S.T. 1523, T.I.A.S. No. 6109; and October 21, 1969, annexed to IMCO Ass. Res. A.175 (VI) (1969).
18. Text of Convention of October 10, 1957, Conférence Diplomatique de Droit Maritime, Dixième Session, Bruxelles 1957, pp. 459–472 (1958), 37 Dept. State Bull. No. 959, pp. 759–762 (1957). See also M. Whiteman, 9 Dig. Int. L. 230–233 (1968).
19. May 25, 1962, text in 57 Am. J. Int. L. 268 (1963).
20. *Done* November 29, 1969, text in 9 Int. Legal Materials 25 (1969).
21. *Done* November 29, 1969, text *ibid.*, p. 45.
22. Text in Int. Legal Materials 284 (1972).
23. February 15, 1972, text in 11 Int. Legal Materials 262 (1972).
24. *Done* November 13, 1972, text in 11 Int. Legal Materials 1294 (1972).

25. *Done* November 2, 1973, text in 12 Int. Legal Materials 1319 (1973).
26. *Adopted* February 21, 1974, text in 13 Int. Legal Materials 352 (1974).
27. August 5, 1963, [1963] 14 U.S.T. 1313, T.I.A.S. No. 5433, 480 U.N.T.S. 43.
28. *Opened for Signature* January 27, 1967, [1967] 18 U.S.T. 2410, T.I.A.S. No. 6347, text in 6 Int. Legal Materials 386 (1967), art. 7.
29. *Entered into force* September 1, 1972, text in BARROS, J. & D. JOHNSTON, International Law of Pollution 373 (1974), art. 2.
30. Report, *supra* note 5, pp. 2, 7 [emphasis added].
31. 3 U.N.R.I.A.A. 1905, 1957 (1938, 1941), 35 Am. J. Int. L. 684 (1941). The arbitral tribunal explained its reasoning in a much-quoted passage:

    Under the principles of international law, as well as the law of the United States, no State has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or persons therein, when the case is of serious consequence and the injury is established by clear and convincing evidence. . . .

    The tribunal holds that the Dominion of Canada is responsible in international law for the conduct of the Trail Smelter. . . . [I]t is the duty of the Government of the Dominion of Canada to see to it that this conduct should be in conformity with the obligation of the Dominion under international law as herein determined.

    The Trail Smelter shall be required to refrain in the future from causing damage through fumes in the State of Washington. To avoid such damage the operations of the Smelter shall be subject to a regime or measure of control as provided in the present decision. Should such damage occur, indemnity to the United States shall be fixed in such manner as the governments acting under the Convention may agree upon.
32. [1949] I.C.J. 4. The Court had to decide whether Albania was responsible under international law for the explosions and resultant damage and whether the United Kingdom had violated the sovereignty of the People's Republic of Albania by reason of certain acts (including subsequent mine sweeping) by the Royal Navy in Albanian waters. The Court rendered judgment in favor of the United Kingdom on both counts.
33. 12 U.N.R.I.A.A. 281 (1957), 53 Am. J. Int. L. 156 (1959). The arbitral tribunal held for France after finding that there would be full restitution of the diverted waters if the proposed electricity project were carried out. It made clear, however, that strict liability would have governed in the event of a finding for Spain:

    It would then have been argued that the works would bring about a definitive pollution of the waters of the Carol or that the returned water would have a chemical composition or a temperature or some other characteristics which could injure Spanish interests. Spain could then have claimed that her rights had been impaired.

    Ibid., p. 303, 53 Am. J. Int. L. 160–161.
34. On self-help, see the U.N. Charter art. 51 and the complementary provision prohibiting "the threat or use of force," *ibid.*, art. 2, para. 4. The doctrine of "good neighborliness" is probably most highly developed in the law of international rivers, where a broad standard of recognition and respect for the multiple and alternative uses of the waters has evolved. See, e.g., Case of the Territorial Jurisdiction of the International Commission of the River Oder, [1929] P.C.I.J., ser. A, No. 23.
35. See TAN 10 *supra*.
36. *Supra* note 20.
37. See, e.g., Convention on Fishing and Conservation of the Living Resources of the High Seas, *done* April 29, 1958, [1966] 17 U.S.T. 138, T.I.A.S. No. 5969, 559 U.N.T.S. 285; International Convention for the High Seas Fisheries of the North Pacific Ocean, May 9, 1952, [1953] 4 U.S.T. 380, T.I.A.S. No. 2786, 205 U.N.T.S. 65; International Convention for the Northwest Atlantic Fisheries, *done* February 8, 1959, [1950] 1 U.S.T. 477, T.I.A.S. No. 2089, 157 U.N.T.S. 157, with several protocols up to that of November 29, 1965, [1970] 21 U.S.T. 576, T.I.A.S. No. 6841; Northeast Atlantic Fisheries Convention, January 24, 1959, 486 U.N.T.S. 157, 1963 U.K.T.S. 68; Convention between the United States, Great Britain, Russia, and Japan for the Preservation and Protection of Fur Seals, July 7, 1911, 37 Stat. 1542 (1911–1913), T.S. No. 564, 104 B.F.S.P. 175, with sequels of December 8, 1942, 58 Stat. 1379 (1944), E.A.S. No. 415, 26 U.N.T.S. 364, and of February 9, 1957, [1957] 8 U.S.T. 2283, T.I.A.S. No. 3948, 314 U.N.T.S. 105. For conventions on particular species, see LAY, S., R. CHURCHILL & M. NORDQUIST. New Directions in the Law of the Sea: Documents 406 *passim* (1973). Examples of recent conventions along these same lines include Convention on Fishing and Conservation of the Living Resources in the Baltic Sea, *done* September 13, 1973, text in 12 Int. Legal Materials 1291 (1973); Agreement on the Conservation of Polar Bears, *done* November 15, 1973, text in 13 Int. Legal Materials 13 (1974).

38. See, e.g., International Regulations for the Prevention of Collisions at sea, *approved* May 17–June 17, 1960, [1965] 16 U.S.T. 794, T.I.A.S. No. 5813; International Convention for the Safety of Life at Sea, June 17, 1960, [1965] 16 U.S.T. 185, T.I.A.S. No. 5780, 536 U.N.T.S. 27.
39. *Adopted* by the nongovernmental International Law Association (ILA) on August 20, 1966, text in 1966 Report of the ILA Committee on the Uses of the Waters of International Rivers.
40. *Supra* note 28.
41. See STEVENSON & OXMAN, The preparations for the law of the sea conference, 68 Am. J. Int. L. 1 (1974).
42. *Ibid.*, p. 13, n. 42.
43. See Conservation Foundation, A Citizen's Guide to Clean Air (1972).
44. *Adopted* November 16, 1972, text in 11 Int. Legal Materials 1358 (1972), arts. 4 and 5.
45. Convention on International Trade in Endangered Species of Flora and Fauna, March 3, 1973, text in 12 Int. Legal Materials 1085 (1973).
46. See TARLOCK, Land use choice: National perogative vs. international policy, 13 Natural Resources J. 343 (1973).
47. U.S.T. No. 549. See also BILDER, Controlling Great Lakes pollution: A study in U.S.-Canadian environmental cooperation, *In* Law, Institutions and the Global Environment, *supra* note 4, p. 294; STEIN, The Potential of Regional Organizations in Managing Man's Environment, *ibid.*, p. 253.
48. Almost all the United Nations specialized agencies and several other agencies are participating in projects in the Sahel. UNEP is also giving close attention to these projects, in line with decisions by its Governing Council to accord high priority to the areas of land, water, and desertification.
49. By its resolution 3001 (XXVII) of December 15, 1972, the United Nations General Assembly decided to hold a "United Nations Conference-Exposition on Human Settlements" and to accept the offer by the government of Canada to act as host. The Conference-Exposition is scheduled to take place from May 31 to June 11, 1976.
50. On nationality and movement of peoples, see MCDOUGAL, LASSWELL, and CHEN, Nationality and human rights: The protection of the individual in external arenas, 83 Yale L. J. 900 (1974).
51. On international law and the population problem, see NANDA, The role of international law and institutions toward developing a global plan of action on population, 3 Denver J. Int. L. & Policy 1 (1973); The World Population Crisis: Policy Implications and the Role of Law (Proceedings of the American Society for International Law regional meeting and the John Bassett Moore Society of International Law symposium 1971.)
52. G. A. Res. 217A, U.N. Doc. A/777, p. 71, art. 15 (1948).
53. Report, *supra* note 5, p. 4.
54. *Supra* note 52.
55. Annex to G.A. Res. 2200A, 21 U.N. GAOR Suppl. 16, p. 49 (1966), reproduced in 61 Am. J. Int. L. 861 (1967).
56. November 4, 1950, Eur. T.S. No. 5, 213 U.N.T.S. 221.
57. Text in Basic Documents on International Protection of Human Rights, L. Sohn & T. Buergenthal, Eds., p. 211 (1973).
58. See G.A. Res. 2542, 24 U.N. GAOR Suppl. 30, p. 49, U.N. Doc. A/7630 (1969), See also ECOSOC Res. 1672A-D (LII), 52 U.N. ECOSOC Suppl. 1, p. 7, U.N. Doc. E/5183 (1972).
59. Introduction to PICCIOTTO, Relation of International Law to the Law of England] and the United States, p. 10 (1915).
60. SLOUKA, International environmental controls in the scientific age, *In* Law, Institutions and the Global Environment, *supra* note 4, pp. 208, 229–230.
61. KUNZ, The "Vienna School" and international law, 11 N.Y.U. L.Q. Rev. 307, 399 (1934).
62. FALK, R., *supra* note 4, pp. 37–38.

63. *Supra* note 5.
64. *Ibid.*, p. 59. The pertinent Recommendations are as follows:
Evaluation and review: Recommendations 4(1), 11, 14, 18, 41, 48, 54, 55, 60, 61, 62, 63, 70, 73, 74, 75, 81, 85, 88, 91, 92, 94, 95, 106, 109.
Research: Recommendations 4, 12(2), 13, 16, 18, 20, 23, 24, 26, 28, 41, 42, 43, 44, 45, 48, 49, 51, 52, 53, 59, 62, 64, 65, 66, 68, 73, 76, 78, 79, 80, 84, 87, 88, 89, 94, 95, 102, 106, 108.
Monitoring: Recommendations 18, 25, 29, 30, 40, 46, 51, 55, 57, 67, 73, 74, 76, 77, 78, 79, 80, 87, 90, 91, 94, 95, 105.
Information exchange: Recommendations 2, 4(2), 5, 16, 19, 20, 26, 27, 35, 41, 45, 46, 49, 51, 52, 53, 56, 58, 74, 84, 91, 95, 96(1), 97 (20), 100, 101, 102.
65. See, e.g., Report of the Governing Council of the United Nations Programme, U.N. Doc. UNEP/GC/10, p. 8 (1973).
66. See generally FERARU, Transnational political interests and the global environment, 28 Int. Org. 31 (1974).
67. Agreement on Cooperation in the Field of Environmental Protection, May 23, 1972, text in 11 Int. Legal Materials 761 (1972). See also USSR-US: Memorandum of Implementation of Environmental Agreement, September 21, 1972, text *ibid.*, p. 1408.
68. 42 U.S.C. 4321 (1970).
69. See note 66 *supra*.
70. GOLDIE, International impact reports and the conservation of the ocean environment, 13 Natural Resources J. 256 (1973).
71. Draft Declaration on the Human Environment, U.N. Doc. A/Conf. 48/4, Annex, para. 20, p. 4 (1972).
72. For the history of draft Principle 20 up through the final modified incorporation of the idea in the General Assembly resolution, see SOHN, The Stockholm Declaration on the human environment, 14 Harv. Int. L.J. 423, 496–504 (1973).
73. See TAN 6 *supra*.
74. G.A. Res. 2997, *supra* note 6.
75. Text in Environment Stockholm, p. 17 (U.N. CESI 1972). Eleven NGOs also promulgated the "Statement of Youth and Student NGO's," *ibid.*, p. 19.
76. MEADOWS, D., D. MEADOWS, J. RANDERS & W. BEHRENS. The Limits to Growth (1972).
77. See TAN 66 *supra*. SCEP, Man's Impact on the Global Environment (1970); SCOPE, Global Environmental Monitoring; SMIC, *supra* note 15.
78. See, e.g., I.I.E.A. World Energy, the Environment & Political Action (1973).
79. See note 66 *supra*. See also note 75.
80. *Supra* notes 10, 16, and 37.
81. *Supra* note 17.
82. *Supra* note 20.
83. *Supra* note 21.
84. *Supra* note 22.
85. *Entered into force* August 9, 1969, text in 9 Int. Legal Materials 359 (1970).
86. Report, *supra* note 5, Annex 3.
87. *Ibid.*, p. 48, corrected text; see Report of the Second Session of the Intergovernmental Working Group on Marine Pollution, U.N. Doc. A/Conf. 48/IWGMP.II/5, pp. 7–8 (1971).
88. *Supra* note 23. See also TAN, pp. 23–26 and notes 24 and 26.
89. *Supra* note 25
90. *Supra* note 26.
91. Statement of Objectives, correct text in IWGMP Report 7.
92. *Supra* note 27.
93. *Supra* note 28.
94. *Supra* note 29.
95. *Supra* note 44.
96. *Supra* note 45.
97. *Supra* note 37.
98. *Ibid.*
99. The Statute of the I.C.J., art. 34, provides that "Only states may be parties in cases before the Court."
100. Nottebohm Case [1955] I.C.J. 4.
101. Flegenheimer Claim, 25 I.L.R. 91 (Italian-United States Conciliation Commission 1963).

102. Case Concerning the Barcelona Traction, Light and Power Co., Second Phase [1970] I.C.J. 4.
103. See Seabeds Report (1973), *supra* note 11, vol. 5, sec. 21, pp. 1–9.
104. Australia and New Zealand have each brought suit against France in the World Court in respect of a dispute concerning the holding of atmospheric tests of nuclear weapons by the French government in the Pacific Ocean. The I.C.J. issued an Order Concerning Interim Measures of Protection in each case on June 22, 1973, text in 12 Int. Legal Materials 749 (1973). On July 21, 1973, however, France conducted a nuclear test in the atmosphere over Mururoa in the Pacific Tests area; protests followed.
105. *Supra* notes 20–22.
106. *Supra* note 24, art. 7. So as not to prejudice the results of the upcoming Law of the Sea Conference, however, the convention further specifically provides that the "nature and extent of the right and responsibility of a coastal state to apply the convention in a zone adjacent to its coast" will be resolved at a meeting of contracting parties after LOS-III. *Ibid.*, art. 8.
107. *Supra* note 13.
108. See Canadian Prime Minister's remarks on the proposed legislation, 9 Int. Legal Materials 601 (1970). See also BEESLEY, The Arctic pollution prevention act: Canada's Perspective, 1 Syracuse J. Int. L. & Commerce 226, 235 (1973).
109. In the *Fisheries Jurisdiction* Cases, the United Kingdom and the Federal Republic of Germany have challenged a claim by Iceland to extend its exclusive fisheries jurisdiction to a zone of 50 nautical miles around the island. The underlying international agreements upon which these suits are founded are found in 397 U.N.T.S. 275 (1961) and 409 U.N.T.S. 47 (1961), respectively; the Icelandic Resolution of the Althing on Fisheries Jurisdiction appears in 11 Int. Legal Materials 643 (1972). The I.C.J. has issued a preliminary injunction and has decided it has jurisdiction in both cases. See Order of August 17, 1972 Concerning Interim Measures of Protection, *ibid.*, p. 1069; Judgment of February 2, 1973 Concerning the Question of Jurisdiction, text in 12 Int. Legal Materials 290 (1973); Order of July 12, 1973 Concerning the Continuance of Interim Measures of Protection, *ibid.*, p. 743.
110. *Supra* note 104.
111. *Supra* note 39.
112. On the international authority to be created to deal with the seabed beyond national jurisdiction, see STEVENSON & OXMAN, *supra* note 41, pp. 4–8.
113. "At this point of affairs" or "in these circumstances"—international law doctrine of changed conditions.
114. A Study of the Capacity of the United Nations Development System, U.N. Doc. DP/5 (2 vols., 1969).
115. Commission on International Development, Partners in Development (1969).
116. UNITAR is a separate agency, part of the United Nations system; the other two bodies are appraisal units within the U.N. Secretariat itself.
118. G.A. Res. 2997, *supra* note 6.
119. For similar projections concerning the future of ecological conditions and of the international environmental legal order, see BRUBAKER, S. To Live on Earth (1972) and OLMSTEAD, Prospects for Regulation of Environmental Law, *In* International Law Association, The Present State of International Law, p. 245 (1973), respectively.
120. Report, *supra* note 5, p. 40.
121. Bangkok Conference on World Peace through Law: Recommendations of the Conference (1969).
122. *Supra* note 27.
123. Resolution on Nuclear Weapons Tests, *In* Report, *supra* note 5, p. 66.
124. *Supra* notes 104 and 110.
125. See TAN 30 *supra*.
126. *Supra* note 26.
127. See BEESLEY, The Canadian approach—Environmental law on the international plane, *In* Private Investors Abroad—Problems and Solutions in International Business in 1973, pp. 239, 273 (1973).
128. *Supra* note 72.
129. *Supra* note 49.
130. See PILPEL, Legal impediments to voluntarism, *In* The World Population Crisis, *supra* note 51, p. 83.
131. See MONTGOMERY, The case for compulsory regulation of reproduction, *Ibid.*, p. 67.

132. *Supra* notes 63–64.
133. See, e.g., RUSSETT, B. & H. ALKER, K. DEUTSCH & H. LASSWELL, World Handbook of Political and Social Indicators (1964).
134. Report of the Governing Council of the United Nations Environment Programme, U.N. Doc. UNEP/GC.II/10.
135. *Supra* note 76.
136. See, e.g., The no-growth society, 102 Daedalus (Fall 1973).
137. See STEVENSON & OXMAN, *supra* note 41, pp. 28–30.
138. Report, *supra* note 5, p. 23. The moratorium was subsequently rejected at the next session of the International Whaling Commission 1 month later.
139. See particularly ILC, Report, 11 U.N. GAOR Suppl. 9, U.N. Doc. A/3159 (1956), reprinted in 51 Am. J. Int. L. 154 (1957).
140. See GARDNER, The role of the U.N. in environmental problems, 26 Int. Org. 237, 254 (1972).
141. See the suggestions of I.C.J. Judge Philip Jessup in Do New Problems Need New Courts?, 65 Proceedings: Am. Soc. Int. L. 261 (1971).
142. See, e.g., Development and Environment 6 *passim* (the "Founex Report" 1971).
143. Meadows et al., *supra* note 76, p. 29.

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 languor of SALT II, the "bargaining chip" reescalation 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 finger only the American nuclear arsenal are found to be "security risks" because of alcoholism, drug abuse, mental illness, and indiscipline.

I think about the largely untold slaughter of countless 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 chrome-plated diplomacies that make laughingstock of Security Council sanctions, and, generally, about the old Adam of sovereignty that tenaciously fights delaying actions against the achievement of fundamental rights and freedoms midst 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 profit ends and social responsibility begins, that grudgingly consign mere fractions of colossal GNPs toward the alleviation of human want, and that fail generally to perceive the moral and *realpolitik* 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 nonrenewable 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 pollution as *the* central theme 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 sociopolitical injustice, mass poverty, fundamental

ecological instability—and about how together they have set in motion, with help from the prevailing myopia, a vicious circle from which our present State-centric system appears to offer little or no real escape. I think about, for example, the implications attending exponentially growing populations and rapidly dwindling finite resources, in conjunction with accelerating large-scale poverty, already widespread social-political degradation, and the day-after-tomorrow prospect that even poor nations will have their own nuclear weapons with which to bargain and coerce (as a by-product, for instance, of the atomic power plants that many of them are now building and/or planning). Plainly, this medley of conditions augurs ill the possibility (probability?) of increasingly autocratic elites using ever more violent means to engage in a competitive "resources grab" of unprecedented proportion to secure at least for themselves, if not also for their deprived peoples, some hedge against the future—and with potentially catastrophic short- and long-range effects heretofore unimagined or disbelieved. The interdependent drama can evolve, of course, in varying combination and sequence. But through fantastic displays of psychological denial, by which we make abstract that which is concrete, we frustrate perception of it, ignore finding real solutions to it, and consequently contribute, however unwittingly, to the unfolding of the "crisis of crises."

True, despite the Cuban missile and other crises that have harrowed our existence over the last quarter-century, we have managed to squeak through. For better or worse, we are here today, and this suggests that I may be mistaken, or at least overly pessimistic, in my grim sense of the future. In fact, considering the recent big power *détentes* and the sobering influence of the Arab oil squeeze (tenuous though these developments are), it may be that the way is now open, perhaps as never before in our lifetimes, for a world that is moved more by enlightenment and persuasion than by irrationality and coercion. In other words, I take very seriously the caution lately voiced by British physicist John Maddox and others against succumbing to the "doomsday syndrome."[1]

Still, even if not certain or inevitable, a new Ice Age does threaten hard upon us. Whatever the positive steps so far taken, none assures the burial of the nuclear war system, the eradication of gross sociopolitical injustice, the rollback of mass underdevelopment, or the redress of fundamental ecological imbalances. To the contrary, these perils persist and grow, and both singly and in combination threaten not just the quality but the very existence of life as we know it or would have it. Moreover, there is scant evidence that governments are seriously inclined, let alone prepared, to take the giant strides that are needed to save the future from them. More or less paralyzed by mounting symptoms of chronic political instability and abuse, they stumble along piecemeal and timorous. More or less mesmerized by the rewards of temporary self-interest, they cling to the fallacy that civilization will survive no matter what. A new Ice Age threatens not only because of the severe malignancies we have inflicted upon the global body-politic, but also because we are inert and/or indifferent in relation to them.

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 guarantee human survival?

I, of course, cannot speak for education worldwide, nor indeed for education everywhere and at all levels in the United States. But if the general posture 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 bannered Final Report of the Carnegie Commission on Higher Education, the 6-year, $6 million end-product of 21 special reports and a series of auxiliary studies under 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."[2] 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 jeopardize creativity, experimentation, and reform. These findings are unnerving 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 academe lays claim to intellectual and political legitimacy: curriculum and scholarly values, i.e., what we teach and why. To be sure, this omission was deliberate; but is it 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 outcries 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 alto-

gether 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 particular reflection of our times that the few educators who are addressing these matters are doing so less with assistance from the public fisc 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 nations of this world appear generally unmoved to save the future from potential disaster, so also do the academies. 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.

Nor 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 despair. 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 merit, of all values among all human beings."[3]

* * *

Preliminarily, it needs emphasizing that an optimal human survival curriculum, or what I choose to call "world order education," would be at once 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 compleat liberal education," it would be centrally concerned with the meaning, value, and improvement of life *as a whole*. The following chart, contrasting between

"traditional" and "world order" approaches to the study of international affairs, quickly illustrates what would be principally involved:[4]

Issues	Traditional Approaches	World Order Approaches
1. Analysis is presumed	value-free	value-oriented
2. Appropriate time-dimension is	past and present	past, present, and especially future
3. Ultimate analytical goal is	description	prescription
4. Primary actors are	nation states; governmental elites	continuum from individuals to supranational institutions
5. Geopolitical emphasis is	national interest	global interests
6. Problems are seen as	discrete issues	interrelated issues
7. Power is	basically military and economic manipulation	not only the ability to coerce
8. Large-scale violence is	an acceptable means to implement policy goals	ordinarily unacceptable
9. Human survival is	assumed	problematical

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, sociopolitical 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 nonviolent change," "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 analyses. The simple point is that, as general curricular reference-points, each incorporating a diversity of inquiries which tend toward common issues of fact and policy that transcend the capacity of our State-centric system, they would serve to focus attention upon those regrettably 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-political 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 benefits 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 they 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 others of 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-tested knowledge and skills; it would mean blending new perspectives with old tools. To quote Montaigne, "[we] are all framed of flaps and patches and of so shapeless and diverse a contexture that every piece and every moment playeth his part." [5]

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 different curricular conclusions (just as will, parenthetically, the passage of time itself), and the most one can ask is that curricular decisions will reflect thorough and enlightened judgment about what knowledge is especially needed to make ours a more secure and just world for years to come. The four problem areas would and should be approached, in short, more in tentative than dogmatic spirit—all the while bearing in mind, however, that ours *is* an "endangered planet" and that it is now time, as perhaps never before, for the academy to respond accordingly.

Guiding Principles of Study

The overriding principles which should guide a human survival or world order education are best summarized by the chart set forth above (Reference 4, pp. 9–10). Special attention should be given, however, to the following key terms: "globalism," "interdisciplinary problem-solving," "futurism," and "policy-oriented analysis."

By "globalism" is meant a break from the syntactical consistency of the word "international" and the essentially competitive and increasingly outmoded participatory model of the world system it implies. Even though Gerald Ford, Leonid Brezhnev, and Julius Nyrere continue to look beyond their national frontiers largely in terms of the specific interests of their respective countries, the time is long overdue when the entire world must be seen as the unit of analysis, much as students of national politics view national communities. A human survival or world order education would involve seeing the world as a holistic social process and seeing, consequently, the commonality and interdependence of such problems as war, social-political injustice, economic underdevelopment, and ecological instability.

By "interdisciplinary problem-solving" is meant a departure from the excessive compartmentalization and narrative which typifies much of international education and which tends to isolate many young people from understanding, let alone helping to solve, the pressing global issues of our day. It is true, of course, that traditional academic boundaries have a proper and useful role to play. But it must be acknowledged that social problems do not arise, and consequently cannot be solved, in unidisciplinary fashion. Nor are serious inroads upon them likely if such problems are left largely to descriptive statement. A human survival or world order education would encourage students to draw from the various disciplines and to venture and test solutions against those of their mentors and peers for the purpose of educating a citizenry to cope with the interrelated threats that will characterize the remainder of this century.

By "futurism" is meant not simply the strategic planning *for* the future on the basis of projected trends, but, further, the reconstructive planning *of* the future in accordance with recommended priorities and goals. A key reason why presently it is possible to talk about threats to human survival is that, until recently, few people have sought to project and plan 20 to 30—even 5 to 10—years into the future, and a key reason why now it is especially important to educate in terms of the future is that, if former Secretary-General

U Thant and others are to be believed,[6] 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 presuming 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, unidisciplinary, too historically circumscribed, and ostensibly "value-free" perspectives. It would mean focusing upon "Spaceship 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 acute observers foresee as *the* critical milestone 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., delimitative thinking);

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

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

(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., prognostic thinking); and

(6) the invention and recommendation of solutions consistent with preferred policies or values (i.e., resolutive 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 realization strategy. Treated as a whole, they are seen as the minimum steps needed for the rational amelioration of any world order problem. Treated either way, they of course imply the involvement of most, if not all, the major disciplines—the arts, 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 tentative only.

* * *

Concededly, education for human survival and human dignity is a very difficult thing to achieve, and not just because of the unparalleled public and private creativity, energy, and wealth it requires. It involves also the rearranging of thought patterns and work habits that run very deep. Unlike the doctor who labels "suicidal" a patient who consistently ignores threats to his/her personal survival, we label as "traditional"—not "self-destructive"—a curriculum which fails to confront the threats that endanger our national and planetary future.

But innovate and revise we must. The world has been superbly organized for everything except the life of its people, and as naturalist-poet Loren Eisely 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."[7] Genuinely to commit ourselves to an educational process that holds out at least the potential for heightened sensitivity to the preciousness 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-

TENTATIVE WORLD ORDER STUDIES CURRICULUM CHART

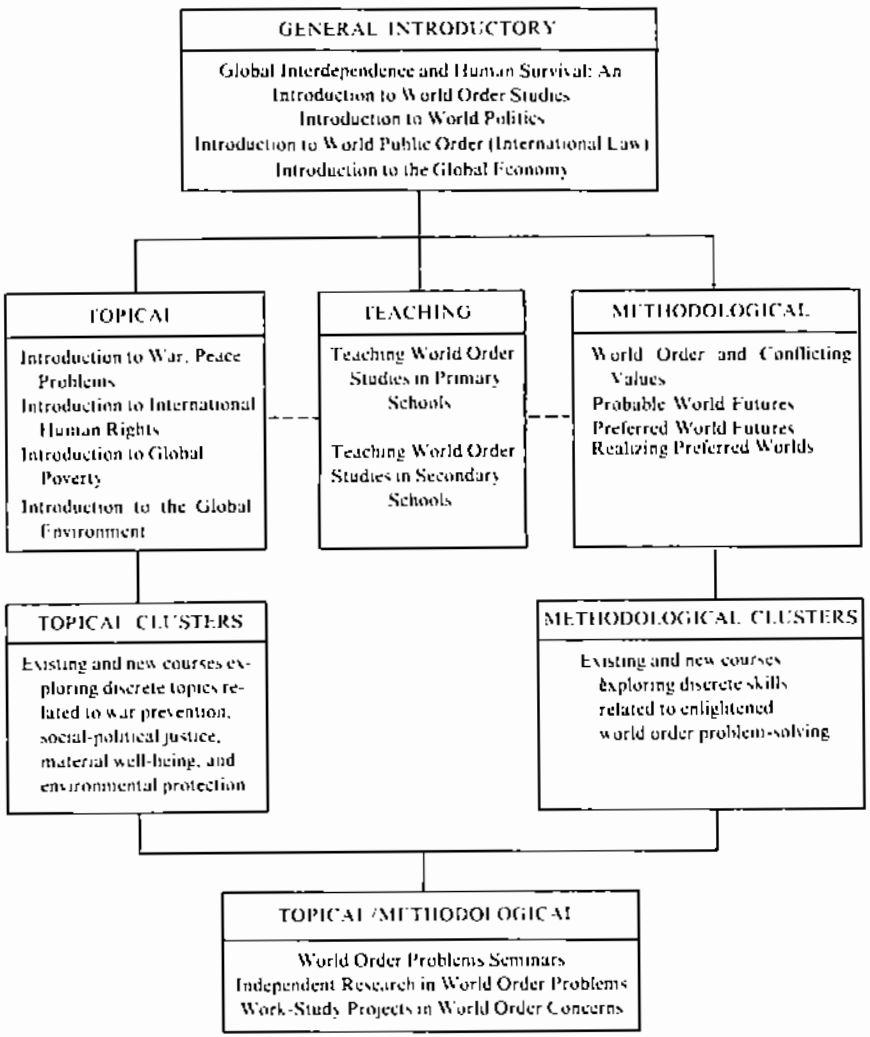

FIGURE 1.

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

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6. State U Thant in May 1969:

> I can only conclude from the information that is available to me as Secretary General that the members of the United Nations have perhaps ten years left in which to subordinate their ancient quarrels and launch a global partnership to curb the arms race, to improve the human environment, to defuse 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 very much fear that the problems I have mentioned will have reached such staggering proportions that they will be beyond our capacity to control.

Quoted from The United Nations: The Next Twenty-Five Years, Twentieth Report of the Commission to Study the Organization of Peace, 1969, p. 7. To same general effect, see generally Heilbroner, R. 1974. An Inquiry into the Human Prospect. pp. 31–58. W. W Norton & Company. New York, N.Y
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SOCIETY'S NEEDS IN SCIENTIFIC AND TECHNICAL INFORMATION*

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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 generations 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 licit 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 crux and a chief causal agent. It may well be that the innocent respectability of mere librarianship and the provision of incomprehensibly arcane journal literature for the egghead elite of scholarship may be the straw that makes or breaks the future 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 attack, but I shall hope to show now that such an evaluation of present needs in scientific and technical information is no overstatement.

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 cumulating 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 and McLuhanesque way it *is* the ultimate product of the work of the creative agent.

* This paper was originally presented at Drexel University as the fourth in a series of six lectures on Society's Technological Needs.

Scientific and technical information is thus the raw material resource on which our present revolutionary crisis rests, and it is therefore in this light that we must examine its historical evolution and find out first what it is that makes it work the way it does. Then we stand some chance of finding out what it is that is making it stop working like that and take a new route. We may desire to ease its path through that route or we might chose to divert it in new ways; in this case it seems impossible to avoid action and unlikely that we can avoid actions that cause dramatic and far-reaching effects throughout the entire world.

The root of the whole matter is that scientific knowledge is basically different from all other forms of scholarship and all other forms of creative activity. Science consists of universal, positive, impersonal knowledge, but what matters about all these qualities is not so much any philosophical truth which they may or may not have, but that scientists act in general as if these things were true. Science seems universal in that researchers in Tokyo, Philadelphia, and Kiev all think they are working on elucidating the same puzzles about superconductivity, immunoglobulin, and plate tectonics. They footnote, correct, and extend each others work and tend to get much the same ideas about what to go onto next and when to drop an unfruitful line of enquiry. Work of Marek's disease seems oblivious to any influences of the language, politics, religion, or personality of Marek. It may well depend quite a lot on his scientific reputation and the spread of his influence as a teacher or team leader or journal editor, but these are part of a social organization within science rather than exterior to it—at least in intention.

At all events it is a different position to anything, for example, in the creative arts. Can one imagine a priority dispute between Beethoven and Mozart or Picasso and Klee to match that of Darwin and Wallace or Salk and Sabin? Darwin and Einstein might be great creative geniuses, but they were discovering a universe they took to be outside themselves and thus, however magnificently distinct be their personal style, their discovery is impersonal. Each scientific discovery, large or small, carries with it a feeling that it was there to be found, all in its own order and time perhaps, but to some degree inevitably. As science is laid down, piece by impersonal piece, like some gigantic universal jigsaw puzzle devised in the mind of an infinitely cunning Laplacian creator, the contributions are not always sure-footed; they are far from secure either in the short or long term.

In the short term, every scientist knows that he is capable of error. Sometimes it is a stupid error of a misplaced factor of 2π or a wrong sign, sometimes one jumps to a false conclusion or misreads the meter, sometimes the error is so sophisticated that one does not discover it until the next pieces of the puzzle fail to fit properly into place. Sometimes too, we do not realize that the contribution has been made before or must be altered to take account of other evidence that has escaped our attention, and at other times we might not realize that a pedestrian comment in the style of Wonder Dog can be the blinding inspiration for some perceptive peer.

These phenomena occur so widely together with all the long-term changes in the paradigms of science that the act of creation in science remains incomplete without the assent 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 tested 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 Mendel 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 consensual sensorium. It is the workings of this sensorium 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 find something new in the technical areas of scholarship they do not follow this paradoxical law of claiming private property by open publication, but use the normal property law of keeping their creation and deriving benefit from it as a nation, a company, or an individual. One may invoke secrecy at the national or the industrial level, or one might use the legal devices of patents and licenses which trade a disclosure of information in return for a right to profit from the possession. Clearly this is advantageous in many respects which may be overriding, although what one loses is the assistance of the rest of the world communication both in the process of validation and in the collaborative enterprise of proceeding further to build on this new advance.

A much larger exception in the world's scientific labors 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. Those 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 cumulation and testing and communicated to them by the processes of education, training, and the encapsulation of knowledge into textbooks, manuals, 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 Gutenburg Revolution. Quite sharply around 1500 the printed book graduated from its original role producing artificial manuscripts to become a new force of mass dissemination to a much wider audience than had been available to copyists. 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 reprinting, and developing ever wider circles of readers and writers. As the presses became more and more voracious and easily available, the pulse of publication quickened. By 1600 some vital 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 seventeenth century it had quickened dramatically further.

This exponential force of destiny was so powerful that ephemeral publication of many sorts began to abound, political and religious tracts and broadsheets, sermons, and then the newspaper. In science, benefitting enormously already through the many potential authors to be found among the artisans and instrument-makers near to the printers, the force was so persuasive that the first two scientific journals were organized almost simultaneously in London and in Paris.

Those two journals, the *Philosophical Transactions* and the *Journal des Sçavans* produced very quickly, by the invention of the scientific paper, the major revolution of all time in the social organization and rate of flow of scientific and technical information. Splitting knowledge into atomic entities instead of waiting for it to gel and cumulate into a book obviously makes it run faster and much more cooperatively. There was indeed reaction to the method in the time of Newton, but by the eighteenth century the process settled down to a steady growth. Science encapsulated in papers became a sort of conspiracy that made knowledge run faster than people. And the scientific journals and its papers then grew exponentially much faster than books, doubling in numbers 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 in 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 1660s. If we have problems it is perhaps because the United States is highly developed and cannot perhaps burgeon quite so 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 cumulation 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, and 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 main 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 virtually perfect pace with the journals and their papers which were enabled thereby to continue their expansion unchecked through this size barrier. During all of the nineteenth century and halfway through 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, libraries, 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. It is this crude fact that makes me think 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 are agreed 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 when so high a fraction of their manpower and money is devoted to these 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 scraping 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 sensorium 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 sublevel. 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" publication. Preprints are systematically sent in mass circulation, and "preliminary" reports are steadily looking like more and more regular publications of their originating agencies. The mail, the telephone, the jet plane, and the tape and videotape recorders are all available technologies of rapid dissemination. Laboratories and institutes have been known to have open circuit communication by phone and computer with distant colleagues as a regular working tool.

Obviously a change has taken place, and equally obviously only a hairsbreadth of technical perfection separates us from the ultimate limit of being in reasonably instant, reasonably universal contact with all peers everywhere. Put that way it might seem startling and a sort of technutopia, but I for one believe it to be both inevitable and a good and valid societal need which has to be engineered efficiently and quickly. It is, I believe, even possible to suggest at least one rather grand but perhaps workable scheme which would help this process along well enough to last for another few generations. Before that, however, we must explore a force that holds back this sort of change.

The last generation of increased speed has been bought at high cost. The unique property of the scientific paper, the thing that made it the very life's blood of science and technology, was that these atoms of knowledge served a double function. As one published the unit contributions to be validated and used by one's peers, quite automatically it laid down the archive of learning. The serried ranks of scientific journals constituted what was called "The Literature." One searched the cumulation of journals and then one knew what was known. Of course, the really old stuff had been packed down into textbooks and handbooks; it had been absorbed with the mother's milk in that process known as graduate education or one could look it up in the *Handbook of Chemistry and Physics*. Then you were running with the pack and trying with them to do something new.

The automatic double function has been lost in the latest and ultimate round in improving the speed and efficiency of communication between peers. No longer does the process at the research front pack down automatically into a corpus of knowledge. It probably never did it very efficiently anyway. The eighteenth century crisis of encyclopedism and later ones of complete and compendious bibliographies show there were problems then. The more recent concern with textbook writing and the appearance of special journals devoted to "Reviews of Recent Advances in X, Y and Z" show that dissatisfaction has grown. One must remember that the corpus must be somehow packed down, wrapped up, digested, and made available, not only for those on their way to the various parts of the research front. All those who are using what we already know and those who work in any way behind the front need this knowledge for it is the ultimate product of all the effort and creative energy that has been used up to date in all the world.

What I say is that we should cut the anchor and sail clear. Let us admit that communicating at the research front and managing a cumulated corpus of learning are by now separate and distinct functions and do what we can

to help each separately and in relation to each other. Our present practice seems like using a total 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 more things than will eventually need to be incorporated into the received story of the nation.

I chose 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 form that parallels the *Wall Street Journal* and the *Financial Times*. The most rapidly communicative journals have moved from monthly to weekly, and I suppose that they will wish to go daily—for highly prestigious hot news one already uses the ordinary newspapers for scientific items unless the anchor is down and "proper" archival publication is jealously conserved. Presumably one could already use the accepted technologies of simultaneous 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 comparative cost of alternative services why such a newspaper format could not be produced in Russian and Japanese as well as any other language over 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 threw it away or recycled it each day. The content would not be scientific and technical news stories quite so much as the analogs of the stock market prices which are what make those other newspapers essential. Whatever we do in scientific and technical communication we shall need those monitoring devices of the massive abstract journals—*Chemical Abstracts*, *Physics Abstracts*, *Index Medicus*, *Mathematical Reviews*, and all the current awareness aids such as *Current Contents*, the *Citation Index*, *Indexes of Chemical Compounds*, and so on. We shall also need more and more of the "quicky" journals with their letter form of publication.

I calculate that if one were to put all this mix together in a barrel, perhaps cutting out some of the more obviously overlapping entries 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 newsier parts of the journals *Science*, *Nature*, *Lancet*, and the *New Scientist* and sufficient space for advertising (in the capitalist countries only) to make it no more uneconomic than the present tottering services—only a brave few of which are commercial and survive without heavy subsidy. I am not quite so starry-eyed an idealist as to imagine that anyone will design and deliver to us such a complete package, nor do I believe that the entrenched forces of present services will readily relinquish their holdings to any alternative. I do suppose, however, that this is where we are probably heading, willy-nilly, and that we might make transitions easier if we took step by step actions that eased rather than thwarted the process.

Assuming then the *SciTech News* arrives every day everywhere and is duly thrown away, how then do we pack down the archive of new knowledge for all the would-be users at the research front and behind? Strangely enough the basic problems and present trends seem to be in the areas of comprehending, consolidating, and ordering the cumulating information rather than in those of publishing techniques. Journals of the traditional sort go on and will continue albeit with new printing technologies such as photocomposition and microform and new economics because of rising costs and a falling affluence of scientists and libraries, because they exist as the end-product of work in the field. Journals are for publishing in rather than for reading. In that form it sounds cynical but in so much of the heart of science and technology there is no substitute for the traditional hard copy which is given peer review once it has been found by the communication process.

In publication the trend seems to be with international high status journals of which *Physical Review* has become the paradigm for the whole world community. If you live in Istanbul and do something really good in physics it goes into *Physical Review* not into the domestic Turkish journal. We still tend to follow the original historic foundations of the various National Academies of Science and consider national journals in totally transnational subjects to be still a matter of pride. I do not see that this is functional, realistic, or economic. Far better it would be if each area of science had its analog of *Physical Review*, and if *Physical Review* itself were universally treated as the single high status journal. Again it is only a hairsbreadth of technology that stops us from multilingual publication and rapid delivery. Again it would be idealistic not to suppose that there are grave economic problems as well as organizational and probably political, but perhaps it can serve as a target toward which we can direct steady change in pursuit of our needs. What of low status journals and even the national journals in fields that have such an international giant? Is there a case for preserving at greater and greater expense with less and less return a medium for papers which have consumed resources without meriting (rather obtaining) high status publication? How much should we be willing to pay for the mere national and personal pride of showing results and giving opportunity and visibility to unrecognized worth and recognized non-worth? I confess I do not know, but I think that these questions must be asked explicitly and answered within the next generation. In this country of all places one knows the value of preserving multiple channels and avoiding monolithic centralization of power. My guess is that a certain element of monolithicness is built into science; in the transnational community there is only the one chemistry and no alternative. My guess, for what it is worth, is that as time goes on we shall be less and less willing to subsidize any publication that is not high status in its own right, and even more unwilling to clutter the communication channels with information pollution so generated.

The trick of ordering all this scientific and technical information so that it can be found in *SciTech News* each day, and comprehended and consolidated from the high status traditional style publications lies in a new re-

search result in bibliometrics which I should like now to explain. Bibliometrics sounds as if it means some sort of book-counting routine indulged in by librarians to tell them how many cataloguers they need to service a flow of readers. It probably includes that sort of practical art, but it has become rather sophisticated of late and in this recent 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. Belver 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 cumulations. 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 frontwards, 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 unmistakable nomenclature that was devised for the biological genera and species of botany and of 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 reach 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 is 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 regions 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 birds 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 nontaxonomic, 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 incompetence 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 tapes 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 over 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 atoms 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 rather 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 not only tells us much more than we have ever known about the nature of knowledge but it also gives the vital clue on how to cope with it after the frustration of indexing.

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, Metallurgy, 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 these unique subfields that should each be served by their proper journal. Physics or Chemistry of 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 nontaxonomic 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 setting down such material into textbooks and reviews, but the old idea of "divide and conquer" makes the problem seem to me to be far from insuperable. 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 in two catagories: 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 Pitts 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. Whitby 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 utilitarian 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. Bernd Matthias 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 tremendous subtleties of human behavior. Certain industrial laboratories have managed to capture some of this atmosphere. The General Electric Laboratory under Irving Langmuir, Steinmetz, and Coolidge who laid the basis for the giant company's present day business, 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 encourage environmental research projects in the academic atmosphere. This is vitally 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 nation is not lack of financial support but poor 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 than 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 intrigued and interested and given their heads.

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

4. Large sums are spent in cut and try fitting together in the absence of a full basic understanding. This work is absolutely essential and should not be frowned upon or neglected, for after any major breakthrough, a development phase must be entered, 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 99+ percent of our multi-billion dollar research and development support in this country. It is very important and necessary but administrators should not confuse it with great innovation. A Fermi is not a Henry Ford and *vice versa*, although the Fermi's sometimes fancy themselves as great development engineers.

The competent administrator must realize and heed these four basic facts. Among the rarest 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

head this list with General Leslie Groves who was in charge of the Manhatten District.

The superconductor which will make the transmission of electric power over long distances economic and possible, the ultimate understanding of the nature of the interaction between sunlight and auto exhaust and the particulate haze, the question of how much NO_x should be tolerated, the question of sulfur dioxide being oxidized by platinum catalysts to sulfuric acid, and the questions of chronic low level hazards to health all require breakthrough solutions and, therefore, should be attacked in a fundamental manner. We have hundreds of Ph.D. theses each year on problems which relate 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 certain to be consumed in larger and larger volume as our crude oil supplies dwindle, and this involves many matters—from mining methods to chemical processing for gasification and liquefaction—that are the subjects of extensive research and development 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 esoteric field restricted almost entirely 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 handled 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 reaction. This is in 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 20 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 reacting 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 catalysis 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 source. The new ideas 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 CO_2 using steam. Strangely

enough, this reaction is thermodynamically permissable 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 top graduate students in chemistry and chemical engineering to work in the field of heterogeneous catalysis. This would help greatly in oil refining as well for we are desperately dependent at the moment on foreign supplies of platinum and the new auto exhaust 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 enormously 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 primeval nebula. Other theories exist and my personal view is that it is more likely that the major part was due to the intense radioactivity which ionized the gases and led to the production of complex organic chemicals by plasma chemical processes. In the laboratory we have shown that such systems produce polymeric compounds, even amino acids, in good yield. 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 cadmium 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

hydrogen. This is one of the processes being developed for direct hydrogenation of coal. The transition elements are the most active 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 phosphorous and sulfur form more than four bonds and it is thought that this may invoke d orbitals which are stabilized in the particular molecule 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 acidity to dismember hydrocarbons, removing hydride ions 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 the understanding of 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 radiocarbon 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 have occurred. 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 on line.

In the years I served on the Atomic Energy Commission, I nearly launched a national program of putting 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 multidisplinary 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 and observational program faithfully reported is underway on this improtant 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 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 Environment 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 insofar as 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 cause. 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.

I recall vividly experience gained on the Atomic Energy Commission which in many ways is similar to the present situation in which public authorities find themselves—making decisions of importance to the environment. For good and sufficient reasons we were pressing hard for the development of our atomic defense armament but were challenged by critics citing the dangers of the radioactive fallout from atmospheric tests. Also controversies grew up on the matter of the occupational hazard from radiation to uranium miners and workers in atomic plants across the country from Hanford, Washington, to Savannah River, South Carolina, which had one question in common, What, in fact, was the level of exposure? In many cases only experts were able to make such measurements, the levels were lower than those easily measured, and the experts all worked for the AEC or its contractors and thus were not above question as to objectivity. How then were the facts to be brought out for guidance? The joint Congressional Committee on Atomic Energy would call us up regularly and a great volume of expert testimony was produced in this way, but it did not properly and fully answer the question of the magnitude of the radiation dosages. Of course, the health and genetic effects of small doses, either chronic or acute, are still being intensively researched and debated and will continue to be so long as our ignorance in this area persists. However, in the matter of the amount or how to measure the exposure, our knowledge has been adequate for many years, but our situation in the middle fifties was that nearly everyone who knew the technique was in one or another way beholden to one of the protagonists or contestants, the AEC or the protestors or the labor unions.

So it was in this context that a new profession was created, the Health Physicist. Contracts for the institution of training courses were let to universities, fellowships for the students were established, and jobs for the graduates were assured. In this way the AEC got surcease from the tortuous problems of making its own assay and assessment.

There is an analogy with our present situation, an analogy so close that, I think, once again we must create a new profession to settle the points of fact as they are known and to give the debate the substance it richly deserves, credence, and validity.

The new profession will be the Environment Doctor, probably formally called the Doctor of Environmental Science and Engineering, but let us call him what he is, the Environment Doctor. His job and role is to bring the facts out, to tell us before we take a step the likely consequences for the environment, and to tell us how to correct some of our past errors. He will not make the decisions himself but will recommend to elected and appointed officials. The objective is to provide the decision-makers with the best possible information.

We will expect him to be trained in all aspects of physical and biological sciences and engineering. He will have the breadth of the M.D. and the same general approach to his profession. His task is to say what the overall effects on the environment are likely to be for any proposed new action

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 professionals 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 as 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 lines, 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 out 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 classes in graduate school and 2 years of supervised field practice in close analogy to the years 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 interdepartmental 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 skills stored in the universities. This may help free man to live with the increased population which seems to be inevitable. At least it should help him to make better uses of his resources and opportunities.

I have here the pamphlet sent to 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 many choices of industries and government agencies. One student has had five offers from federal agencies in Washington, D.C. We have 30 students in the program and we have raised about $800,000 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 this country and abroad training Environment Doctors.

We have not really faced the questions of licensing as yet, but we will 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 restrict the issuance of licenses to UCLA graduates only, but the state board examinations would be tailored to the kind of training they receive and we expect that 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 the energy and environment crisis we face today. Many schools, universities, and colleges do this now, but I think we need more of it and it should be done on 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 this same course might be fuel 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 electric power. Another course might be the air pollution problem in all its multitudinous aspects, including such hidden subtleties 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 corn consumes five pounds equivalent of hydrocarbon 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 pretty high places.

Earthquake 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 universities. How would it be to have a course on 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 better to have an interdepartmental curriculum, somewhat similar to the Environment Doctor Program in the graduate school, in the undergraduate school aimed not at training the professionals but at 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 area.

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 catastrophy.

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 Doctor, please feel free to visit us. I want to thank the National Science Foundation and the Scaiffe 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

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In October 1962, I published *False 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 speaking about "green revolution," Mexican wheat by Borlaugh, and miracle rice from IRRI Philippines, from Los Baños near Manila. Yes, we do have now a much higher wheat harvest in Pakistan and India, because Pundjab 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 Indian arable land is irrigated, compared to more than 75 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! 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 India-China competition will be soon *unbearable*, with many political implications.

In all the developing countries, after a slight improvement during 1967–1970, the amount of food harvested per capita is now decreasing. A. Boerma, 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 rices," but no "miracle harvest." With the new varieties, some rich rural people

* Dates of French publications. English translations published in 1966 and 1970, respectively, by A. Deutsch, London.

become richer in India and Pakistan but many poor become poorer, and unemployment or underemployment figures are still increasing. They have now become terrifically high. 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 together 40 to 50 percent of the rural population, are in such a situation. How can a link be found between the workless 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 landowners are their main support. Democracy and socialism are still the official targets of "Sonal Bangla." The small farmer can generally neither receive credit at a reasonable rate, nor has he the basic necessary knowledge to realize the green revolution. The Comilla 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 mostly turns out people to be unemployed, and who are often unemployable.

There is a great difficulty in creating increased agricultural production, and still greater difficulties in reducing the growing birth rate. After 20 years of family planning, only 13 percent of the 100 millions 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 big inertias, the agricultural and the demographic ones, we will have very soon a *general and terrific 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 the same 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 is it more important to reduce the birth rate?—in over-populated areas, such as the Indian subcontinent, South Asia in general, Carib areas, et cetera. 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

uses, misuses, and wastes the natural resources, air and water, mineral ore, and oil. A rich person living in a New York suburb wastes—more than uses—500 times more minerals, air, water, and oil than an Indian peasant, a Bihari, for instance. In these circumstances, to reduce pollution and exhaustion of nonrenewable resources, it is more important *to reduce the number of births in rich countries.*

It is also important to organize a world distribution of scarce resources on another basis than the market economy. We are now in a long and general war, *"for human survival."* This war needs allocation of natural resources organized centrally, on a world basis. We have in front of us 10 to 12 years, before we will attain the point where the destruction of natural environment could be irreparable.

It is difficult for me, in such complex fields, to prove this assumption. The proof has to be given by the other parties, which now accept the destruction. They will be, one day, at the History tribunal.

FOOD, FEED, AND ENERGY*

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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. When measured on the basis of the caloric 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 recognize the calories expended in producing the animal products. TABLE 1 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 9182 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 going than an American. Such data also open up entirely new vistas on basic economic relationships, such as personal income, salaries, and expenditures.

This paper expands 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 that food. Judged in such a manner, each hectare involved in the production of food or feed 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 first 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 fishing vessels or food- and feed-carrying cargo trains until the latter part of the nineteenth century. After 1910 transportation vehicles relied almost

* Paper originally given at a symposium on Energy and Society, December 1973, called by the Swedish Academy of Science.

TABLE 1
CALORIES IN FOOD INTAKE, KCAL PER PERSON PER DAY (1970)

	Total Calories	Plant Calories	Animal Calories	Feed Calories	Total Primary Calories
USA	3,300	1,869	1,431	10,017	11,886
India	1,990	1,871	109	763	2,634
Difference	1,310				9,252

exclusively on fossil fuels. Most agriculture functioned without the input of outside fuel until almost 1860 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 tillage 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 substituting of the tractor for horses, mules, and oxen. Primarily this released vast acreages, 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, spurted agricultural production. It is however, far too little recognized that this 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

Farm efficiency culminated in mechanization, or more specifically tractorization or motorization. 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, 1.13×10^6 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 1969 the generation of such electricity for farms through electric power plants required around 0.5 million kcal for each United States citizen.

TABLE 2
TRACTORS AND MANHOURS IN UNITED STATES AGRICULTURE*

	Tractors (million horsepower)	Manhours (billion)
1920	5	13.4
1950	93	6.9
1960	154	4.6
1969	203	3.4

* Data from Reference 6.

TABLE 3
ENERGY USE OF UNITED STATES FARM PER YEAR PER CITIZEN, 1969*

	10^6 kcal	Equivalent in Gasoline (liters)
Tractors	1.13	79
Fertilizers	1.44	100
Electricity	0.51	36
Other uses	3.84	270

* See also Reference 6.

The cultivation of each acre of land currently requires a direct energy input of 2.52×10^6 kcal, or formulated another way, the feeding of each American requires an extra fuel input equivalent of 600 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 steel, rubber, paint, and other commodities necessary for this huge machinery should also be added to the farm budget.

In such a broader context the relative standing of food emerges 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 appreciably boosts the energy base behind food, a factor which applies not only in developed countries, which generally show a high input of fertilizers, but also in poor 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 4
PRIMARY CALORIES AND NITROGEN FERTILIZERS (1969–1970)

	Energy Account (E) (kg coal equivalent*)	Primary Calories (PC) (kg coal equivalent)	PC/E percent	Nitrogen fertilizers (N) (kg coal equivalent)	N/E percent
USA	11,144	640	5.7	150	1.3
USSR	4,445	388	9.2	38	0.9
Poland	4,223	434	10.2	49	1.1
China	526	173	33	4	0.7
UAR (Egypt)	268	230	86	9.7	3.6
India	191	146	77	8	4.2
El Salvador	190	177	93	25	13.0
Mauritius	182	220	121	28	15.4
Indonesia	111	119	107	11.4	10.2

* 1 kcal = 0.146 kg coal equivalent.

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 calorie input. When machines were teamed with draft animals in transition 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 manhour 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 return 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 (sun) 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.

IRRIGATION COSTS

I have alluded to irrigation costs. When practiced they share the top position with fertilizers on the energy account of a modern farm. This is poorly recognized. The dearth of studies in this regard is the more notable as irrigation installations have so conspicuously dominated the postwar scene of development investments both in the rich and the poor world via the World Bank as well as in various aid programs.

Studies show that basically only small scale irrigation is clearly profitable.

Only a few big dams can be classified as economical, and this is chiefly due to subsidiary gains in power. Nonetheless, in the cases of both the big San Men dam in China and the High Dam at Aswan, agriculture has emerged as a far bigger devourer of electricity than anticipated. Analyzed as to energy, the balance is critically askew and even negative. Time does not permit a further penetration of this vital matter, merely two observations. The true costs for irrigation water from such big dams are so far above the reasonable that it is highly dubitable that we the affluent can continue to afford this extravagance in food production. Even in California the well-to-do farmer does not pay more than one-sixth of the actual costs of the water he is using.

Analyses by leading economists have in general reached the conclusion that satisfactory returns can only be attained through high-value, specialized crops (as, e.g., tomatoes, roses, or bananas and in some cases, cotton). They complain that "the simplest principles of accounting . . . have not been applied." Key food crops do not pay the costs. "Water supply decisions have largely been made in the political arena rather than in the market place and this to exploit public romanticism for making the deserts bloom."

Yet, man has carelessly gone out and recommended to an impoverished world removing the constraints of water through this device. This is one of the two major reasons the green revolution is in jeopardy; the other is the energy demands for fertilizers, both in manufacturing as well as in the long-distance hauling over land and sea.

The alternative of acquiring irrigation water by removing salt from ocean water is still further removed from any economic reality. Besides, the energy requirements of extensive desalination are backbreaking. Under reasonable assumptions the removal of salt from enough sea water to grow one average man's subsistence crops would require as much energy as he on the average now uses for everything. This is not taking into consideration the excessive amounts of capital and raw materials. Furthermore, this is not taking into account the pumping around nor the costs of disposing of the salt wastes.

This is particularly relevant to feeding the poor and hungry world. The uneven use of energy is in itself crucial, but in effect we have created both fisheries and an agriculture so costly in capital, material input, and energy subsidies that they simply are beyond reach of the poor world. It has been far too little recognized that the success of the so-called green revolution to a decisive degree hinges upon the huge postwar investments in irrigation which came to completion and fruition at that juncture in time when the new high-yielding varieties were launched.

The Broader Scene

Such modern intense farming presents in many ways a complete contrast to that of primitive agriculture. What it has done to increase yields per hectare and more markedly by increasing yields per manhour (sometimes as much as 50- to 100-fold) has, however, been at the cost of large inputs of energy, primarily fuel and electricity. Some of this power flow is not

spent on the farm but far away in manufacturing chemicals, building tractors, 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 is focusing attention on the driving force of man's extra input of energy, which is by and large supplementing the prodigious free flow of sun energy. Oil pipelines, refineries, supertankers, tankcars, and gasol drums belong to this new indispensible 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 dominants, both in price structure and in energy demands.

As Table 5 indicates, we have evidently created a third sector which is persistently growing in pace with the congregation of humans. An unexpected 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 or pattern is feasible in less developed countries. Can that world allow itself the energy and resource feast 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 frivolity is stupendous.

In The Red

Most surprising is, however, the fact that when all energy inputs on the farm 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 hectare than the calories carried in the harvested soybeans; the amplitude according to various computations by this author is 2.35 to 3.5 times.

Table 5
Kilograms of Coal Equivalent per Capita

	Primary Energy in Food	Energy Used on the Farm	Energy Used in Processing and Marketing
USA	640	1010*	652*
Australia†	580	90	490

* Transportation frequently exceeds half of this total.
† Calculated from Reference 3.

TABLE 6
ENERGY BALANCE PER HECTARE FOR CORN 1969–1971 IN THE UNITED STATES

	kcal × 10^6
(1) PRODUCTION	
Yield in the field	14.3
Processing loss (15%)	2.1
Available for consumption	12.1
(2) USE	
Feeding animals (74%)	9.0
Human food (26%)	3.2
Human consumption of animal products (14%)	1.3
Net kilocalories for human consumption	4.5

GROSS RETURN (Field production)

$$\frac{\text{Field yield } 14.3 \times 10^6 \text{ kcal}}{\text{Fuel requirement } 6.34 \times 10^5 \text{ kcal}} = 2.3$$

Additional energy input as fuel for production of food	liters
Fertilizers/manufacture	592
Farm operations	liters
Plowing	21.2
Disking (twice)	12.0
Planting	4.4
Cultivating (twice)	11.5
Harvesting	16.0
	66.1
Total	658

3.7 persons fed/hectare corn to meet caloric (not protein) requirements. Thus net energy per person is 1.2×10^6 kcal

1 liter gasoline = 9.6×10^3 kcal 658 liters fuel equivalent to 6.34×10^6 kcal

NET RETURN (human consumption)

$$\frac{\text{Net food energy } 4.5 \times 10^5 \text{ kcal}}{\text{Fuel requirement } 6.34 \times 10^5 \text{ kcal}} = 0.71$$

Corn has been researched in this regard[7] 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).

If the energy input via spray chemicals and for the drying of the harvested crop is added, the energy requirements increase by 0.20×10^6 kcal. This renders a final ratio of 2.2 and 0.69, respectively.

The net return obviously would be higher if 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.[4] This is a calorie ratio of 41 (172×10^3 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 has been cited as an example of similar energy inconsistencies, as each whaler brought home in oil only ⅛ to 1/12 of the total amount of fuel used by the ship. Besides oil, the whaler 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 35 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 genetical engineering), (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 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. 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.[5]

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. Tilling practices need readjustment to these goals. More perennial crops may be another logical response. 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 so 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.[3]

This ties in with a whole range of questions centering around manure disposal and sewage utilization. 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

TABLE 6
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1 liter gasoline = 9.6×10^3 kcal 658 liters fuel equivalent to 6.34×10^6 kcal

NET RETURN (human consumption)

$$\frac{\text{Net food energy } 4.5 \times 10^6 \text{ kcal}}{\text{Fuel requirement } 6.34 \times 10^5 \text{ kcal}} = 0.71$$

Corn has been researched in this regard[7] 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).

If the energy input via spray chemicals and for the drying of the harvested crop is added, the energy requirements increase by 0.20×10^6 kcal. This renders a final ratio of 2.2 and 0.69, respectively.

The net return obviously would be higher if 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.[4] This is a calorie ratio of 41 (172×10^3 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 has been cited as an example of similar energy inconsistencies, as each whaler brought home in oil only $\frac{1}{8}$ to $\frac{1}{12}$ of the total amount of fuel used by the ship. Besides oil, the whaler 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 worldwide and were to give the present world population a corresponding nutritional standard, this would require some 35 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 genetical engineering), (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 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. 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.[5]

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. Tilling practices need readjustment to these goals. More perennial crops may be another logical response. 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 so 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.[3]

This ties in with a whole range of questions centering around manure disposal and sewage utilization. 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

quadruple. Percent increases in such inputs as fertilizers, pesticides, and power exceed the corresponding gains in yield by 2.5 to 3 times. In other words, intensification of agriculture has to be achieved by taking entirely new approaches, reversing this present trend.

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

I. 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 1963 estimated that during the period 1957–1959 300 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

* This paper was written early in 1974; since then many of the world modelling projects mentioned in this paper have undergone considerable modification. We would like to emphasize that the views of the authors are relevant only to the state of the models in February 1974.

† Thirty-ninth Study Seminar; Food and Nutrition: Planning Policies and Programmes, Institute of Development Studies, University of Sussex.

supplies 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 that due to rising wealth, which leads to the basic economic theorem of aggregate *supply* planning.

$$\begin{aligned}\text{Required supply increase} &= \text{Increase in demand}\\ &= \text{Increase in population} \times \text{basic per capita needs} + \text{Population} \times (\text{Increase in per capita income} \times \text{elasticity of demand})\end{aligned} \quad (1)$$

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 225 percent over the period 1965–2000.

This approach has a number of basic assumptions; these may be presented thus:

Assumption 1: Economic *demand* = human *needs*

Assumption 2: Adequate food supply ⊃ 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 symptom 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 nutrition experts was with the aggregate deficiency of the suitable protein *supply* in the poor world. As recently as 1972 Georg Borgstrom was able to say "The phenomenon of world malnutrition is, however, to a major degree due to a shortage of protein." [4]

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 in poor countries have now become theoretically adequate, with the subsequent disappearance of the "gap." TABLE 1 shows the dimensions of the changes. With these new figures, nutritionists such as Prof. Len Joy are able to state with confidence that, "People whose calorie intakes are adequate are not generally to be found suffering from protein deficiencies." [5]

TABLE 1
RECOMMENDED "SAFE" LEVELS OF PROTEIN INTAKE
(G/KG BODY WEIGHT/DAY)

	Adult	18-Month-Old Child
1950	2½	3½
1973	½	1½

The disappearance of the "protein gap" was largely caused by a revaluation 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 nutrient composition of much food is also satisfactory nutritionists have been forced to 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

$$\text{Required supply} = \text{Population} \times \text{"safe" quantity of nutrient}$$

The "safe" quantity (S) may be calculated by taking the mean requirement (R) and adding 2 × standard deviation of the distribution to provide 97 percent adequacy (FIGURE 1, top graph). Thus, already agricultural planners will plan to produce well in excess of *theoretical needs*. The Planner must now look at *actual* intake distribution; this is usually represented by a *skew* distribution (whether the population sample is the world, a nation, or an area) (FIGURE 1, 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*‡ patterns, 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 consume. In a money economy this is related directly to *income* whereas in a subsistence economy it reflects the ability of a peasant to *produce* food. Thus, when we refer to altering demand, we mean raising *incomes* and improving the capacity of the subsistence farmer to grow food.

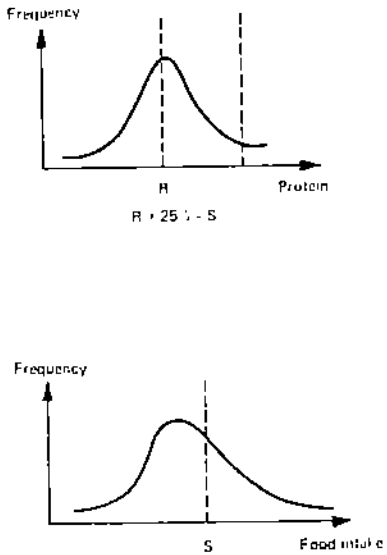

FIGURE 1.

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[6] has calculated that the application of this logic to Maharastra would require a target for 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. Joy:

> 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 supranational 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 $\neq$ DEMAND (3). The inequality being produced by the dichotomy between physiological requirements and economic and cultural barriers to the fulfilment 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 realization 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 @ 70 grms per capita, the total availability is also more than twice the requirement.[7]

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[8] comes to the conclusion that whereas undeniable short-term increases in wheat and rice production have occurred in India since 1967, the wretched social and nutritional condition of the Indian peasantry has further deteriorated owing to the implementation of the "high yield varieties." Landowners with easy access to capital in areas with irrigation have greatly benefitted. 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 93 percent in spite of an increase in agricultural production of 66 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 skew distribution of consumption. The following four features of the world trade in food indicate the extent of the inequality of the present world system:[9]

(1) Nine-tenths 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 revolution, 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, Maharastra. 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 coupled with a rise in overall affluence, 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 maldistribution 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 superstructural changes is similar to that required for the alteration of the political realities.

However, such alteration of superstructural 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.

§ Reflected in some of the following legislation affecting food consumption.
Indirect—Progressive income taxation, death duties, corporation taxes.
Semidirect—Old age pensions, family allowances, maternity benefit.
Direct—Subsidized school meals, factory canteens, free infant milk, orange juice, cod liver oil, vitamin tablets.
Affecting quality of food—Weights and measures acts, public health inspectorate.

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 inegalitarian 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. The first 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.

It is within this content—that of *very slow* 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 doubled 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 *in 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.[10]

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 planned to match *desired* patterns of consumption while nutrition plans ensure that *need* is translated into effective demand. Unless it *is* so translated then 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 a recent impetus by the work of Meadows.[11] For a fuller description of sys-

tems analysis, the systems approach, and the recent crop of world models, to which we shall refer briefly here, see Clark *et al.*[12] 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, pollution, 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 criticized within this context by Marstrand and Pavitt[1] 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

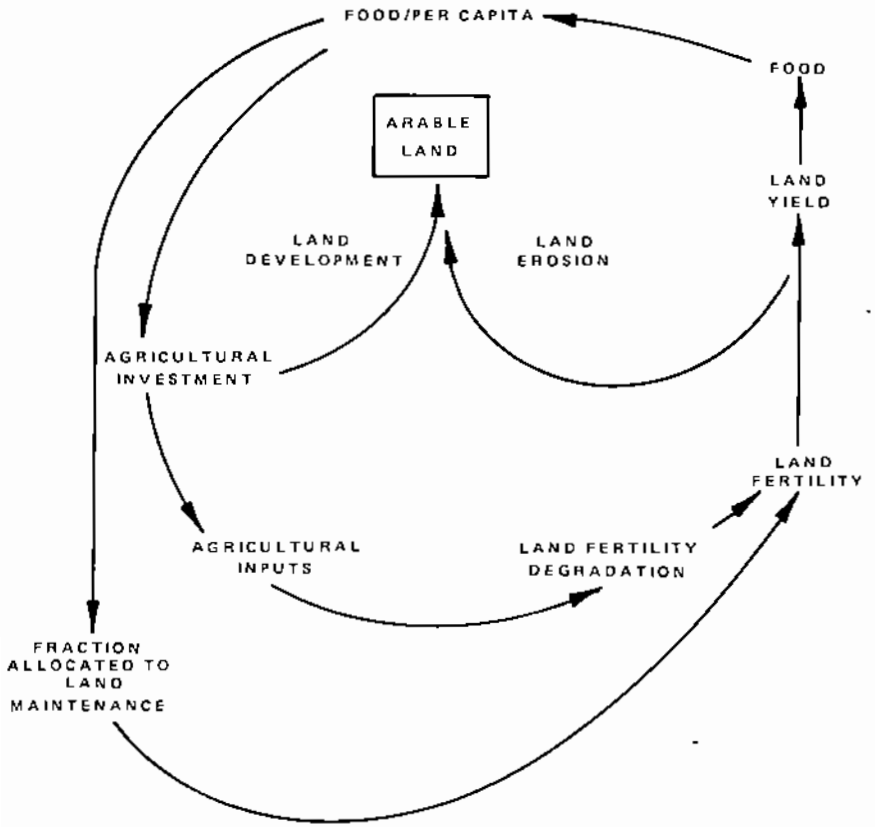

FIGURE 2. Meadows agricultural system.

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 totally 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 *inequitable* 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 *not* 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 shortages 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 begun to eat less due 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.[13] 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 Bariloche model[14] 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 Bariloche subsystem is divided into three subsectors: agriculture, livestock production, and fishery. Demand in the model is stimulated by a "basic needs" function, but prices are not considered explicitly. Again the model is supply orientated 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 American could feed its population adequately, without external dependence, within a fairly short space of time. The critical assumptions in

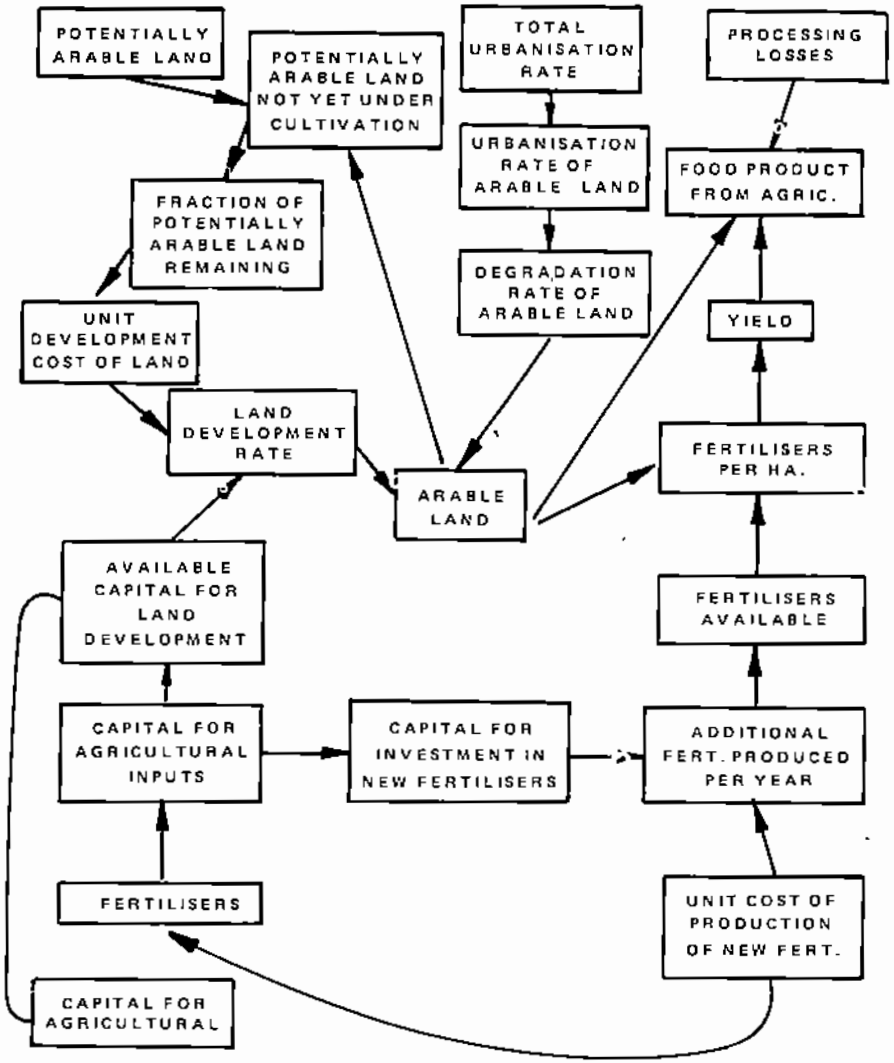

FIGURE 3. Bariloche agricultural system.

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.[15] 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.

Little information is available so far concerning the agricultural subsystem of the Mesarovic interactive world model.[16] A food production and arable 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 improvement in our view, over the models so far mentioned is the interactive implementation (see Hopkins[15] for a description of interactive computer simulation models). This allows small perturbations to be introduced and by an interactor 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 team's world model[18] the agricultural subsystem is 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.

B. 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 1960's is given by Borgstrom.[4] Typical problem areas which could have widespread effects are discussed. For example, in the chapter entitled "Japan—The Time Bomb" Borgstrom 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 (10 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.

Oury[19] of 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,[20] prepared with two main objectives: to assess the potential increase in the 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.[21] The study, which covers both the developed and less developed countries, examines the implications of two separate assumptions regarding the pace of economic development: a pessimistic one, implying no improvement on past 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 intakes would be near adequate control. Using their pessimistic assumption, the FAO estimated that per capita demand for food, held back by slower income growth, would not reach by 1985 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 those 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 "new" study was to select assumptions for growth rates of population and Gross Domestic Project 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 for the same commodities or groups of commodities for 1975. The fifth was to calculate the balance between production and domestic utilization in 1975 for the major agricultural commodities 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 98 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 function (log-log, semilog, 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 Oury[19] criticized their blanket adoption of the same methodology for all developed countries. Centrally planned economies probably depend more on policy and administrative measures than do market economies. Also demand projections of less developed countries based on aggregate national averages 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 in the main on historical trends of individual commodities, being supplemented by a review of national plans and of available economic projections made by various governments or institutions. It was admitted 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. This is what was attempted in the detailed regional studies made for the Indicative World Plan[21] 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.[22] In order to be compatible 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 faster 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 change from a net importer of agricultural products ($1.5 billion in 1963/3) to net exporters in 1975 and 1985 ($2.2 billions in 1975 and $3.3 billion in 1985). The content of the exports would in the main be grains, 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. Thus, 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 elasticities of demand. Data are derived from both OECD and FAO food balance sheets, which provide data on production, trade, and various utilizations of each commodity. Population was assumed to correspond to the "medium" assumptions on which the FAO projections were based.

Production projections were obtained assuming continuation of recent trends, under the general assumptions 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 account was also taken of increased use of fertilizers and effect on land use of reclamation schemes or increased urbanization.

The OECD work took more account of structure than the FAO and thus moved more toward a 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 attempt to explain relationships and should 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 its study of interrelationships. The traditional projections clearly take 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 unqualifiables 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 developments of models in western and eastern Europe appear to have been for different reasons. Some countries in western Europe were reacting to the failure of traditional forecasting techniques to predict the important changes in energy supply from 1958 onwards (substitution of oil for coal)—a failure which was intimately linked with the incapacity of extrapolations and isolated regressions to forecast breaks in the trend. Other western European countries found that even fairly sophisticated economic analysis failed to elucidate the effects of alternative policy measures.[23]

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.*[12]

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 Bachue model[24] models income 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 malnourishment 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[25] is that supply is not modeled, although it is soon to be added;[26] thus, 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, initially 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 population is treated as an endogenous variable, the Bachue 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 supply model could be based on the Bariloche work mentioned earlier, although the specific objections of Marstrand and Pavitt[1] 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 reform or increased aid flows could be evaluated using reduction of inequality as a criterion of effectiveness.

The model would thus contribute both to our understanding of the dynamics 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.

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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 reside in high-rise government housing built in the last 4 years, 14- to 24-story 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 500 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 9800 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, 99 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 Pruit-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 despoiling of their city's endowment of visual richness, architectural heritage, and natural beauty of landscape, 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, Paris, 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 cities' 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 or 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 a 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 communication 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 interactions by drawing upon all the interdisciplinary professionals involved—the urban planners, architects, 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 matters, 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 focussing on the following areas.

History and Philosophy of Tall Buildings

The first element in a systems 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 Meister," 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, Soleri, with his supercities or "arcologies."

These committees will seek, philosophically, to determine what are the motivations for the high-rise. Are they in the desire to satisfy a primevil 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, et cetera) 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 bring form and order 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 Fourastié[2] calls "la société de l'homme moyen riche," and to 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." [3] Thus, it is expected that the committees would 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 for the future. The excellent recent account by Winston Weisman,[4] 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 useage, 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 broad in 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 Hans Aregger and Otto Glaus.[2] 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 heights, 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 framework 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.

Psychophysiological 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 Sociopsychological 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 crowding (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.[5, 6]

Political and Organizational Ecology

The initial plan for this project somewhat purposely avoided the single, overriding, and most important of 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 these 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 enliven 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[7] 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-

grams." American cities, for example, while once characterized by a power structure or power elite which was monolithic (dominated by ward politics), are now rapidly becoming polylithic or dispersed in their political decision processes and as a result are facing serious problems in reaching consensus on major problems. Perhaps what is being said here is that this committee's members are being urged to submit comments on what an engineer might call the "efficiency" of the delivery systems of big city governments in performing their functions.

This may be illustrated by some examples in relation to tall building planning. First, there was a recent announcement of a move to impose building height restrictions in our national capital, Washington. Yet, in another important capital of the world, Moscow,[8] they are carefully moving from a second phase of tall building projects characterized by those high-rise buildings on Kalinin Avenue, including the CMEA Building, and the buildings of the National Hotel "gydroproyect," to a third phase in which the siting of tall buildings is being coordinated directly with the scheme of the central area of the city and with the centers of the seven planning zones surrounding the heart of the city.

The classic example of political interaction, of course, has been our own famed city of San Francisco, which has had a long history of respect for environment and for the preservation of urban values. Just as in 1966 they initiated the "Freeway Revolt," which halted construction of the double-decked Embarcadero Freeway, so in 1971 they provided their "High-Rise Building Revolt." Although it lost at the polls, it did result in the formulation of a rather remarkable document, "The Urban Design Plan for San Francisco." [9] This Plan may well represent a universal model of how all planning for height and bulk of buildings should be set up in order best to meet the needs of each individual city in the future.

Of greater importance, a consideration of such situations with respect to the political and organizational ecology of cities will lead to new political awareness on the part of our designers, many of whom are disconcerted by political issues. This is not unexpected, for it has been pointed out[10] that politics and design frequently have comparative qualities which are diametrically opposed to each other, as follows:

Politics	*Design*
Pragmatic	Idealistic
Emotional	Rational
Short-term	Long-term
Chaotic	Orderly
Power-oriented	Professional

External Transportation and Parking

Two committees will be dealing with consideration of all modes of transportation—auto, bus, rapid transit, PRT (personal rapid transit), and pedestrian—bringing the occupants to the tall building. New technologies will be treated, as well as nontechnical solutions, such as staggered working hours and the reduction of peak traffic demands. The effects of

environmental controls will be considered, as well as delivery, services, such as goods and materials, via pneumatic devices, containerization, 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"), sun 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[11] 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.

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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. Thus, 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 rises 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 adaptation 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 so 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

accident every 11 minutes and that, during the same year, 220 million working hours were lost through industrial accidents. The United States reported that 800 miners, on the average, were killed in that country every year. Despite all the technical progress made, occupational safety and health is still a very real concern.

I do not want to deal at length on the efforts made by ILO to prevent accidents and protect workers' health at their places of work. Let me just mention that out of the 238 conventions elaborated by the organization and adopted by the International Labor Conference between 1919 and 1973, 56 conventions deal, directly or indirectly, with health and safety matters. Some of these texts hold good for all occupations; others are for specified trades only including the most highly developed industries. One of the latter is the convention adopted in 1960 to protect workers against ionizing radiations, which is a matter of vital importance in the nuclear age and at a time when workers are subjected to dangerous radiations through the increasing use of x-rays for quality checking.

The Model Code of Safety Regulations for Industrial Establishments for the guidance of governments and industry contains more than two hundred series of safety rules, which are continually changed to keep abreast of technical developments. A new edition of the encyclopedia *Occupations and Health* was issued in 1972. These volumes and many others issued by the ILO are used every day by labor inspectors, by doctors, and by engineers in industrial undertakings.

For the last 10 years an Occupational Safety and Information Health Center has been operating under the auspices of the ILO. Its task is to provide up-to-date, full and systematic information about developments which should be brought to the attention of all those who are interested in preventing occupational accidents and disease.

The concept of the working environment as an integral part of the general human environment is relatively recent. However, in fact, many of the environmental pollutants originate at the workplace and the techniques to control and eliminate them are originally developed at the workplace. Likewise, the medical knowledge on the etiology and therapy of environmental diseases is often derived from occupational medicine. Thus, 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 the global environment problems.

The importance of the involvement of the ILO in an interdisciplinary environment program resides in the fact that it is the international organization which, by virtue of its tripartite structure, has a special mandate to bring to the fore the social considerations involved in the work of ecologists and government planners.

Economic resources will have to be diverted from production to the preservation of natural resources. This will affect production costs, employment opportunities, and development of economy as a whole and in particular in the polluting sectors.

These social costs are known to occur, but so far insufficient attention has

been given to the means of balancing the costs and benefits of environmental protection or to the way of meeting such costs without upsetting social and 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 improvement and economic development are reconciled. Measures to mitigate the possible adverse effects of environmental measures, including measures for reconversion of industry and manpower, should be planned from the outset as an integral part of the approach to the protection of 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 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 settlements, i.e., the distribution of populations between rural and urban settlements 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 areas in which the ILO is engaged through the World Employment Program launched in 1969.

The socioeconomic 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 at the place where people spend a large part of their daily life and where the impact of scientific progress becomes the most perceptible for them. Prevention is quite a broad domain, including medical, physiological, psychological, and technical aspects. This is why, personally, 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.

E. Energy

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 Pharoahs, 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 at 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 exhaustible 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.

Therefore, it is against a background of rapid and momentous change and sweeping claim and counterclaim that I attempt in this paper to develop a framework in which to consider energy policy from a global perspective, focusing on the political and institutional issues and alternatives. The paper covers a vast, complex, and amorphous subject matter in a very tentative way. Its main purpose is to stimulate thinking about energy issues in ways that will help us to transcend our particular interests.

World Energy Context

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 enterprise.

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, resurgent nationalism in Western Europe successfully resisted the emergence on that continent of strong supranational institutions.

Concurrently with the development of nationalism, large private corporations renewed 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 postwar 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, typified by the oil companies, may have appeared to host governments to be the agents of Western economic imperialism. However, the same 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, contradictions between political nationalism and multinational economic enterprise 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

overthrow 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—pursued 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 crash 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. Thus a 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 few 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 unhindered 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 concessions in resource-rich areas were relatively easy to obtain and revenues to the host government were kept low. Governments generally encouraged the large private multinational oil companies in their far flung operations through a variety of tax benefits. The communist countries were the only major area from which the multinational oil companies were excluded in their global search for low cost oil.

Throughout most of this period it was a buyer's market. The main problem was to avoid a glut. The Texas Railroad Commission played a leading role in controlling the enormous surplus production capacity in the United States, while the international oil companies themselves, acting through a series of overlapping joint ventures, were able for the most part to manage worldwide production rates so as to avoid chronic oversupply.

Abundant oil at low prices facilitated the rapid recovery of Western Europe and Japan from the devastation of World War II, followed by their achievement of very high standards of living. Consumers generally responded to the price signals they were receiving by adopting energy-intensive technologies. Energy conservation measures were, in short, uneconomical.

The declining costs of cheap oil and gas relative to other essential commodities generated exponential growth rates in demands throughout the world. The growth rates experienced in European countries exceeded that in the United States, although the United States entered the post-World War II era from a much higher consumption level. High growth rates resulted eventually in a very high aggregate demand and, because prices continued to remain quite stable, the high growth rate continued to apply, requiring enormous additional supplies to balance demands.

Well over half the known low cost oil reserves are in the countries of the Middle East that surround the Persian Gulf. If the world community had continued to consume its energy resource base in an economically rational way, the low cost oil would have been drained from even the immense Persian Gulf reserves in a short time.

Several factors prevented this from happening. First, a large enough fraction of the low cost petroleum reserves were concentrated in few enough places to make the monopolization of crude oil production a distinct possibility. Second, the governments of producing countries, strengthened by nationalism, became able to reclaim sovereignty over their natural resources. Indeed, nationalization of foreign-owned oil concessions and production facilities became a major way for governments to enhance their political stature and popularity at home. Third, the continuing Arab-Israeli conflict eventually galvanized those Arab nations that were oil rich and sparsely populated to bring the oil weapon to bear in the conflict. And, fourth, military adventures by American or European forces aimed at recapturing cheap energy were deterred, perhaps more by the risk of war with the Soviet Union than by the capabilities of the indigenous national governments to resist. (It is ironic that the power of the Middle Eastern monarchs, who view communism as their archenemy, may in fact be substantially enhanced by the constraints that Soviet military power places on possible coercive actions against them by the Western countries.)

In any event, OPEC was conceived in the mid-1960's and, after a difficult

period of gestation, emerged in the world arena as a major political and economic actor. Led by its Arab members, OPEC rapidly closed the post-World War II era of cheap fossil energy by political actions. The consensus on which those actions rest is tenuous, however, and it remains to be seen whether the high prices OPEC is currently charging for its low cost crude oil can be maintained in the face of multiple tensions within the cartel and growing pressures exerted on it from the outside.

The second major characteristic of the world energy context in the post-World War II decades has been the conversion of energy resources into increasingly refined forms for consumption. The trend of major significance on a global scale in this regard has been electrification. The consumer preference for energy in the form of electricity seems pervasive, except in the transportation sector (even there, modern mass transit systems are electrified). The growth of central station power generation and the development of long distance transmission networks made electricity available in many regions at prices competitive with prices for fossil fuels for many end uses of energy. Where prices were competitive, electricity would generally be preferred over fossil energy, since it was clean and instantly available at the point of consumption.

Electric power consumption grew in most countries at roughly twice the rate of energy consumption as a whole. Thus an increasing fraction of the energy used in the world was consumed as electricity, and an increasing fraction of the world's energy raw materials were consumed in generation of electric power. The trend toward electrification is not likely to abate in the near future. Indeed, the increased physical scarcity of oil and gas (apart from the politically created scarcity), the environmental as well as economic costs of converting solid hydrocarbons into liquids or gases for consumption, and the availability of nuclear fuels and technology for power production may accelerate worldwide electrification, even though overall energy growth rates may slow.

The third salient characteristic of the world energy context in the post-World War II years has been the realization of economies of scale. This trend had prevailed by and large throughout all sectors of the energy industry. In a few decades, the capacity of crude oil tankers has been increased from tens of thousands to hundreds of thousands of tons, the diameter of natural gas pipelines have increased several-fold, and the capacity of electric power generators has increased from 100 to over 1000 MW. Technological development made possible economies of scale, resulting in lower unit costs for the energy output. Lower costs in turn spurred growth in demand. High growth rates on top of large aggregate demands made possible even larger scales incorporating further technological improvements. The progressive realization of economies of scale was thus in large measure responsible for diminishing the significance of distance between producing and consuming regions and for the prolonged decline in real energy prices worldwide during the cheap energy era.

The political implications of economies of scale in the energy industry are profound. It has been widely noted that the development of supertankers

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 dispersed, yet intimately interrelated facilities involved in a large-scale fuel cycle, require highly centralized managerial control if they are to be operated efficiently.

In contradiction 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 ones. In addition, large-scale energy technology, implying a relatively few very large facilities, injects into location decisions a high political and strategic content. 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, technologically 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 national territory the strategic facility were 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 stockpiling in advance of needs, 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 Atoms for Peace plan in 1953 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 for the development of civilian nuclear power under pervasive 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 moneys 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 operate on a global scale through a complex network of affiliates and licensees.

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 fossil fuel exhaustion, although these 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 competion 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 increases and substantial increases in other fossil fuels prices.

In any event, the economic feasibility of nuclear power rests on two major factors: fossil fuel costs that are high compared with those 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 capacities. In general, the advent of nuclear power would seem to reinforce most of the major existing trends in the world energy context, including electrification and economies of scale.

While the worldwide oil industry was politicized only quite recently, the nuclear power industry was politicized from the start. For various reasons, 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 counter-claim, action and reaction, whereby 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 fact that governments of both producer and consumer countries have acted to restrict the

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 importing, 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 supplier of uranium enrichment services. As another example, Canada is, on a nationwide 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 totaly dependent on oil imports from the Middle East. As a third example, the Sheikdom of Kuwait, a small sparsely populated patch of desert stretched on top of an immense oil reservoir, 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 planet into the Free World and the Communist Bloc. Until recently, the Soviet Union and East European countries developed their energy resources and economies 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, Euorpean, 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 matter 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 impulse 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 bereft of indigenous energy resources. Japan and Denmark come to mind in this regard.

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 to an extent 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 abetted by outside communists.

Just as domestic political factors condition energy development and production policies in 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 luxuries to be enjoyed in times of economic growth and abundant energy supplies, or whether such institutions can also deal effectively with conditions of chronic scarcity requiring stringent rationing and conservation.

Thus, the energy postures 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 ones of primary interest at present—may be assessed with reference to energy 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 user may be hurt less by a partial supply interruption than the efficient user.) 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 intergovernmental 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.

Energy Policy Goals and Criteria

It is clear that the world community is far from agreement on a meaningful goal or goals for a global energy policy, and even farther from agreement on the content of such a policy. Indeed, most governments have not yet formulated, much less implemented, coherent national energy policies. The general correlation between growth in energy consumption and growth in gross national product has been meticulously measured and usually admired, but even that relationship remains to be explained fully. Indeed, the gradually diminishing energy/GNP ratio that prevailed in most affluent, industrially advanced countries appears to have reversed in the late 1960's.

Perhaps the major factor preventing agreement on energy goals is the profound asymmetries in the energy postures of the actors in the world arena. Differences between states in their factual energy circumstances seem at least as important as differences between them in internal political or economic institutions. With these reservations in mind, the problem of formulating world energy policy goals may be approached.

In addressing the Special Session of the United Nations General Assembly on raw materials and development on April 15, 1974, Secretary of State Kissinger declared a common goal of the world community to be "abundant energy at reasonable cost." It is hard to disagree with such a statement. It is natural for societies, regardless of their political, economic, and cultural circumstances, to seek ample supplies of energy at low costs, just as all persons want plenty of food for themselves and their families at prices they can afford. The tragic fact is that a diminishing fraction of the world's population has enough of either essential commodity.

Without departing too much from the thrust of Dr. Kissinger's formulation, our common goal might be restated more concretely, more modestly, and yet more provocatively as: *assured supplies of sufficient energy at equitable prices with acceptable environmental consequences.*

The term "assured supplies" evokes two thoughts: security against intentional interruptions and reliability against accidental interruptions. The first has political and the second primarily technical implications. Both, of course, usually result in higher economic costs.

Perhaps settling for "sufficient," rather than pressing for "abundant," energy supplies implies too large a shortfall from common aspirations for the common goal I have postulated to be widely accepted. Certainly, in representing the United States, which consumes twice as much energy per capita as Europe and 30 times as much per capita as Africa, Secretary Kissinger was well advised to speak in terms of abundant energy as a worldwide goal since most people would think that half the energy used per capita in the United States was an overabundance for them. However, from a global perspective, it may be desirable in the long run to push for a concept of sufficiency in planning levels of energy production and consumption, as well as in levels of strategic armaments.

Two reasons prompted me to change "reasonable cost" in the Kissinger formula to "equitable prices." First, the world's energy difficulty in the short run arises from the exhorbitant 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 distributional justice. Hence, in allocating 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 departure 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 crash 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 satiation 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 appear to tilt toward consumer 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 also that 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 specified energy policy goals, to provide a means to evaluate the extrinsic impact of proposals and actions in the energy field

on other important values and sectors of activity, and generally, to provide standards whereby conduct may be judged uniformly and with some degree of objectivity.

For example, certain areas where criteria need to be developed are implicit in the tentative formulation of an overall world energy policy goal I suggested above. They are "sufficiency" with respect to the aggregate amounts of energy available, "equity" with respect to price and distribution in general, "assurance" or security with respect to relationships, and transactions and "acceptability" with regard to environmental effects. Sufficiency and equity criteria would provide basic measures of the internal performance of energy policy, whereas security and environmental acceptability of the internal performance of energy policy would measure external impacts. None of these concepts is concrete enough to constitute a meaningful criterion in itself. These words, or similar ones, are, however, useful points of departure for the development of law or rules of conduct in the energy field.

I will illustrate by indicating briefly the direction in which the debate might move if "security" were adopted as a point of departure for the development of specific criteria. With respect to security we may begin with the contrasting ideas of self-sufficiency and interdependence. Despite their frequent use in international and national rhetoric, what these terms mean in the energy field remains unclear.

To some, energy self-sufficiency means actual and exclusive reliance on domestic energy resources. To others, it may mean the potential to rely indefinitely on domestic resources after some transition period, and to still others, the capability to rely exclusively on domestic resources for a limited period of time. Complete self-sufficiency would amount to a self-imposed embargo on energy imports in order to assure that an embargo could not be externally imposed. In some national circumstances, such self-sufficiency may seem to be derived from a rational desire to develop more self-reliance economically and politically, while in other cases it would appear to be prompted by some kind of national masochism. The capability for energy self-sufficiency, after a period of time, may be useful in slowly deteriorating political circumstances but of little value in a world where political action can result in rapid changes in world energy flows. The capability to be self-sufficient for a period of time, in the event of supply interruptions, would seem to be a reasonable national energy posture, although the costs of maintaining adequate stockpiles of the required primary fuels may be quite high. It may be noted, however, that as energy consumption grows, stockpiles would have to grow proportionately for such a policy stance to maintain its effectiveness. In any event, energy self-sufficiency as a security measure would in most circumstances involve substantial economic and environmental penalties for the country concerned.

It would seem that even in security terms the pursuit of energy self-sufficiency may be counterproductive in some circumstances. One example would be a nation without nuclear weapons that, at great cost, developed a self-contained nuclear power program. Such a civilian nuclear power

posture may appear to be a security threat to neighboring countries without 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 energy 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 encircle the globe with complex production, transportation, processing conversion, and distribution networks. No nation involved 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 unreal. 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 goal and criteria long enough for us to understand that each term begs a variety of questions and masks 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 communicating 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 statement 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 strategic options: (1) restore cheap oil; (2) develop higher cost fossil fuel resources; (3) accelerate fission power; and (4) limit energy demand.

To illustrate the opportunities and constraints in the current stategic 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 elsewhere. 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 fission power in the previous decades. However, this did not happen.

All four strategic options specified above are interrelated. Furthermore, they can be pursued in ways that will either conflict with or complement the others. Thus, development of higher cost fossil energy resources or limiting energy demand may induce a drop in oil prices. Alternatively, continued high revenues may be realized on cheap 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 concert 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 assert that an indirect attack on the producers' cartel would be more effective, namely, disintegrating 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 rate, nationalization, and conditions for future foreign investment.

If economically efficient oil prices were reestablished, 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.

Of the $7.10 per barrel it currently costs 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 energy 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 vast 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 cheap 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 regions, 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 nonfossil resources such as fusion 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 establishes 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 Fission Power

The acceleration of fission 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 fission power in view of the unresolved certainties 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-

mand for electric power. Rather, they are intrinsic to the nuclear industry and the materials and technology it involves.

The operational safety of nuclear power plants has been an area of concern from the beginning. There are, however, larger uncertainties and major unresolved problems, especially when fission power is viewed on a global scale over a long period of time.

One problem area relates to disposal of radioactive wastes. So far in human history, the debris of previous civilizations that perished long ago has been innocuous when encountered by later civilizations. Indeed, without the debris of earlier civilizations, mankind would be largely without its history. When a civilization based on fission power perishes, it will leave behind radioactive wastes that will be deadly for hundreds of thousands of years to any living matter that might touch it. Radioactive waste is indeed a problem that transcends all national and cultural differences and spans the centuries ahead. Any solution involves much more than technology.

A second major problem relates to abuse of the fuel materials—plutonium, high-enriched uranium, or uranium-233—that are used in fission power. Tens of thousands and eventually millions of kilograms of these materials will be present in nuclear industrial facilities dispersed thoughout the world. Simple nuclear weapons are not technically difficult to make. Only a few kilograms of any of these materials is enough to make a nuclear explosive capable of mass destruction and only a few grams of plutonium is enough for a deadly radiological threat.

If we accelerate the use of fission power, we do so in a violent world. The possibilities for nuclear violence will soon multiply and diffuse throughout the world. Effective safeguards to prevent such violence remain to be developed.

Finally, we should note that fission power as a long run energy option depends on the successful development of breeder reactors based on uranium or thorium conversion. Otherwise, low cost uranium resources would be exhausted in a few decades and higher cost uranium and thorium resources would be depleted in the twenty-first century. Breeder reactors would stretch the viability of the fission option to thousands of years, but a commercial breeder reactor has not yet been developed. If we accelerate nuclear power we, nevertheless, commit ourselves even more deeply and irreversibly to breeder technology. The problems of operational safety and safeguards against diversion or theft associated with the breeder reactor are even more difficult to solve than those raised by the present generation of fission power reactors.

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 imports, and reduce environmental side-effects. 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 harder time limiting demand than more authoritarian forms of government. Indeed, it remains to be seen whether parliamentary 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 consuming 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 profligate 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 obstructions 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 stabilize energy relationships is worldwide, long term, and urgent. Thus, a priority 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.

PART II: POLICY MEMORANDA FROM WORKING GROUPS

THEORY AND RECOMMENDATIONS: GROUP REPORT 1

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This memorandum, which has been drafted under great pressure by one of us and discussed only for a very limited time, does not reflect the full range of our discussion or the full divergence of our views and attitudes. We are content, however, that it should go forward as the best expression of our joint views that we could produce in the time available. It is subject to any qualifications or additions that we may individually wish to make.

Our terms of reference are very wide, and we have arranged our response in three sections. The first deals with the intellectual framework within which we have approached our task and which has engaged much of our discussion. The second contains our general recommendations on three areas of concern. The third contains our views on the role of the intellectual community in the ongoing process in which this conference should be one of many interacting parts.

There is no comprehensive accepted theory that accounts for the process called human history or defines the nature and extent of the role played therein by human initiative or the ways in which human standards of judgment are formed and changed. We know a lot about this process from our interpretation of event and experience. The social sciences clarify and reinforce this knowledge in varying degrees in their various fields. Hypotheses multiply and conflict. We think we can best contribute to this area by describing what seem to us to be its most important characteristics.

Since our conference prospectus requires us to adopt a problem-oriented perspective, we need to define a problem; for problems are not data but artifacts of concerned human minds. We regard as problematic any field of actual or prospective event that implies some promise or threat and invites enquiry to discern whether some change that is within human control would be likely to make its outcome more acceptable.

This definition has several implications that we think are useful to express, since they mark a difference between problems of the kind we are considering and most technological problems. (1) Not all human problems, when analyzed, are found to have acceptable solutions, attainable by acceptable and feasible means. (2) Problems involving the abatement of threats are often different from those involving the realization of promise, although for convenience we will adopt the common (but we think fallacious) practice of subsuming the first under the second. (3) "Changes under human control" include changes in the way problematic situations are perceived and in the criteria by which they and our hypothetical interventions are judged no less than changes produced in the course of events.

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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 exercise 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 be 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 thus 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 imponderable. Some economists concerned with welfare postulate 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 *developmental policy* and *environmental policy*. The de-

veloped nations have greatly increased their productions of wealth and their power to increase it still further and this has enriched virtually all classes of their citizens and improved the quality of their lives, individually and collectively. However, this system has involved an inequality of distribution so great that the needs of the poorest citizens have not yet been satisfied, despite extensive redistribution of wealth by political means. This inequality powers the demand for further development, and this development is reinforced by the self-exciting industrial system of the West, which has a built-in urge to grow. In some of the underdeveloped countries, the needs of the poorest are even more manifest and the case for development is even stronger.

On the other hand, development has already produced, in those places where it is most concentrated, serious pollution of earth, air, and water, depletion of nonregenerative materials, including fossil fuels, and a more than exponential growth of population. Whatever interpretation be put on these familiar facts, it is generally accepted that future development must have much closer regard to its environmental effects and that much of it needs to be directed to undoing the effects of past environmental waste, where this is possible, and to reducing, if not eliminating, it in the future.

We reject the idea that such conflicts are between different *kinds* of criteria—unless the value of development be costed solely in terms of costs and benefits to the developer. All our uses of natural resources are *developments of our environment*. Every such use has costs and benefits in many dimensions. All should be considered. Because damage to the environment, unless reflected in the costs of the developer, has been so often ignored, it is appropriate that special interests and institutions should emerge for the protection of the environment. We welcome, for example, the creation in the United States of the Environmental Protection Agency. However, we believe that a more positive attitude is needed. It should be the aim of all development to leave the environment "better" (as good farming does) or at least not "worse" than before.

Such conflicts are currently sharpened by debate about "limits to growth." We take different views about the importance and urgency of these threats. Dr. Maddox' paper, "The Question of Economic Growth in a Finite World," is a timely reminder that any global picture drawn basically in terms of physical limitations must fail to do justice to the political and social realities that define human problems in different societies and to the elasticity of political, social, and economic institutions. Even allowing for this, there is room for a wide variety of views and, more generally, mental climates in which views on this huge subject can be generated. We are, however, agreed that the most intractable of these threats in the long run may well be the need to stabilize the populations of the earth at a level and by means which will not deny to any of its inhabitants the basic conditions of human life. On the short term, however, owing to present numbers, trends, and distribution of population, the most urgent threat seems to us to be global and, still greater, regional shortages of food. Even this, however, 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 result 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 here 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 Tinbergen'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 imbalance 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 undeveloped 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 need most and have least to offer. We recognize, therefore, a need to supplement the market by transfers of more or less unrequired 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 resorted 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 extremes of 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 contribute 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 state 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 are sociopolitical 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 penetration, 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 so 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 unrequited, 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 underdeveloped countries, labor intensive activities are likely to need fostering far 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, is controversial. Both invite a major shift 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, represented 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. Hitherto it has been commonly assumed that the poor can become relatively richer without denying some increase of incomes to the rich, merely be skewing the distribution of that part of the increase 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 2 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 the developed countries will have to take place in today's conditions by reductions in real terms of the larger incomes in favor of the lower ones. We do not think that this painful process can be safely or equitably left to the incidence 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 Tinbergen. We believe further that many other problems arising from inequality of human rights will be abated by reducing inequalities of incomes.

A final 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 shaping 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 continuous 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 1930's 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 1930's.

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 correct approach to some international decision-making in the trade field, was GATT, a mere negotiation 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 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 want to 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 articulate all the ideas which arose, 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 planetarium" 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" *

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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 snarled 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 enormous 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 phase 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 somehow 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 1.

sense of 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 name stood for, what it was contributing, what it had inherited of enduring promise, and what it had generated of frightening threat. All that would be true if there had been no Club of Rome, and although I personally 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 autonomous population issue, deserve thought now in the context of the manageable 50 hence years, it has also obscured 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 ancesters, 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

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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 accompanied 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 these 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 14 years. Although this growth has occurred throughout most of the world, it has not lessened 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 refineries built in recent years has been insufficient.

(2) Our growing awareness of the adverse environmental impact of fossil energy sources has introduced an additional impedence 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

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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 are certain that the exponential rise in energy consumption cannot 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 vast power blackouts and/or international conflicts over increasingly scarce supplies or transgressions 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 a level is approached that is adequate and not unacceptably below that of the largest 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 entire populations regard 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 99 percent. Recently the supplies of oil from the Middle East have been becoming 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 realistic, 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 that 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 alternative 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 in the past so cheap, we have become accustomed to using it very wastefully; if we examine where our energy has been going, much of it passes up the chimney, out 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 installation of adequate insulation, 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. Families 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 swallows over one-third of all the liquid fuel used. What king of old had to be pulled by 300 horses? Yet, that is what many motorists have become accustomed to. Both legislative and social incentives will be required in order to redress the present situation, but it is the very excesses of today 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 rather 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 deprive the less affluent of automobile ownership, but rather should transform energy and resource wastefulness into an expensive 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 accelerated.

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 of 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 "recycle" 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 total 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 remotely, 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 single 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 involuntarily 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 result from the 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 "burn" 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 amount 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 thermodynamic 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 possiblity of a criminal diversion of this source of plutonium for a 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 judicious 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 solved 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 precombustion sulfur removal, and on-line low-BTU gasification processes. Somewhat further into the future will be the possibility for direct liquifaction 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 principally 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 tea kettle," 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 Lardarello, Italy; in Geysers, California; and in Wairaki, 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 $\geqslant 150°C$, 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 waters. 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 subterranean water. Much research and development is required to solve these problems.

Hot dry rock at reasonable depths below the earth's surface represents a huge 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 this example: the power density of the solar influx, on the average, is about 250 W/m^2. 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 wide use in countries such as Australia, Israel, Japan, and South Africa. Systems for unit-building heating and cooling have, however, received only limited attention, and a high priority should be attached to research and development that would reduce the costs of this technology. The amount of energy savings possible in this sector is considerable, since heating and cooling consumes, for example, two-thirds of the residential/commercial energy use (or 14 percent of total energy use) in the United States. The prognosis for success is very good, especially since the costs of competitive fuels appears destined to continue to increase. Solar heating and cooling systems are more capital-intensive upon installation than present systems, although lifetime costs are likely to be lower than those of fossil systems 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 of electricity by solar energy, very little research has been done, and we urge that programs in this area be instituted without delay. The applicability of these systems is of course greatest in the arid regions, but it is also more general than is usually believed. Two basic techniques can be employed, solar thermal and photovoltaic. Solar thermal systems collect the sun's energy as heat, and use this heat to generate electricity via conventional methods. The heat may 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 as extreme unit costs of components required in large numbers and the high failure rates of existing materials to tolerate the extreme operating environments involved.

Photovoltaic systems are converters of the sun's quanta directly into electrical energy without using the heat-intermediate step. Photovoltaic systems, such as those employed in space applications, are far too expensive for terrestrial application, with cost per installed kilowatt as much as 500 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 solid-state properties of photovoltaic materials be accelerated so that low-cost direct conversion devices can eventually be constructed.

The development of bioconversion technologies represents another prom-

ising avenue for solar energy utilization. Organic biomass, such as wastes or organic materials specially grown, are converted to gaseous or liquid fuels or, alternatively, are burned directly for the energy content. The great advantage of these technologies is that they produce fuels such as petroleum and methane, which are in short supply. A possible side benefit of their development is an increase in food supplies. At present, although some of the bioconversion technologies are feasible, they have yet to be established as economical sources of energy. Some, such as the growth of algae in large ponds, may, however, have adverse environmental impacts, and these must also be studied.

Of the many other ways in which solar energy may be converted for practical use, we shall mention here one very promising example, that of producing hydrogen fuel by direct photolysis of water. It appears to be possible to use sunlight to drive a chemical reaction involving water to produce hydrogen by applying our knowledge of the natural process of photosynthesis and recreating synthetically some of the essential steps of nature's process. Research of this type is still in its infancy, but the potential impact of success is enormous, since hydrogen is a relatively nonpolluting fuel suitable both for electricity generation and for transportation and since water is both the source and the principal product of combustion in this case. This technology, should it be developed successfully, could provide mankind with much of his energy needs essentially forever.

Nuclear Fusion

Another new and essentially unlimited source of energy would result from the success of the effort to control the nuclear fusion reaction in light atoms, which is the source of the energy of our sun. The easiest and most energetic fusion reaction is that between the 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, artifically 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 amount 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 the element plutonium, which is both extremely toxic and dangerous from the point of view of possible diversion for clandestine purposes.

The conditions necessary to achieve controlled fusion are extremely difficult to fulfill. The most arduous problem is the confinement, away from any wall, of an extremely hot (more than 50 million degrees) gaseous mixture of hydrogen isotopes. To solve it, two different approaches have been followed, magnetic confinement and laser compression. A considerable research effort has been devoted to magnetic confinement; it is now based mostly on the "tokomak" device, first proposed by the Russian physicist Artzimovitch.

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 boilers 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 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 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.

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-tenth of that in Western Europe. Even if economic growth were to be slowed 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 eventually 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.

FOOD PRIORITIES*

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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 masterful feats belong 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 feed 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 channeled to direct human consumption (Soybean mixtures with cereals stands out as a prime avenue.) 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, oilseeds, 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 complete accounting is called for which evaluates our measures from a management standpoint, or 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 outtakes 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 worm'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 acreages. The flow of energy and raw materials must in a completely new

* Addendum to Group Report 2.

way be incorporated into everything connected with industry and transport economy.

We find ourselves on the threshold to mankind's most critical period. Our first and immediate task is to find our way back to reality and to organize viable action programs. We cannot allow ourselves to continue the current mad rush downhill, largely uncontrolled.

MANKIND, ITS NUMBERS, HEALTH, AND FAMILY ARRANGEMENTS: GROUP REPORT 3

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The interactions between population, health, and economic development are multifactorial and complex. In the broad perspectives 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 total economy and ecology of man and environment. Such dislocations are becoming increasingly recognized. Accelerated environmental deterioration and pollution, malnutrition, increased 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 humanitarianism 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 emergent 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

* Chairpersons.
† Rapporteur.

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 maldistribution have contributed to malnourishment and famine. Even at 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 been 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 increasing 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 not be tolerable 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 caloric of food energy produced by modern high technology agriculture, ⅔ to ¾ 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 fails 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. Inherent in many differing cultures is acceptance of the female as the nurturing force in the tribe, the race, or the national group. In part this is based on biology but in addition it is reflected in the almost universal drive recognized emotionally, if not intellectually, by educated as well as illiterate women that they complete their destiny as human beings if and when they are able to nurture, produce, suckle, caress, and love another human being. In another section of this volume a prominent contemporary psychiatrist, Dr. Lawrence Freedman, links the primal trauma of birth and the subsequent supportive care of the infant or 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 as 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 before the fetus is viable if preventive measures have been unavailable or failed; (4) making education available on 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) beginning recognition that equality of status and occupation between men and women may serve as a substitute in some measure for repeated childbearing; (7) revising and lessening the pronatalist 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 nationalistically 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.

Dealing with Complex Systems

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 resultants of subgroups of people showing differing, 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 magnitudes, 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 stepwise reparatory gestures, after the fact, and points at the symptom more often than the cause. In his evolution, survival value and some self-correcting stability (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 repairs. We must avoid the tendency merely to turn down the heat control when the house is already in the grip of a spreading fire.

Another innate limitation of human response is the self-protective habituation to a warning that remains peripheral. Just as the individual "learns to live with" a headache and even ignore 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 laws 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 human 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.

Balancing Liberty and Control

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 had 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 proposed recommendation, or especially a supranational one, as an intolerable 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 appreciation 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 imperatives 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 "processes" people—it can increase productivity, efficiency, and lower production costs if it can *process more of people* without increasing cost. To this degree technology can be alienating in some situations. For *quality of life* men and women must adjust to technology so that technology does not control them (even though technology is man-made). In this sense there is an apparent contest between man and technology, one feature of which will affect quality of life. Some difference will, and perhaps should, reside in individual initiative and in individual refusal to permit conditions of life to become unbearably dehumanizing.

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. Anglo ethics might reasonably be expected not to deal responsibly for *all* humanity. In such areas as this, unbiased agencies, starting without 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 disposition, quality of life, political stability, health, education, and welfare programs. Not recorded as easily visible, but of great importance, are *attitudes towards 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 train its own questions and answers. Survivors per 100,000 male live births from selected life tables for selected countries (India, Mexico, Japan, and New Zealand) show an increasing longevity from 1921–1974. The span of life has been lengthened, and age at death, as of 1974, commonly occurs by the ninth decade of life (90–100). Conceivably 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 variations through age groups from youth to senior citizens. Equally, rate of doubling populations, types of population, and zones of population are to be analyzed. Problems such as demands for

the statutory right to determine one's own death (euthanasia), abortio policies, and population limitation by social or political pressures are fore seen.‡ Techniques such as artificial insemination, sperm banks, genetic an enzyme analysis, amniotic fluid research, surrogate motherhood, controllin such characteristics as sex of offspring, and elimination of genetic defect by manipulative genetic techniques introduce new potentials that *societ must* confront. The *applications* of such techniques introduce a whol new imperative into the decision-making process.

Equally, such possibilities as "cloning" (the growing of twins or multipl images of an organism with the total *whole* biological character of th original—such "copies" identical in mind, matter, and man—might b grown from the nucleus of an adult cell of the organism) could introduc an entirely new evolutionary concept in possible genetic options for futur populations. Planning and decision-making in many of these emergin fields are foreseen as an assumptive priority in the realm of numbers in th not too distant future.

Recommendations

Knowledge Gaps

Twentieth century technological man has in many ways become so awar 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 ourselve largely unknown. A better understanding of man and his behavior i fundamental to our efforts to develop strategies that seek to optimize th quality of life for psychosocial man as well as to maximize the survival o biological man. Our endeavor to learn more about ourselves and our be havior should not be just a haphazard accumulation of facts and figures It must be guided by a still unformulated sense of values based upon th recognition that we are a single species. Anything short of this would no 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. The desires and motivation, both conscious and unconscious, have largely been overlooked. It is essential to know urgently more of the motivational factors and the social incentives that induce families and states to want 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.

At the research level 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 only now beginning to realize its obligation to provide genetic counseling and to give potential 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, either temporary or permanent). 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 "trainees" now become a new cadre of teachers—perhaps with a greater understanding of persons to be retrained. Flexibility and ingenuity in the trainer are essential. Condescension 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 in the nature of population considerations: (1) Intrapersonal 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 bases 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 allocation and utilization as pertains to problems of fertility planning, mortality statistics, aging and senescence, economics, family, and social

and political change as they may interrelate. (4) These communication foci 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 testing 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 programing 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 in the program 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 seen as 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 is 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 assuring 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, assuring nationwide coordination and implementation of plans, and assuring 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 communities, it is encouraged to do so. As capability increases and involvement broadens, the authority should provide assistance, leadership, and support to local activities.

Increasing attention should be paid to operational studies aimed at providing better delivery systems for health, education, fertility regulation, food, water, pollution control, and other basic requirements as established.

With respect to fertility regulation, research is required in problems of motivation, education and regulation techniques, and conception control methodology.

Agencies at the international level, in addition to their usual role as providers of technical, and in more limited instances, financial assistance, must exert leadership in developing criteria and guidelines of common basic needs required to preserve and improve quality of life. Finally, international agencies and organizations must demonstrate moral leadership attempting to assure equal rights for all human beings everywhere, while constantly recognizing national sovereignty and political realities. In so doing they will be the structure for coordinating and implementing population policies.

Policy Determination at the Operational Level

In any process undertaken to plan actions designed to meet some purpose, a system of priorities must be established to provide an orderly approach to activities. Various methods have been proposed and tried in evolving these priorities, ranging from thoughtful judgement to surveys of leaders and scientists, and including various "systems approaches." The Secretary General, Kurt Waldheim, in his address to the United Nations in April 1974, presented his judgement in terms of six major areas of "global emergency . . . mass poverty, population, food, energy, military expediture, and the world monetary system." McHale, in his interim report to the Academy, undertook a survey of "Individual World Priorities Estimates" disclosing response rates of 37 percent for social, economic, and political issues; 23 percent for behavioral and health; 19 percent for materials, resources, and energy; 14 percent for arts and humanities; and 7 percent for environment and earth science concerns.

Evidently each nation must devise its own list, whether through a centralized planning activity, polls or surveys, or other techniques appropriate to its political system. Yet, since we are dealing with human beings concerning their rights and responsibilities, common guides or criteria would appear necessary. A step in this direction is the "biological bill of rights" previously published.[1] Emphasizing improvement of the quality of life as the primary goal, this recommendation recognizes certain basic minima required to preserve that quality.

Too often public health measures aimed at the reduction of mortality have been blamed as a "cause" of the population problem. Evidence to date does not bear this out. At most, public health would appear to be only one of a multiplicity of factors acting on death rates, including other technologies, education, social, and economic changes.

There should be no implication or threat of withholding public health or other measures aimed at improving the quality of life. To this end the 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 trying to preserve that diversity.*

Reference

1. Mudd, E. H., J. N. Moore & R. Cancro. 1973. Population, Health, and Family. Ann. N.Y. Acad. Sci. 216: 145–151.

PRIORITIES IN EDUCATION, PUBLIC INFORMATION, AND USE OF BASIC KNOWLEDGE: GROUP REPORT 4*

Lawrence Z. Freedman, Anthony N. Judge, Leona Marshall Libby, Willard F. Libby, Pauline K. Marstrand, James Martin, John McHale, Michio Nagai, Ralph W. Tyler, Burns H. Weston

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, three groups of problems for which solution is 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 attention: (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 interactions 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 enable diffusion of this 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 section on "Means." The most definite of these are support for the establishment of a multidisciplinary United Nations University; the creation of a profession of "Environment Doctors," and the starting 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 effect.

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, Aurelio Peccei, and Peter S. Thacher.

(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 specialist 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) Those 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 armaments, 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 change 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 benefitted enormously, many became richer, but with heavy penalties in terms of health and environment, and the natural environment became irrevocably 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 30° 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—energy "forests" solar, wind pumps; and development without degradation.

By What Means:

(1) By the fullest use of all available written, material, transmitted sound and vision, meetings, and seminars.

(2) By establishing appropriate schools of study in developed 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. Peripatetic multidisciplinary teams might be set up by UNEP 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 adults with the necessary awareness, sensibility, and confidence (see separate annex).
(6) The World Academy of Arts and Sciences 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 institutes 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 $300 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 one international problem-oriented organ of information combining the resources, audience, and perspectives of UNESCO "Courier," WHO "World Health," FAO "Cares," et cetera, into one widely distributed carrier of messages on world priorities.
(11) The creation of videotape packages in a greater number of languages than the above, and with images appropriate to the recipients.
(12) Holding of one or more "ideas-fairs" per year (perhaps on a regional basis) is 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.

(5) Begin preparation of information packages on: disarmament, climatic change, and population, resources, and environment.

10–20 Years:

(1) Facilitate continuous diffusion of awareness in communities.
(2) Have 10 percent of children in at least 6 advanced countries and 20 emerging countries in educational programs of the kind outlined.
(3) Have 500 schools training about 5000 graduates to be members "environment doctors" teams.
(4) Introduce fiscal incentives.

In *twenty to fifty* years appropriate child, adult, and environmental training institutes should be established in all developed countries and at least 30 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 industralized society, if that is their wish, 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 evident 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. Peoples need to feel that their own cultures are just as valid, and to know that development in Europe certainly, and America possibly, grew out of an existing culture, some of which was adapted, 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 valuable which maintains the diversity and thus propensity for survival of mankind.

It is important also to avoid the raising of aspirations beyond the possibility of fulfillment, as, for instance, has happened in some countries which have trained graduates in skills more appropriate to developed countries. It is also necessary to stamp out the notion that development/improvement necessarily means repeating the consumption pattern and life styles of America 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 getting 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 additional formal education in later life should be made available as widely as possible.

DEVELOPMENT IN ELECTRONIC TECHNOLOGY OVER THE NEXT TEN YEARS RELEVANT TO THE SPREAD OF KNOWLEDGE*

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International Channels: Satellites of larger capacity than today's at similar cost. Substantial drop in cost of earth stations. Very inexpensive receive-only antennas.

Long Distance National Channels: Maximum capacity of trunk:
1972: 32,000 voice channels;
1974: 108,000 voice channels (L5 carrier);
1978: 240,000 voice channels (waveguide);
1980's: more than 1 million voice channels.
Any type of information can be sent over these channels (data, facsimile, image, TV, et cetera).

Wire City Facilities: Rapid spread of cable TV. Increasing numbers of TV channels into the home. Two-way cable TV. Development of optical fiber cables vastly increasing wired city capabilities.

Computers: Fifth generation of computers oriented toward interactive use with mass storage and telecommunications. Pocket computers.

Man-Machine Dialogue: Development of more natural and powerful facilities for dialogue with machines via telecommunication links. Growth of a new culture of man-machine interaction for learning and problem solving.

Data Banks: Directly accessible storage sizes rising from 10 billion bits to 10 trillion bits and higher.

Computer Networks: Large numbers of different types of computing and storage facilities linked nationally and internationally permitting conversational interaction.

Broadcasting: Techniques such as cable TV and British CEEFAX permit interactive television. Immense potentialities of broadcasting media likely not to be achieved owing to institutional constraints.

Libraries: Computerized libraries with capabilities for automatic searching and browsing from telecommunication-connected display screens.

Facsimile Networks: Fast transmission of documents via communication networks.

* Addendum to Group Report 4.

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.[13, 30]

The science of violence can be applied to public policy only through impinging on law and the relationship of internal and international violence on war and the stages of civilization. It must range from aggressive drives to the techniques 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, guerilla warfare, rebellion, revolution, and war reveals remarkable diversity of opinion. Some authorities assert that we are genetically predestined to violence; others, equally eminent, see men as peaceable lambs whose herds must be disbanded and reorganized and whose shepherds, if they are to cease butting each other, must be replaced.[6, 7] In between are scientists whose theories and observations coordinate the phylogenetically predisposing and the ontogenetically reinforcing, achieving a synthesis of both.[16, 17]

In the past 12-month period, approximately 600 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.[10] 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 the 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.[1-3]

For the first time in an American hospital, pregnant women were not treated like sick robots, patronized 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 suckled and caressed her child as soon as it was born instead of hours later after both had recovered from the anesthesized surgical intervention—modern obstetrics.[4]

Yet for that newborn child, as 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 extrusion from a warm, dark sea of amniotic fluid to the cold, bright amphitheater of gasping for air, issuing its bellow of rage which evoked the satisfied sigh of misunderstanding relief from the bystanders. 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 howl—and our obliviousness to that primal trauma—still affects her in ways she does not know, and we can only suspect.[5]

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 phylogenesis, borrowing from the archeologists, the paleontologists, the ethologists and through participation in the research of the comparative psychologists[15] while training myself as a psychoanalyst.[14]

For man the accidents 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 affectionate care of adults, at first female (usually aided by a male), who fed him and created the micro world which he saw, heard, felt, suffered, enjoyed, imitated and rebelled against, to 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 focussed upon those first representatives of his species. He learned love when they soothed, nurtured, and loved him. He learned fear, pain, and hate when they deprived, frustrated, 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, Rosvold. We studied anxious, aggressive, and sexual behavior in the Rhesus Macaque,

† See Bolk (and others) on human developmental retardation.

an infrahuman primate.‡ We observed (as ethologists were already reporting from observations of animal behavior in more natural settings) the extraordinary complexity of the approach-avoidance dynamics and of their relationships, of the tantalizing rituals by which animals of different sexes and of the same sex experimentally, tentatively develop rituals preliminary to sexual intimacy, to aggressive attack, to anxious retreat, or to grooming succorance. We saw how intermingled behaviorally were the first intimations of the relationships by altering the androgenic state of the female and the testosterone titre of the male. We discovered the crucial role played by the biochemical brew of the animal (as well as his nervous and muscular system), of his capacity to succor, to relate sexually, to attack, to retreat, or to tremble in fright.[15]

At the same time, as I studied I underwent myself the experience of psychoanalysis through which I learned of the primacy of early experience, of the complexity of human feeling, of the tentativeness of human relationships, of the primitiveness of human feeling, of the gripping and sometimes overpowering grasp of the need to be well-regarded, to regard oneself with some esteem and with some affection, and of the enormous reward experienced when one was assured that others cared for him, that one cared for others, that there was a group of which one was a part, and that by definition there were other groups from which your own group membership itself separated you. And one sensed, if one did not know, that identification with a group and its esteem and acceptance of you, was psychically a matter of life or death, of self-love or self-hate and might become biologically, as well, a matter of survival.

I studied, along with my colleagues, the role that one's social class played, how one's economic,[12] and social status affected the crucial group role.[8, 9] I observed the role of the media[11] in transmitting these attitudes, and the role of religion in reinforcing them. We have learned how language and vocation affect the social position assigned.

I had just been a medical officer in the United States Navy during World War II, assigned to care for sailors and marines who were imprisoned in American barracks, as well as German prisoners of war who were being held in adjoining barracks. Thus I saw, clinically, the Nazi enemy as mentally ill patients. I found myself so preoccupied with the human suffering of the "enemy" that the stereotype of the genocidal Nazi never once entered my mind.

During the time which I spent as the psychiatrist to prisoners in my own military service I was struck with how various forms of physical illness, as well as mental illness had extraordinarily different rates of incidence and prevalence among men from significantly different backgrounds. Their personalities preceded their illness and explained those differences. I was

‡ See the work of Lord Zuckerman in England, Carpenter and, later, Harlow in the United States, who also investigated this animal which in some significant respects is capable of analogous and homologous forms of behavior (and, questionably, feeling) as that experienced by the human animal.

struck with the observations 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.[31, 32, 37] He was found to be significantly different in origin and personality from the sexual and acquisitive offender.[35, 36, 38]

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 hitherto had seen only as an expression of the most intimate form of destructive interaction between anonymous figures. I was struck with the extraordinary recognition 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 distortion, which in the assaulter'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-approbation, of identification with an existent group which approved of him, and of which he could reciprocally approve, were very similar.[19-23, 26-29, 33]

I thought that I recognized in this encounter between the insignificant, often despised and marginal of men, and his extraordinary assault upon the most celebrated, heroic, and rewarded of men (the reverberations of which affected that encounter among other men) the ultimate in human encounters. In a sense this was as inevitable, as significant, as inexplicable, as existential, and as transcendent as that earlier experience which each had shared, the initial cruel, anxious separation from the mother and the encounter with the threatening and molding world. I further developed that understanding later when as Psychiatric Consultant to the National Commission on the Causes and Prevention of Violence which was appointed immediately after the assassination of the brother of John Kennedy, Senator Robert Kennedy.[26-29]

Finally, there were studies of mass killers, a man called Zodiac,[24] a man called Speck, a man called Whitman, men who apparently mindlessly killed many persons from their own country, but not from their own group, and the ghastly mass killings by our soldiers, as what happened at Mai Lai,[25] when this country was at war with another country.

For the past 10 years, I have observed the structure and development of an inner-city gang, a gang which in its outward form deliberately and with remarkable success emulated, in its titles, in its structure, in its status, the institution of the state. It defended and it defined its territory with power and trickery and skill and persuasion. Its leaders had governmental titles.[43]

It extended its territory by attacks, by subordinating the leaders of the enemy, by coopting their loyalty, and by adapting successively to the emergence of the Civil Rights Movement, of the nationalist movements among previously oppressed minority groups, of political militancy, of economic opportunity.[44] I saw, as one of the mechanisms, the terrorization of the young, the terrorization of the enemy, and the terrorization of the enemy's leaders.

During this past year we have seen the emergence of terror as an international phenomenon, inspired nominally by traditional nationalism, by political ideals, by political preferences, by a sense that the rights that had been suffered could be set aright by the powers against the force of the governing powers only through the use of terror or guerilla warfare and, finally, perhaps through rebellion and revolution.[39-42]

In all these seemingly disparate sets of observations, I had discovered remarkable similarities. Genetically inherited, developmentally learned, inwardly experienced, outwardly manifested, they for generations, eons, 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 dangers of loneliness. Within each was seared the penalities 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, worst, overlooked. With this comes the need for the love, the esteem and the companionship which permits one to esteem and to accept oneself.

Violence, the complex and 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 disinterest 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 ascribing it to the social and the political system of which one is an outcast, a hated and hating shared. But if these too 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 gentility, to courtesy, to mannered existence.

The answer is at once terrifying and, for those who seek peace, edifying. It is an unhappy reflection that ordinary men will kill on command without excessive pain to themselves, that in this sense they, like assassins whom we may fear or despise, are made of the same stuff. Conrad found the ordinariness 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 polistaraxia, the study of upsetters of the

community. That word has two parts: *polis*, the nation state, and *taraxia*, the upsetters. It is a dynamic and ever present tension. But if 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 polis.

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 humans who inhabit this planet live out their lives as fulfilled members of a planetary polis.[14]

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EDUCATION OF CHILDREN FOR ENVIRONMENTAL AND "SOCIAL" AWARENESS*

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One cannot overlook the importance of the early childhood years in developing human beings who can respond appropriately to information about world problems. Individual hierarchies of motives, the wide variations among individuals in the length of time they will postpone immediate gratifications for more distant rewards, and individual differences in perceptions of complex phenomena and in focus of attention are influenced markedly by early childhood experiences, much of it in the form of conditioned learning. One may suggest, therefore, some early experiences that can be provided for children to help them develop the capabilities for dealing with information.

One of the first objectives is to develop confidence in the child that he can explore new places and new behavior without losing the love and nurture of his parents and other teachers. Modern man must be able to explore his environment, investigate new ideas, and gain wider experience with men of different backgrounds. This requires confidence rather than fear and sensitivity to positive and negative aspects of new experience to which he can respond, rather than behavior guided by tradition. With young children, avenues for exploration need to be opened up in a way that furnishes new experience where the child must cope with some disagreeable features as well as enjoy the pleasant ones. As the range and difficulty of the places he explores are increased, he learns to approach new experiences with confidence and to be guided by his own observations and interpretations rather than to accept traditional attitudes without question. This kind of early education is very important for the development of a genuine world community.

A second emphasis is in developing faith or confidence in the capacity of each generation of men to solve their problems rather than to place this faith in the answers that have been given in the past. To develop this the child needs to have many examples within his observation and participation that show the world as something men are always learning more about —not one in which everything is known. He needs to see people at work on the analysis and solving of problems rather than waiting for someone to tell them what to do. He needs to discover that knowledge is made by men and is growing and changing as man finds out new things from his experience. Education for contemporary man is not finding ready-made answers from books but learning how to inquire, how to formulate ideas

* Addendum to Group Report 4.

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 circumscribed 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 multicultured and multivalued society, children need to have experiences with persons who come 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-

stood as individuals, not as stereotypes. Realism regarding men and women from different parts of the world is essential in establishing a workable world order. Early exploration of human relationships is *the base on which realism can develop.*

The above is a condensed suggestion regarding the program of education for children who can become audiences able to use information appropriately. To build on this education for youth requires redirection. *At present*, the schools in all nations lack authentic materials regarding the development of human society. Most of them are either grossly distorted myths or a narrow selection of the field of study based on ethnocentric perspectives or limited notions about the important areas of man's achievements. Furthermore, most of such material fails to involve the student in seeking to understand man's condition, his aspirations, his strivings, and his achievements. It leaves him untouched without learning anything significant.

The exchange of students on a massive scale is likely to have a positive influence in developing world citizens, but the relatively brief time that a student spends abroad has, in the past, been largely occupied in activities entailing limited cooperation.

Instead of the usual exchange program, a more promising option is a carefully designed work-study program in which students from various nations serve together on task forces responsible for achieving a goal recognized as important by all.

In order to gain wide endorsement of such experimental programs, opinion leaders, teachers, organizations, editors, and TV-radio producers will need to be kept informed of the purpose and progress of the experiments.

PRIORITIES FOR IMPROVING THE WORLD STRUCTURE OF PUBLIC ORDER: GROUP REPORT 5

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We commence with the fact 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 competence 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 constitutive decision process of any community is one which strengthens that community and maintains or improves its ecological and social environment, realizes 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 convene a constitutional congress and to reorganize the constitutional process of their community in accord with common interests. This eventuality is as unlikely now as before. But this does not make an exercise in normative formulation futile. Every current choice with global ramifications has, perforce, constitutional impacts; 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 recommending world constitutive 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 incapacity or irresponsibility.

—assure that decisions are taken from perspectives of common rather than special interest.

—assure wide access to organized as well as unorganized arenas, with an appropriate balance maintained between regional and centralized decision-making.

—mobilize authority and effective power in a quantity sufficient to make constitutive decisions effective.

—encourage persuasive rather than coercive techniques for decision-making, but develop an institutional adequacy for coercion when world common interests require it.

* Chairperson.
† Rapporteur.

Given the dispersion of power in the world and the extraordinary range of institutional phenomena, it would be fatuous to recommend one particular institutional arrangement over others. Institutional arrangements from the rich archives of human experience and the novel arrangements yet to come must be shaped in varying contexts with due account for power realities so as best to realize policy. In every context, however, the arrangements should be tooled to adequately perform the following functions:

—provide an adequate, accurate and timely flow of intelligence to decision-makers and appraisers, depicting a wide range of options and the costs and benefits in terms of all values consequent on each.

—allow for democratic and vigorous promotion by officials, non-officials and functional groups of policy alternatives.

—establish procedures utilizing the institutions of the United Nations and the network of specialized agencies for the prescription as law of those policies which enhance the minimum and optimum public order requirements of the world community.

—allow and reward the timely invocation of decision-making when there is an apparent deviation from prescriptions.

—utilize the existing agencies of world government to secure fair and effective application of law to behavior which has been authoritatively deemed to violate prescriptions, including the applications of sanctions aimed not at punishment, but above all at the restoration of public order.

—terminate those prescriptions which are no longer consonant with community needs with compensatory schemes where appropriate.

—maintain an ongoing appraisal by officials and non-officials of the aggregate performance of the constitutive process in realizing the goals of the world community.

A number of specific recommendations are put forward in this context. We urge the members of the United Nations in their forthcoming conference on the future of the oceans of the world to confirm the status of the oceans as an inclusive resource, subject first and foremost to international competence. Second we reaffirm the proposal that individual uses of the ocean be licensed by an international agency, the proceeds directed to public international purposes including development.

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 ecological unities or interdependences of this comprehensive ecosystem 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 outerspace, 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 sum of their interests in all the great component sharable resources, to 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 interdependent global social process, people apply institutions to resources for the production of values.

By "priorities" we understand reference to perspectives about common interests. In rational conception, priorities must, accordingly, refer both to intensities 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 interdependent with all other values and the decision processes by which they are secured, any estimate of priorities must be tentative and instrumental within particular contexts. The important perspective must be a demand to grapple with the "big, blooming, buzzing 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 spoliation and exhaustion of resources, accelerating population growth, and increasing technological potentialities for destruction, the mere infusion of a more relevant intelligence about the environment into routine decision is not, however, enough to clarify and secure 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, oceans, 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 authoritative decision by which they seek to secure this enjoyment.

Priorities 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 resources under inclusive competence, as free as possible of exclusive competence 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 historically been shared.

Regulation of Enjoyment

Resources Inclusively Enjoyed

The emerging customary norm that every community is responsible to all others individually and collectively for injurious use of the great shareable resources that comprise the environment should be communicated and ceremonialized in all possible media. The prohibitions of the 1963 Test Ban Treaty should, thus, 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 wastes, supersonic flight and so on, states and the general community should design measures for the prevention and deterrence of such activities and for rehabilitation and reconstruction. The recent Convention for the Prevention of Maine Pollution from Land-Based Sources should be expanded to include airborne sources and extended to

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

Viable organized regimes for high seas fisheries and for exploitation of seabed 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 information should also be supplied to some centralized 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 Inclusively 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 functions, 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 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-Exposition 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.

It is, for example, important to make the concept of the working environment 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 environment 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 settlements, i.e., the distribution of populations between rural and urban settlements 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 important 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, little regional, and inadequate national planning for the long-term future. In implementation of the planning and development tasks already indicated, "Earthwatch" or some equivalent should be expanded into a comprehensive environmental intelligence 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 full and effective performance.

Promotion

The promotion function might be more explicitly located in the structures 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 appropriate 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 comparable to the International Law Commission be established to engage in the continuous clarification and recommendation of prescriptions appropriate for all community levels. The tremendous importance of the expectations about lawfulness created by habitual, cooperative activity might also be more explicitly recognized.

Invocation

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 ombudsman 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 considerations 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 employed 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 authoritative 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):

I. Priority subject areas
   1. Human settlements, human health, habitat and well-being
      1.1 Human settlements and habitat
      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. Oceans
   4.1 Marine pollution
   4.2 Conservation and protection of living aquatic resources
5. Conservation of nature, wildlife and genetic resources
   5.1 Plants, animals, and endangered species
   5.2 Ecosystems, 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. Ecodevelopment
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 habitat and environmental design and improvement of human settlements.

WORLD ORDER PRIORITIES*

Karl W. Deutsch

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During this century, we have passed through three cycles of approaches toward greater world community and of retreats from it. Between 1900 and 1913 the "one" world of that time was held together by market forces, the gold standard, international trade and finances, mass migrations, a common middle class subculture, and the contest 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 nationalistic 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 feeble 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 consensus 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 preoccupations, 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 catastrophies even larger than those of the past. Most of the priority con-

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cerns we are going to discuss have been proposed before, most often singly, by some special group interested in this or that particular measure. What had been missing has been the will to implement them and to do so jointly, so as to gain the effects of their interaction, which are essential if we are to cope with our cumulatively mounting dangers.

Among the matters requiring priority attention are worldwide food production and food storage against famines anywhere, the alleviation of extreme poverty, the international reductions of armaments and arms expenditures, the nonproliferation of nuclear weapons and weapons of mass destruction, the identification and development of new sources of energy, the slowing down of population growth, the conservation of nonrenewable resources, the development of substitutes and of techniques of recycling, the substantial increase of research and development efforts for these purposes, and research on the conditions conducive to habit change and to the more ready acceptance of innovations and reform.

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 postulate, in fact, we consider absolutely essential, a strong world unit directing and serving a system of world regions. Such a world unit would either be a completely new institution 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) taxing 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 problem 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 generation.

Immediately we recognize that simply setting limits on total world emissions is insufficient. Attention must also be focussed on the *distribution* of pollution in 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 mixes, the population distribution and the resource scarcities of each region.

Constraints must be set not only on the pollution generation 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 unit'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 of the decentralization 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 regulation will need to be organized around geographically contiguous regions, as in 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 externalities 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 Pregel

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 beset by internal confusion? Our leaders place personal ambitions before national guidance.
>
> We are watched by warlike barbarians who envy our wealth. The government seems to be controlled by social theorists who preach strange doctrines.
>
> Our elected candidates orate endlessly, substituting slogans for good judgment and phrases for deeds.
>
> Some of our men in government treat our laws like fences, 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 tower, workmanship grow shoddy, goods inferior, prices outrageous, politics more corrupt, but the one thing we fear most is boredom. We cannot stand time on our hands.
>
> Yet we demand shorter work-hours and more time to be bored, an unwholesome cycle wherein senses have replaced the soul.
>
> Is it man's fate always to muddle through, bog down periodically and rise briefly from his gutter?
>
> Yes, we have everything—everything—except the most precious of all possessions—a collective unity, a common integrity.
>
> It would seem we are surrendering our responsibilities and are indifferent to the quality of our leaders, opening the gates to infiltration by activists who pretend to champion the people but are actually political adventurers.

That was Sententius Galbo, an olive oil merchant talking to his wife, Cornelia. The place was ancient Rome. The date was 462 A.D. 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, et cetera.

We know the problems? But nobody can claim to have definite answers. Anyhow, 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 death. That human rationality and human good sense will prevail in the long run we take for granted. It is up to us members of the older scientific-technological establishment to persuade our younger impatient scientific nihilists that ours is the course 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 Saver, 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 Kalinga 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 Herio-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.

His contribution to international cooperation has been immense. He participated in the founding conference of UNESCO to which he has been repeatedly the British Delegate; he has served as consultant to the United Nations and its specialized agencies. Indeed, I understand that his missions have taken him over 2½ million miles in the past 25 years to study the application of science and technology to the problems of less developed countries.

Ladies and gentlemen—Lord Ritchie-Calder.

MANKIND'S SECOND CHANCE

The Lord Ritchie-Calder

Center for the Study of Democratic Institutions
Santa Barbara, California 93103

Lewis Mumford in *Interpretations and Forecasts* and Gerard Piel in *The Acceleration of History* have sent us back to the uncanny predictions of Henry Adams, the American historian who outraged his classical contemporaries at the beginning of this 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 spurts 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 compared 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 prognostication was pretty grim. He said:

> According to my score of ratios and curves: at the accelerated rate of progression since 1600 it will not need another century to turn Thought upside down. Law in that case would disappear as a theory or *a priori* principle and give place to force. Morality would become police. Explosives would reach cosmic violence and disintegration would overcome integration.

He reckoned he was making generous allowances in his time scale of civilization when he extended the passing of the perihelion to 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 octogenarian 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 untrustworthy sequence. Processes which have reached the parallel for what we call Eternity swing off at a tangent from one another—just as the comet at 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 Wisest* and believe we are in transition from "Epoch A" to "Epoch B," from seeming purposelessness in "Epoch A" to personal fulfillment through improved quality of life in "Epoch B." As 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 accommodated to the changes of phase produced by the discovery of natural forces, of the elements and the sources of energy and consciously adjusted them to our material advantage. In the process we produced cultures, societies, and institutions. We accumulated knowledge and dispensed 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 congestion of the brain and from the sclerosis of our political arteries. To paraphrase Adams: Justice has given place to law enforcement. Public morality to corruption. With the nuclear bomb *Homo sapiens*, thinking man (or *Homo insipiens*, 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 updraught of inflation and being tossed hither and yon. The helplessness is not confined to politicians, to the economists, to the financiers, to the stockbrokers, to the workers, scrambling for higher wages, or the shopkeepers coping with higher prices, in the so-called advanced countries. Inflation becomes starvation in the poor countries which we have snarled 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 prices. This is a sardonic commentary on "The Green Revolution." The plant-breeders and the agronomists may have excelled in producing high-yielding grains and rice but the hungry will be cheated if the indispensable irrigation water, nutrients, and protectors 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 Bioengineering Age in which we will manipulate the nature of man himself. Each is as epochal as the Bronze Age, the Iron Age, the Rennaissance, 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 estate, within which billions of people now and the billions still to come have to contrive to survive and to 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, Stettinius, Attlee, and Eden, who had been briefed about the atomic bomb which was to be exploded a

month later in the desert of New Mexico. They only knew it was a bigger bomb, a thousand times more powerful than the chemical bomb, but no one had told them about radiation and the genetic effects and none of them then foresaw the military, political, social, and psychological effects of the release of a cataclysmic weapon.

There was nothing in the provisions for the United Nations which would take care of 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 UNECO--Education and Cultural Organization—in the thinking about which science had been treated as something to be taught in schoolrooms or teaching laboratories or, with the grace and patina of time, might qualify as culture. That it was the social and economic dynamic of our time and the flywheel 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 scientific advances and the momentum given to them by the crash programs which telescoped 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 withered in the chill 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 to developing countries of packaged reactors and fusion reactors to provide the energy to hasten them on their way to industrial prosperity have not been fulfilled.

Nor did the powers signing the Charter in 1945 realize what communications would do to their empires--independence, yes (that is what the Trusteeship Council was inserted for) but not as fast as events proved. What a British Prime Minister called "the winds of change" were in fact etheric 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 fragments of erstwhile empires. Telecommunication not only encouraged the aspirations of freedom but also the revolution of rising expectations. The highly advanced countries boasted 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 icepacks of the North Pole. I have been in the heart of Africa where the radio bulletins were relayed by talking drums into the swamp forests of the Congo. I have been on the Andean plateau, where the disinherited heirs of the Incas, under the huge dishes of the rocket trackers, were listening on transistor radios to the astronauts gossiping in space. I have been "mooshing" in the snow-deserts of the Arctic with Eskimos who carried 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 look for uranium. Everywhere, but everywhere, people were hearing about the wonders of science.

This "revolution of rising expectations" encouraged people to believe that science and technology would provide answers which would transform their lives—feed the hungry, treat the sick, and liberate the poor from the degradations of poverty.

Now midway to the year 2000, when there is enough overkill in the nuclear stockpiles to provide a hundred tons of TNT-equivalent for every man, woman, and child on earth; when men have broken the gravitational fences 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 memory-capacity of the human brain; when organs can be transplanted in intensive-care units—when such things have been spectacularly demonstrated, the plight 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 beat of the human pulse, there are three more mouths to be fed—and preponderantly in the less-developed countries. This is not due to a great orgy of procreation. Couples are not having more children; more children are surviving the deadly hazards of childbirth, infancy, and childhood to mate 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 dimensions, has curbed the mass-killer diseases. Even while we see what has been happening in the Sahel, south of the Sahara, it is still possible to claim that globally there is enough food *per capita*; but *per capita* means per head not *per stomach* 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 squalor and urban violence. Unemployment is increasing and with it deprivation and denial of human dignity. After years of trying to increase educational opportunity the illiteracy *rate* has dropped but the *number* of illiterates in the world, by addition and multiplication, has 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 resent it. Disenchantment with science and technology and distrust of their salesmen 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 untrammeled productivity has produced. Preoccupation with GNP (gross national product), that dubious index of material wealth, has increased disharmony and alienated the younger generation who saw in it greed and debasement of the quality of life.

Industrial unrest has been generated by lack of job satisfaction. To tell

an industrial worker on the production line that with a flick of a switch he can command slave electrons equivalent to a hundred human slaves is poor consolation for tedium. Executives have been fired by the computers they hired, because the machines could quantify and give a determinism to numbers in place of "hunches" and "shrewd judgments" of a lifetime of business experience. And, of course, there was the growing awareness (to find its expression in the Stockholm Conference on the Human Environment and the setting up of UNEP, the United Nations Environment Program) that the wastes of production are impairing not only the amenities but the biosphere itself.

Somewhere, surely, between grinding poverty and disgruntled prosperity, between denial of necessities and the squandering of world resources, there must be a golden mean which the alchemy of science has not yet produced from the base-metals of politics and economics.

I am not a pessimist about the long-term provided that we can do something in the short-term.

In looking at the parabola of history I should prefer the analogy of the rocket to that of the comet. Just as the Houston Control Center could deflect a rocket by remote control so we could prolong Adams' trajectory. It would still be in Wells' terms a race between education and catastrophe, and by "education" is meant "informed judgments."

Science is knowledge; knowledge is not wisdom; wisdom is knowledge tempered by judgment. What we need is a collective wisdom which can evaluate the trends in science and the inventory of technological achievements.

As I pointed out in the March 22nd issue of *Science*, to suggest that we can thus incorporate a collective wisdom is like proposing to install our modern, secular gods on Olympus with no assurance that they could better handle Prometheus or Pandora. Nevertheless our predicament as mortals calls for some sort of reappraisal and proposals.

The discussions at this conference would seem to reinforce the need for a global science policy. This has been put forward—as tentatively as such an ambitious idea demands—in a seminar which we held at the Center for the Study of Democratic Institutions under the rubric "Guidelines for a Global Science Policy *inside, outside or in conjunction with the United Nations*."

The United Nations, the one coherent institution we have, does not at present provide a nodal point for determining policy, either in terms of science and technology for development or of the development of science. It has never been given adequate money, enough high-caliber personnel, facilities or authority. It is a congeric of 135 sovereign states each determining (or neglecting) its own science policy and incapable (as the sovereign states are incapable) of regulating those major disseminators of technology, the multinational corporations, or of taking better advantage of the "commonwealth of science"—the academies, the professional societies, the movements like Pugwash and this gathering of minds which reflect the sense of the social responsibilities of science.

We need more than intergovernmental oversights which are blinkered by national sovereignty, more than international institutions, like ICSU, and more than transnational traffic which is the *laissez-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 caveats on trends in science that are raising profound ethical questions.

We saw the salutary influence which the nongovernmental organizations had in exposing the complacency of governments and bringing about UNEP.

As a salve 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 new science-generated factors which are implosive—impinging on a globe which is itself finite, the earth man looks at 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 science policies 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 of environmental deterioration due to the proliferation of technology in the recent past. We are facing, in a future more imminent than most people recognize, the implication 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 nongovernmental institutions, of the academies, of the universities, of the scientific ecumenical movements like Pugwash and Pacem in Maribus, 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 would emanate? How

could the scientists participate in decision-making with some assurance that they could influence political action?

We are metaphorically sitting at the command console in Houston Space Control. Which buttons shall we push to extend the parabola of human history?

This is mankind's second chance—the first we fumbled in 1945.

CONCLUDING NOTE

Boris Pregel, Harold D. Lasswell and John McHale

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. Public 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 realism 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 no exception to the principle that a decent regard for the opinion of others is an important element in a collective process of decision. Weight 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 clarify 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-

priate norms for the world community in the Universal Declaration of Human Rights, which outlines some implications of the overriding goal of human dignity. (The specifications of a model of human indignity can be found in Nazi programs for non-Aryans.)

Contemporary specialists 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 prose into explicit references to society and environment.

The policy papers that were prepared by the working groups of the Conference may be reclassified in various ways in order to emphasize important considerations of objective and tactic. For example:

I. 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.

II. 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 account 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" 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."