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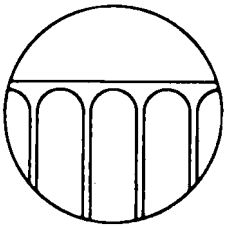

The National Academy of Engineering was established in December 1964 as an organization of distinguished engineers, parallel to the National Academy of Sciences, autonomous in its administration and in the selection of members, and sharing with the National Academy of Sciences under its congressional act of incorporation the responsibility to examine questions of science and technology at the request of the federal government.

The National Academy of Engineering, aware of its responsibilities to the government, the engineering community, and the nation as a whole, is pledged:

1. To provide means of assessing the constantly changing needs of the nation and the technical resources that can and should be applied to them; to sponsor programs aimed at meeting these needs; and to encourage such engineering research as may be advisable in the national interest.

2. To explore means for promoting cooperation in engineering in the United States and abroad, with a view to securing concentration on problems significant to society and encouraging research and development aimed at meeting them.

3. To advise the Congress and the executive branch of the government, whenever called upon by any department or agency thereof, on matters of national import pertinent to engineering.

4. To cooperate with the National Academy of Sciences on matters involving both science and engineering.

5. To serve the nation in other respects in connection with significant problems in engineering and technology.

6. To recognize in an appropriate manner outstanding contributions to the nation by leading engineers.

Foreword

Because of increasing interest in the relationship between United States technology and international trade, the National Academy of Engineering, through the effort of several of its members, conducted an examination of major issues underlying this complex subject. The effort culminated in a seminar held on April 24, 1975 in conjunction with the 1975 Annual Meeting of the Academy.

As a result of the seminar, the proceedings of which are recorded in this document, a comprehensive study of the important issues identified in the seminar is being undertaken by the Assembly of Engineering of the National Research Council under contractual support of the National Science Foundation and the U.S. Department of Commerce.

Included in this document is an address presented at the Annual Members Banquet of the National Academy of Engineering on April 23, 1975. The theme of the address is generally relevant to the subject of the seminar and, as part of the program of the Annual Meeting, was considered appropriate for inclusion in these proceedings.

U.S. TECHNOLOGY AND INTERNATIONAL TRADE

Contributors

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Elizabeth R. Jager, an economist in the AFL-CIO Department of Research, also chairs the Foreign Labor and Trade Committee of the Labor Research Advisory Council under the Bureau of Labor Statistics. In 1971-72 she served as a member of the Export-Import Bank Advisory Committee.

Ralph Landau is president of Halcon International, Inc. of which he was a co-founder in 1946. He has had extensive experience in applying chemical process technology in the United States, Europe and Japan.

INTRODUCTION

Edward E. David, Jr.

This report is intended to inform a wider audience of the critical issues related to U.S. technology and international trade that were examined at a National Academy of Engineering seminar held in Washington, D.C., on April 24, 1975. The seminar was stimulated by the Department of State and further encouraged by the National Science Foundation and the Congressional Office of Technology Assessment. Some of the issues, particularly technology transfer and foreign investment, have been scrutinized earlier by various Academy groups. One group of electronics executives met under the leadership of Edward Ginzton, while the other, which included executives from chemical, information, computer and petroleum companies, was led by Harold Fisher, of the Exxon Corporation. The conclusions of these two groups are incorporated in the papers by Dr. Ginzton and others which follow.

Technology and international trade is a subject that generates a variety of opinions, many of them highly polarized. Labor tends to equate manufacturing abroad and the exporting of technology with the exporting of jobs. Diplomats, on the other hand, see them as tools for building bridges between different societies and governments. The businessman looks upon them as ways of gaining access to foreign markets and, in the end, as a source of profit

for the stockholders and, ultimately, the public.

Technology transfer -- which is an important element today in international trade -- is looked upon warily by military men who see it as enhancing foreign military capabilities. Some economists view technology transfer as a depressant on the U.S. economy, on our balance of trade, and, ultimately, on our standard of living.

Finally, many astute observers see technology in general as the most widely desired commodity in the world, particularly for the so-called value-added economies, of which Japan is a prime example.

I believe the conclusion to be drawn from these conflicting attitudes is that a cost-benefit viewpoint must be taken, but it must be taken with great care. The cost-benefit ratio may be quite favorable in a particular case, but if the costs fall primarily on one sector of the economy, or on one sector of the population, then the trade-off between costs and benefits may not be politically, socially, economically or militarily acceptable.

The Dynamism of Technology

When I was in the Office of Science and Technology, a group chaired by Daniel DeSimone (now deputy director of the Office of Technology Assessment) and including representatives of the Council on International Economic Policy, the Council of Economic Advisors and other Executive Office groups completed a study of international technology transfer. The study emphasized that the most significant aspect of technology is its dynamism; in other words,

technology advances and changes. The critical point, therefore, is that the U.S. can remain healthy and internationally competitive only if it innovates and creates new technology continuously. To this end, the group recommended that we continue our policy of open trade, including technology, which we have pursued for years. Most important, we should not fail to create more desirable technology so that we can have a backlog to draw upon for the future.

Beyond taking account of the temporal aspect of technology as an element in trade strategy, we should beware of drawing broad, general conclusions, for they are likely not to apply to those key cases that are most controversial. For example, government approval for exporting nuclear materials and equipment which could be used in the manufacture of weapons is coming under increased Congressional criticism. As a result, there could be changes in the way export licenses are processed. Clearly there is an issue here; namely, to what degree should the government control commercial technology exports? In the nuclear case, federal control through licensing is made mandatory through the Atomic Energy Act. However, there are no such controls at present for most of technology beyond that with possible military applications. For example, exports of automotive and health care technology are not controlled.

Transnational Aspects

I am impressed by the views of the research director of Seiko, the innovative watch manufacturing company, whom I met on a recent trip to Japan. Dr. R. Hara holds the very interesting view that there is a cultural barrier to technological creativity

in Japan. He puts it this way: "Japanese organizational structure and language are not suitable for conducting advanced, high technology work, but the Japanese are particularly suited for improvement work which requires many years of strenuous efforts, as well as for economical design, and the Japanese are particularly suited for quality control work which supports large-scale production of high-quality products." He concludes by saying, "Japanese industry can be a good partner to Western industry and industry in developing nations so long as each party has a clear recognition of its role. Scientific seeds in Europe, pioneering engineering and development work in the U.S.A., and production of high-quality products in large quantities in Japan with the possibility of transference to developing countries is the wave of the future."

This is a provocative viewpoint, and many of the presentations in this report relate to the appropriate role of nations in world trade. So, although we should beware of broad generalities, it is certainly worth applying generalities to specific instances to see how widely they can be trusted. But more generally, we should beware of advocating broad policies to be applied indiscriminately. The damage of a blind decision in even one critical case could outweigh hundreds of routine decisions which would be sensibly settled even without benefit of global policy.

Seminar Overview

The first three papers that follow were intended to define the issues involved. To Lewis Branscomb, a key one is that there

exists a serious policy vacuum and lack of institutional strength within government insofar as technology and trade policies are concerned. He identified several myths which he sees as characterizing most discussions of the subject, and he outlined three issues of public policy he considers most fundamental:

1. How effectively do federal policy and federal R&D expenditures support the national scientific and technical infrastructure upon which economic performance rests?
2. How effectively does the government incorporate technological insights in formulating its policies?
3. What relationship can and should be established between private companies and the various government entities?

Edward Ginzton concentrated on the issues facing those U.S. companies that are engaged in high-technology engineering and manufacturing. In a world where their overseas counterparts expect and obtain substantial governmental support, Ginzton feels the U.S. government has created, through regulation and legislation, an environment that is "substantially detrimental" to the ability of American companies to compete overseas. He raises questions about present policies in the areas of antitrust legislation, support for basic research, government controls of exports and taxation, and government procurement practices.

Ralph Landau concluded this part of the seminar by making recommendations based upon the experiences of the chemical process industries. He feels our government could give a great deal

more to help private business without getting involved in the business *per se* and, along with several of the speakers, called for some new complementary relationship between government and private industry as a way of maintaining our technological strength.

Following these papers came two case-study presentations covering current situations and problems: William Doolittle described the situation of a particular electronic instrument company, Hewlett-Packard, which does substantial manufacturing abroad; and Raymond Albright explained the role of the Export-Import Bank in the area of technological exports and export controls, particularly as they involve the U.S.S.R.

These presentations were followed by a panel on Mechanisms for Policy Concerning Industrial Technology. Michael Boretsky spoke on policy governing technology transfer that he feels could improve our present world position in industrial technology; Ellis Mottur described the recently established Office of Technology Assessment and its new Program in Technology and International Trade; Elizabeth Jager expressed the concern felt by the AFL-CIO toward technology transfer and proposed six regulations it would like to see established concerning taxes, trade and technology flow.

The seminar concluded with a summary by Herbert Hollomon. Warning that the U.S. no longer dominates the world's technological progress, he called for "some new relationship between the industrial and economic private sector, the quasi-private sector, and the governmental apparatus in such a way that we can begin to know where we have been and where we are likely to go".

Worldwide "interdependence" is rapidly becoming consolidated in international economics. Technology is one of the two most critical elements, the other being natural resources. Thus it is timely and necessary that we understand the possible uses of technology trade in foreign affairs, and in economic terms. It has been suggested, for example, that the nation govern technology exports to assure long-term supplies of natural resources at competitive prices. Whether this is a desirable or feasible strategy is debatable, but we are sure to hear many such proposals in the years ahead. The papers from this symposium will aid us in judging strategies involving technology and trade by defining the critical issues and indicating where the interests of various constituencies lie. They should, therefore, provide an important backdrop for critical decision-making in the years ahead.

TECHNOLOGY AND TRADE: PUBLIC POLICY ISSUES

Lewis M. Branscomb

The increasing importance of international trade is a measure of the increasing interdependence of the United States and other nations. With trade growth rates now substantially out-pacing world GNP growth, the natural, technological, financial and human resources of one country are increasingly critical to the plans and productive processes of others.

Countries, such as the U.S., which are (a) net exporters of farm products and high-technology products; (b) net positive in dollar inflow of investment income and royalty payments; (c) net importers of fuels, minerals and low-technology merchandise, have a vested interest in maintaining technological leadership and allowing unrestricted opportunities for trade and investment. The U.S., uniquely among major industrial nations, tackles these trade issues with political tools and economic policies but not with a well institutionalized science and technology policy. The government's technological concerns have focused almost entirely on military, space and nuclear technologies, although during his last year as the President's Science Advisor, Edward David made a strong effort to reverse this excessive focus by government on the government's own needs rather than those of the national economy.

Thus, we must still discuss technology and trade in the context of a serious policy vacuum and a serious lack of institutional strength within the government to implement such policies as might be developed.

Why is industrial technology so important for U.S. trade? Technology provides the highest value-added leverage to the cost of raw materials. This facilitates our ability to import these materials, and mitigates the effect of a high-wage-rate labor force by allowing us to take advantage of that labor force's high educational level. It seems strange to have to argue for a national economic and technological policy that is built on national strengths rather than weaknesses. Perhaps as a nation we take our successes for granted and tend to concentrate our attention on areas of dislocation or weakness. These are understandably areas of political concern and, hence, a government responsibility, but so too is the need for strengthening national economic performance and maintaining technological leadership.

Why It's Hard to Define Policy

Why is it so difficult to evaluate the U.S. position in industrial technology and to define the national policies that would strengthen it? The measures for this evaluation are multidimensional and poorly defined. Many of the myths and misconceptions about technology and trade result from focusing on only a single measure, ignoring the rest. Among the measures to be considered are:

- The balance of payments
- The balance of trade
- Return on foreign investment
- Income from patents and licenses
- Enterprise ownership
- Domestic employment and skills requirements
- Industrial self-sufficiency
- Success of U.S. products in foreign markets
- Scientific and engineering leadership
- Rates of invention and innovation

Defining an aggregate measure is presently beyond the techniques of economic analysis. Moreover, any effort to define such a measure must founder on the absence of an objective value system for defining the relative importance of each of the above dimensions.

A second reason why policies are hard to define results from confusion about technology transfer. At the trivial level, this confusion treats technology as a fixed and enduring asset, which of course it is not. At a more sophisticated level, one should recognize that just because a nation has a particular technology available to it does not mean that technology can be exploited successfully; the skills, the management resources, the capital and the markets may not be adequately developed. Finally, people constantly forget that technology flows both ways and that our economy has traditionally been more receptive than Europe's to the exploitation of new technology. Under these

conditions, the U.S. economy will benefit more from the free exchange of technology than will others, with the exception, perhaps, of Japan.

The third reason for the difficulty in formulating policy arises from a lack of conviction about applying the classical economic law of comparative advantage. A large part of the effort in national trade policy has been directed to limiting imports and lowering barriers to our exports in industries where we no longer possess a unique technological advantage. In such areas, foreign nations, now able to provide for their needs domestically, may be willing to contemplate restricting U.S. imports in order to protect local industry. They are much less likely to erect import barriers for products such as commercial jet aircraft, where the U.S. does enjoy a unique comparative advantage.

Thus, for the U.S. to have the economic benefits of free trade, our industry must demonstrate enough technological advantages to maintain the incentive for other countries to grant access to our products. But Americans view with ambivalence a strategy that advocates economic interdependence. Some people perceive a conflict between, on the one hand, national security and domestic political requirements for minimizing economic interdependence; and, on the other, the efficiency of an interdependent economy based upon the maximization of our comparative advantage. The formation of producer cartels clearly emphasizes this problem, as does the continued emphasis of major industrial nations on protecting their strategic military posture. In addition, there are

many unresolved issues involving the appropriate extension of national sovereignty over the policies of companies that are physically within their jurisdiction or which may own subsidiaries within the jurisdiction of another nation. Corporate policies of maximum political neutrality may fail to satisfy the expectations of any government. Transfers of technology, the payment of royalties and the location of R&D facilities are particularly sensitive issues in this connection.

Myths That Need Exorcising

A particularly serious impediment to analysis in this field is that measures of national economic success reflect macro-economic data, while the evaluation of technological innovation is essentially a micro-ecomomic analysis. Thus, the evaluation of the international competitive position of a given enterprise, product sector or area of technology may be instructive for what it tells us about U.S. competence in that regard, but it may be exceedingly difficult to draw unambiguous conclusions concerning the economy as a whole.

Discussions of this subject are fraught with many myths that need to be exorcised through analysis. Among them are the following:

- Technology flows unidirectionally from science.
- Government research investments to stimulate commercially-useful technology can never be justified.

- Direct foreign investment usually follows cheap labor rather than rich markets and thus represents "job exports".
- Technological advantage can be protected by export barriers.
- Products made and sold overseas could just as successfully be made in the U.S. and exported.
- U.S. industry can compete on the basis of superior financial and managerial skills alone.

Such myths are much more prevalent in political debate than in the writings of serious scholars of economic and technological policy. The compulsion to search for macro-economic generalizations that can justify sweeping national policies and simplistic value judgments seems overwhelming. Yet the cause of objectivity may be better served by attempting to focus on specific issues and specific examples.

Three Fundamental Issues

The policy issue for debate cannot be free enterprise versus federal intervention. Almost all of us belive in the value of decentralized economic decision-making with a profit incentive for efficiency and innovation. We also believe that society must be able to reach consensus and implement policies that make micro-economic decisions conform to future realities and to the public interest. The real questions are those that deal with maximizing the technical and economic effectiveness of private institutions, and with defining the purposes and improving the effectiveness

of public regulation and intervention. Three issues of public policy seem to me to be most fundamental:

1. How effectively do federal policy and federal R&D expenditures support the national scientific and technical infrastructure upon which economic performance rests? In recent years U.S. "science policy" has never explicitly accepted this focus. The institutional capability of the federal government to evaluate the technological capability of institutions in the private sector is minimal, and historically most of the federal programs aimed at creating new technology have been focused on the government's own operational requirements, particularly in military and space programs.
2. How effectively does the government incorporate technological insights in policy formulation -- in the Congress, the Executive Office of the President and the departments and agencies? The track record for incorporating scientific insights into policy formulation concerning health, safety or the environment is very much better than the evaluation of the technological components of economic policy. Policy for technology is made nowhere in the federal government; economic policy is made everywhere. The intersection of the two is understandably in a poor state indeed.

3. What relationship can and should be established between government entities and private companies, given the delicacy of this relationship in a democratic capitalistic society? How should the government gain access to technological experience from industry without becoming vulnerable to special pleading? How can corporations cooperate with the government without being accused of such pleading? How can the government achieve foreign policy objectives that call for the modulation of international transfers of technology to developing countries, to communist nations or within our alliances? How can the government stimulate the formation of new industries and new private capabilities without disrupting the market economy or playing favorites?

It is popular to speak of "partnership" between public and private institutions, but the simile is not apt. Government and industry have distinct roles and responsibilities. What is needed is consensus on national economic priorities and competence to establish the priorities and carry out the needed policies. The result -- hopefully -- would be increased public confidence in the leadership of industry and government, which today is at a low ebb.

TECHNOLOGY AND TRADE: THE HIGH-TECHNOLOGY COMPANY

Edward L. Ginzton

The issues discussed in this seminar are of critical importance to a company such as mine. We are a high-technology electronics company which, in its 26 year existence, has seen its products find use throughout the world. Indeed, several parts of our company export on the order of 50 percent of their production today.

Our technology, which involves microwave equipment, special vacuum-tubes and analytical equipment used in the chemical industry, is relatively new. It developed, in part, as a result of the rapid progress in applied science which occurred in the United States during and shortly after World War II, a time when corresponding developments in other countries were greatly slowed by the war's impact. Perhaps because of the momentum thus gained, and perhaps because of the emphasis on research which resulted from the perceived "missile gap", research and development in American universities and in industry received substantial support from several agencies of the U.S. government. Our healthy economy and the urgent reconstruction needs of Europe and Japan made the export of American capital goods and other high-technology products important as well as straightforward.

The Challenge to U.S. Leadership

But this period did not last long; soon the industrial strength of Europe and Japan -- and later of Eastern Europe -- began to develop with notable success. During this period, even though exports from the U.S. continued to increase rapidly, the inverse process also began, and in many product areas imports from Japan and Europe created a major impact upon American industry, as well as upon our balance of payments. Products such as Sony radios, VW automobiles, and Nikon cameras are but a few examples of this success; they illustrate dramatically that neither in science nor technology does the U.S. possess unqualified or automatic leadership.

Thus, starting in the late 1950s and continuing to the present, we find overseas industries continually challenging our leadership. This is partly a natural process which we cannot help; there simply is no reason to believe that Americans should be best in everything. However, to a certain extent the successful challenges by overseas companies result from the fact that they have been operating in economic and political climates that favor their success over American competion. In several countries, the existence of American technological leadership was a matter of grave concern to their government. Nowhere was this better described than by Servan-Schreiber's, "The American Challenge". Nor is there any clearer example than the collaboration of the Japanese government with its industry through the controls imposed upon domestic and foreign competion by the Ministry of International Trade and Industry (MITI).

What we have seen recently is a gradual reduction of the support of American high-technology enterprises by lessening investment in research and development, while abroad the successes of American industry are being challenged by government-supported industrial enterprises.

A Detrimental Environment for U.S. Industry

I should like to develop a description of several issues, as I see them, based upon the following observation: overseas high-technology companies expect -- and obtain -- substantial support from their governments whereas, in the U.S., the government is generally passive toward the interests of its industry and, in fact, has created, through regulation and legislation, an environment that is substantially detrimental to industry's ability to compete overseas. I would not want to give the impression that I regard our government's attitude as universally intemperate or harmful. However, I do want to plead that it is imperative that the various elements of the government clearly determine whether their actions in regulating, controlling or supporting American industry are or are not in the national interest. Let me now be more specific.

American high-technology industry, as I know it, is not a small number of large concerns, but just the opposite -- it is a vast array of large, medium and small-size enterprises specializing in a large variety of products and markets. These organizations meet national competition in every country where they sell.

As they do so, they meet a variety of American restrictions on the one hand, while on the other they meet competition from companies that are supported or protected in their respective countries. Some examples: in the vaccum products area it was not too long ago that there existed a substantial number of European vacuum products companies roughly equivalent to their American competitors in size and competence. However, with the encouragement and assistance of the German government several of the companies were merged into a single large unit. With reduced local competition and an enlarged manufacturing and technical base, the merged company soon dominated the German market and became a powerful competitor in other markets.

We had a similar experience in the electron power tube field in France. In this case, we had a joint venture with the tube operation of one of the two major French electronics companies. When it was decided in France that this company should be merged with the other large French electronics company, it was suggested that we might like to withdraw from our joint venture, which, of course, we did. Today the French government, which controls most of the purchases from this industry (broadcasting and point-to-point communications as well as military markets), directs all its business to the merged French company. Our only opportunity is to compete against other importers for items that the French company cannot, or prefers not to, produce.

By contrast, similar consolidations in the U.S. would surely be challenged under our antitrust legislation. Thus, I would ask

a question: in these and related areas, are our antitrust laws -- adopted many years ago -- continuing to serve the best interests of the American people?

Declining Support for R&D

Changing the subject, I am sure it is obvious that the strength of an industry depends upon the quantity and quality of research being conducted in the universities where basic research concepts are developed and where future engineers and scientists are trained. It is common knowledge that over the last ten years or so, there has been a diminution of support of basic research in American universities. How this has happened is not the point for the moment; but I wish to ask: is the reduction of support of basic research in the U.S. in the best interests of the American people?

The ability of any American company to conduct research and development is governed by a vast array of governmental practices, regulations and laws. Some of these relate to the restrictive practices of the federal agencies. For example, such agencies as NASA, ERDA and the National Science Foundation require that under their R&D contracts patents resulting from research are owned by the government; but government is patently unable to exploit such inventions as successfully as a private concern competing in international markets.

Also, several federal procurement practices, such as the limitations on the recovery of company-sponsored research and

development costs, diminish the ability of American companies to invest adequately in future research and development programs. Thus, I would ask: are the federal laws, regulations and practices limiting R&D investment in the best interests of the American people?

Controls on Export and Taxation

Consider now the variety of governmental controls on exports and taxation. It is my belief that the U.S. leans over backward in its interpretation of COCOM regulations and continues some unilateral controls of strategic exports unnecessarily. While I do not suggest that there should be a careless attitude toward exporting strategic items, the administrative burden, both in magnitude and in elapsed time, certainly acts as an impediment to our ability to compete overseas. Many of us in the electronics industry believe that the magnitude of controls is excessive and a number of administrative practices are unnecessary.

European and other countries provide a host of financial supports through taxation and other subsidies. For example, in all of the European Common Market countries the value-added taxes on exports are rebated, sometimes as much as 20 percent. This does not happen in the U.S. Even our Domestic International Sales Corporation (which provides a modest benefit via tax deferral) is being threatened in Congress. Some countries have export assistance provisions, either in the form of easy credits, or other forms of assistance generally unavailable in the U.S. For example, the

French government may organize an extensive trade show in China to demonstrate how the French electronics industry's products can meet Chinese requirements. Several countries also ask their foreign embassies to actively participate in supporting export sales of their industrial concerns. Should U.S. government agencies, such as the Department of State and the Commerce Department, actively support development of market opportunities for American companies -- as is done by many other countries?

Concerning Technology Transfer

Finally, I am aware that technology transfer is widely discussed as it has substantial impact on the retention of American leadership, on success of businesses and on employment. I submit that technology transfer is not a simple concept and that it is dangerous to speak either in its favor or against it without understanding the implications in a particular case. I can easily see that in some cases the export of our technology might be detrimental to American strategic policies, or to a continued success of some particular industry or to domestic employment. Conversely, there are kinds of technology transfer which are simply a continuation of normal business developments and cannot be prevented, whether we like it or not. I submit that American industry, on the whole, knows what needs to be done to guarantee continued success of a particular company or organization. Once again, I should like to suggest that development of categorical laws, rules and practices would not be in the best interest of the American people.

In conclusion, I believe that the best interests of the U.S. will be served by a new partnership between the government and American industry -- a partnership which would be based upon a careful assessment of the role of the government in the support of American technology, both domestically and overseas. We could do a great deal of good by studying the structure and purpose of the Japanese MITI to see whether government-industry cooperation as practiced in Japan would not have useful analogs in the U.S. I would hope that our Office of Technology Assessment would find it possible to explore such diverse and complex issues as this.

THE CHEMICAL PROCESS INDUSTRIES IN INTERNATIONAL INVESTMENT AND TRADE

Ralph Landau

The chemical process industries constitute one of the most dynamic and technologically intensive industrial groupings in our country. The abbreviated expression "chemical industry" as employed in this paper, and in common parlance, stands for a related series of product manufacturers, including chemicals of all kinds, paints, pharmaceuticals, detergents, fertilizers, plastics, synthetic rubber and fibers, photographic supplies, etc. Some of their most distinctive characteristics are the following:

1. This industry is capital intensive, not labor intensive, although perhaps one and a half million jobs (a very small percentage of our labor force representing an industry that earns three times as big a percentage of the nation's corporate profits and seven times as big a proportion of U.S. exports of domestic merchandise) depend on it, directly or indirectly. Of course, additional large numbers of jobs downstream are involved in the further conversion and application of the materials produced by this industry. It has an enormous range of products of all kinds, running into the many thousands even in one company.

2. Chemicals are an international business, and many firms are very active in a number of countries. However, foreign chemical process companies are likewise active both here and in third countries. The international and domestic chemical industry is vigorously competitive.
3. Technologically, the American chemical industry is very strong, and has made many major discoveries and improvements (both in substance and in techniques) which have spread to other countries. The profession of chemical engineering, uniquely developed to its present status in the United States, has taken a leading role in all phases of this industry's growth.(1) However, American companies do not enjoy monopoly of inventiveness, as demonstrated by a number of great and important discoveries which came to this country from abroad. The domestic chemical companies traditionally spend large sums from their revenues in research and development, often around 5 percent (in many companies such as pharmaceuticals, much more). It is one of the largest privately financed R&D efforts in the world.(2) Furthermore, this R&D effort carried out by American companies is virtually entirely concentrated in the U.S.; despite statements to the contrary, foreign R&D by American companies is a minuscule part of the total, for many strong and enduring reasons. Our Internal Revenue Service is trying, perhaps unwittingly, to force a change in this pattern by shifting research jobs abroad; this is the real implication of its

new proposition on overhead allocation by international companies. The reasons for such policies entirely elude me, as they are bound to affect our whole industry and its contributions to our economy unfavorably.

4. The American chemical companies are very strong in financial, marketing and manufacturing skills. Taken together with their technological strengths, the real knowhow of this industrial grouping is in such an overall combination of talents, and explains the success abroad of American private companies, both in export of products and in manufacturing in foreign countries.
5. This combined knowhow is privately owned by a large number of companies. The U.S. government has limited knowhow or ownership position in this area, primarily in explosives and other military requirements, and I have found no significant knowledge about it in either the executive or legislative branches, although individuals can be found in government whose past experience has educated them to the complexities of this very intricate industry.

One visible evidence of the importance of the chemical industry to the American economy can be seen in the figures for the 1974 American balance of trade.(3) In that year, the industry's favorable balance was just under six billion dollars whereas, in the same year, the balance for all other commodities was unfavorable

by almost nine billion dollars. Put another way, the total U.S. trade balance last year with chemicals included was about minus three billion dollars, but without chemicals the deficit would have stood at over nine billion dollars. Furthermore, this industry has consistently maintained a favorable balance of trade over many years. Compare this sterling performance with our automobile and parts industry, which had an unfavorable balance of trade in 1974 of -2.76 billion dollars; for the electrical machinery balance, it was only +1.6 billion dollars; for iron and steel manufactured products, it was unfavorable by -2.8 billion dollars.

In addition, the industry has created an overseas investment base which contributes return of profits as an "invisible" export. Last Year, all U.S. business brought back over six billion dollars of foreign exchange(4) and, while I do not have an exact breakdown of the figure, the chemical industry must have contributed a respectable proportion of this total, probably approaching one-third. Furthermore, our industry earned roughly another 0.8 billion dollars from foreign licensing fees.

It can be seen from this very cursory review that we are dealing with an industry that constitutes one of our country's leading economic assets, and one which, unlike some others, is dependent entirely upon private capital and research for its growth. Hence, it shall be my purpose in this paper to extract some recommendations from this industry's experiences toward the general theme of this seminar in studying what is in the best interests of our country. Technological leadership will be the theme referred

to herein, but it must be clear from the above summary that technology is by no means this industry's only asset. Others, in addition to those mentioned above, are its large scale, its hitherto abundant and relatively inexpensive domestic raw materials, its freedom and willingness to innovate and spread abroad, the opportunities it offers for smaller as well as large companies (the importance of this being that smaller firms are usually more innovative[5][6]), the decades-long close association with a large number of the world's leading process plant constructors and engineers, its high standing in the world financial community, etc. The chemical industry is a most sophisticated world system, of basic economic importance to this country and the industrial sphere.

But, first, a few words about my presuming to speak about so vast and intricate a structure. I have spent thirty years in this industry, the first half in creating, I believe, a widely respected international chemical engineering company that pioneered in licensing technology as well as designing plants for a variety of organic chemical processes, most of them invented by our own R&D efforts -- in fact, my citation for election to this Academy in 1972 referred to my activities in this area. I have also been honored by being elected to the Council of the Academy. More recently, however, I have been involved in helping to create a new worldwide chemical manufacturing company, likewise based on original invention (the Oxirane group). Consequently, in these thirty years I have come to know the great majority of chemical and petrochemical

companies of the Free World. I have presented some of this history in a paper[5] delivered on the occasion when I was fortunate enough to receive the Chemical Industry Medal of the Society of Chemical Industry (of which I am now a vice president). Through my membership on the M.I.T. Corporation (Board of Trustees), I have been privileged to continue my association with the continuous intellectual ferment of the greatest scientific and technological university in the world, from which I first earned my Sc.D. degree in Chemical Engineering. However, I am speaking for myself alone, and not for any of the institutions with which I am or have been associated.

It must be apparent that any analysis of the American leadership role in the chemical industry has to incorporate the total system. Here the non-technical considerations are more important than the technological components. How well the chemical -- and any -- industry flourishes is very much affected by taxation, monetary restraints, governmental restrictions on investment and dividend policies, governmental action pertaining to environmental requirements, nationalization threats, tariffs and other barriers to the flow of capital and goods, and the like. The productivity and innovative quality of our domestic environment are still very much in need of improvement, and indeed I have testified on some aspects of these matters before Senator Bentsen's sub-committee of the Joint Economic Committee of the Congress.[7] A recent editorial in Science touches on the same subject.[8] But, clearly, these matters are not properly the function of our Academy and this

seminar, although we should be concerned about them. Nevertheless, the technological component of the chemical industry is indeed one of its major assets, and its protection is a legitimate concern of the National Academy's studies.

A Case of Copying

The Export Control Act, which has been in existence since 1949, bears specifically on this issue, and my company has had some unusual direct experience with its functioning. A few years ago, it came to our attention that one of our own licensees (a government-owned company in a friendly country) for an important original process of ours had sold what appeared to be a close analog of this process to a country in the communist bloc. After our own extensive investigation, we succeeded in obtaining evidence of what appeared to be outright copying of our process. We initiated litigation to recover damages, and succeeded only after intensive effort in persuading the Commerce Department to invoke the provisions of the Export Control Act. The result of these combined actions was a settlement by the foreign government entity involved: with us, for monetary compensation, with our government, for cessation of such activities. To my knowledge, this was the only time a foreign government organization was so penalized under the Act with respect to improper technological exports from the U.S. Unfortunately, one of the terms of the settlement was a reduction in the period of secrecy obligation by our licensee, and that group is now offering a process somewhat like ours in

various countries of the communist bloc, at least. Of course, we are counting on our own R&D to help maintain our leadership in this area, but our new competitor gained at least a twenty-year head start by having access to so much of the latest American technology in this area.

My account of the foregoing experience is intended to underline what I feel to be are the legitimate areas of government intervention in our field: namely, to help protect American patents and trade secrets from abuse or piracy and to recognize the vital role of government in helping private industry (as I have emphasized above) in its efforts to earn foreign exchange and profits by trade and investment abroad. The knowhow of our industry owes nothing to government inspiration or funding (with surprisingly little defense budget fallout except in a few instances, such as government research in high technology metals like titanium, used in many ~~chemical~~ chemical processes), and it should, therefore, be up to each owner of such knowhow to decide how best to exploit it to maximize his earnings. Usually, if not always, the owner is in the best position to assess the competitive merits of his technology as against that available from others.

Priorities in Exploiting New Technology

It is my observation that, increasingly, owners of such knowhow follow a system of priorities whenever they have new or improved technology to exploit:

1. First preference clearly is to mount a manufacturing plant

in the U.S. at the earliest possible time, to prove out the technology and to secure a favorable position in the marketplace. Included in this strategy would be a major effort to export the products to foreign markets, thereby permitting faster loading of the domestic plant, and development of market penetration abroad. In our industry, however, the cost of shipping the great majority of its products abroad is quite high relative to the selling price, and most countries have erected substantial tariff barriers (as indeed have we) so that there are limits to the amounts of products that we can export in the face of foreign competition.

2. Hence, second preference would go to investing in a plant abroad, as early as market considerations permit, to exploit the same technology, with, if possible, the same ownership as in the U.S. If the foreign market has been prepared by exports from the American plant, it is ripe for a "world size" plant to be built. The risks here are inherently greater, but if the investment is timely and well chosen it can gain for the American company a possibly commanding lead in the foreign markets and ensure its ability to compete successfully without freight or tariff barriers. Furthermore, such foreign manufacturing usually leads to further needs for imports from U.S. plants (such as raw materials and intermediates), and the net result is definitely greater exports from the U.S. than if

no foreign manufacture were undertaken. Finally, if such action is not taken, sooner or later, other foreign companies will figure out how to move into this market, and despite patent and trade secret protection (which are highly variable and weak depending on the country involved), the American company will see the loss of its former technological lead. In some countries, also, the laws or practices make sharing the investment with domestic entities mandatory, and this can lead to complications for the American investor.

3. In the absence of opportunities to invest, third preference would be given to judicious licensing of the technology in friendly countries abroad. The high cost of R&D today makes licensing of an important discovery generally very unattractive because the royalties allowed by trade practices are too low to permit an adequate return compared with manufacturing the product. Just when the new technology is really well established and production is rising, the royalty payments cease, and secrecy obligations usually expire. Furthermore, the high R&D cost is due in large measure to the percent of failures found in all company research efforts. A licensor wants to pay only for the successes, and does not contribute to the cost of the failures. Thus, the export of goods from the U.S. or their manufacture in selected foreign countries is much superior to licensing for royalties or equivalent. This is also true when the discoveries are only improvements, and which would command little if any royalties. Of course, there are companies and groups which own technology but have no manu-

facturing capabilities or aspirations; these are most likely to license their knowhow.

4. The last preference would be given to sale of the technology to countries whose foreign policy is often unfriendly to us, particularly in the communist bloc. Here, the concept of a joint venture as we understand it is particularly difficult, if not impossible, to implement, and enforcement of secrecy agreements and protection of patent rights held by the western firm is uncertain. Moreover, competition in the international marketplace from products made in such licensed facilities often comes back to bite the licensor hard, for many of these countries do not price their exports in a rational way, but in any fashion to earn foreign exchange, or to accomplish their government's foreign policy goals. However, no evidence is available to me to suggest that communist countries are not scrupulously honoring their contractual obligations; still these run out eventually, and the country is free to use the technology in any way it sees fit.

Our experiences with Japan, a friendly power and one whose economic health is important to us, show what can be done by application of the imported technology and its effect on the trade of the countries providing the technology. In any case, unless the cash return or equivalent in valuable raw materials or products is high enough, this path may well turn out to be a poor one in the long run for any really advanced technology.

5. The above sequences, while representative of present thinking, do not cover all the real possibilities in our complex industry. Thus, an American invention may first be commercialized abroad, then introduced into the U.S.A.; the reverse is also possible. We have had many experiences in these types of arrangements, and there is usually a good reason for them.

The Competition for Russian Favor

Since the present unfavorable economic trends in the communist satellite powers are making it increasingly difficult for these countries to buy technology from abroad, it is primarily with the U.S.S.R. that these concerns exist.(9) This is not the place for me to speak about detente, but no private owner of valuable technology can afford to overlook the problems mentioned above, and be guided accordingly.(10) This is equally true of the demand by that country for large and cheap credits. As the New York Times said,(11) "That Moscow should want maximum competition among western nations for its favor and its orders is entirely understandable. But even those who believe in greater Soviet-Western trade, as we do, may question whether subsidized credits for a major industrial nation -- as the Soviet Union has become -- is in anybody's interest, especially when the creditor is in a shakier economic position than the borrower...the U.S.S.R. today is very much of a 'have' nation compared to almost any other country in the world. It ought to begin acting less like a mendicant and more like an equal trading partner."

It is this international competition for Russian favor (technological and financial) which makes the American problem so complex, since, as I said at the beginning, the American chemical industry does not hold a monopoly on inventions or knowhow. Hence, an important role for the U.S. government in protecting our position lies in diplomatic efforts with our allies and friends to minimize such international bidding for credits and the sale of knowhow except when the terms are fair. At least so far as this industry is concerned, government can play its best role by avoiding any regulatory activities, except its obligations under the Export Control Act, which permit selective vetoing(10) of the proposed international transfer of technology. This has very rarely been exercised in recent years. In any event, there is need for appropriate appeals, preferably to a Presidential level science and technology council. Our government will make its most effective contribution to international trade by generally deferring to the judgment of the owners of the knowhow as to the best ways of exploiting that knowhow. I cannot see how any government planning function in this area could be productive at all; on the contrary, it would have a depressive effect on a very progressive industry. In any consideration by the U.S. government regarding the international transfer of technology, the first concern should be the encouragement of our domestic economic health, for it is this which continues to fuel our strong technological progress. Some aspects of this problem are referred to in one of my papers.(5)

Efforts should be made by our government to encourage development of patent systems in the suddenly affluent OPEC countries, where in many instances no such patent systems exist. Because of this lack, American inventions can be utilized freely, in conjunction with the cheap hydrocarbon resources of these countries, to flood the world market with goods that can undercut our own or our allies' exports. Certainly these matters should be taken up by our government in its energy talks with OPEC countries, and in its trade talks with many other countries. Anti-dumping provisions for products made in the absence of law and the presence of cheap hydrocarbons (priced below world energy prices) must be embedded in future agreements of this kind. Furthermore, care should be exercised in trade negotiations generally, not to damage so valuable an industry; for example, only sector bargaining should be considered.

How Technology Is Traded

Implicit in all of the foregoing has been my sense of the comparative insecurity of American technological knowhow, particularly where the American owner can have no participation in the manufacturing plant.

Consider the pattern of trade in technology:

1. The great bulk of the technology exported from the U.S. goes to Western Europe and Japan.
2. The great bulk of the technology exported from the west to the east bloc (and now possibly of the Middle East) comes from Europe and Japan.

3. The east bloc (and third world countries generally) prefer to buy complete packages wherever possible, including financing, supply of equipment, engineering design, knowhow, license rights for same and consulting services during startup. This practice has given Western European and Japanese companies great advantages over the U.S. firms for a number of reasons. To mention just a few:

   a. Financing of the type favored by the customers is not feasible in America. Loan terms considerably in excess of five years are now common, and government insurance and other schemes are much further advanced in Europe than in the U.S.

   b. Europe and Japan have had lower costs of equipment and personnel than we do.

   c. European and Japanese technologists are much more willing to live in Eastern Europe and communist China for long periods during construction and startup, despite such episodes as the sentencing of one Vickers-Zimmer engineer for espionage in Red China a few years ago, and cancellation of the contract.

   d. European and Japanese entities are much more willing to engage in barter arrangements, even including output of the proposed plants, so as to permit the communist bloc countries to finance the projects largely from the west.

e. As mentioned before, many European organizations, particularly those in which governments are involved, are willing for national prestige purposes or balance-of-payments reasons to sell technology very cheaply compared with what would be considered an adequate return by comparable American entities.

f. American companies have generally felt that once a sale of process knowhow or other form of knowhow takes place behind the Iron Curtain it is difficult to police copying of this knowhow elsewhere; therefore the compensation should be reasonable, not bargain-basement pricing. However, the extensive European and Japanese competition described herein has made this philosophy very difficult to achieve in most instances.

g. It is known that the Italian Communist Party and very possibly the French counterpart are very active in promoting sale of technology from companies inside their countries to the communist bloc countries. Luigi Barzini stated in The New York Times several years ago[12] that the Italian Communist Party received a commission on all sales to the Iron Curtain countries.

4. Although, as mentioned above, there exist technology export controls in the United States, and the COCOM countries to a lesser extent, their effectiveness is

diminishing. Of course, it has been difficult to persuade the COCOM and OECD countries to cooperate very effectively in this area. But the greater problem is due to the fact that technology is increasingly leaking from Western Europe and Japan (even though originally of U.S. nationality), by a variety of means (instances of each kind are known to us, and to others in the industry), viz:

a. Outright misappropriation. It is the widely held belief by American industry that many such cases of misappropriation of American technology have occurred, but it is exceptionally difficult to prove this for any specific case.

b. Disclosure by American personnel employed by foreign entities, emanating from their knowledge of American secret knowhow. Often these instances involve contravention of personal secrecy agreements with former employers.

c. Disclosure by European personnel who have worked on projects involving American knowhow, to other European companies which are not yet bound by any formal secrecy obligations, and who then retransmit the data behind the Iron Curtain. A ring of this type was recently uncovered in Italy, but the same practice has been known to occur in France and elsewhere.

d. Espionage by employees of one company with relation to employees of another company which has American

technology and which the first company then re-transmits to the Iron Curtain. It is believed that at least one such case is known to have occurred in Japan.

e. Espionage by east bloc government and technical personnel in Western Europe and less often in the United States.

This question of Soviet espionage is at last receiving more public scrutiny. Recently, Mr. Tom Normanton, a member of the British Parliament, made the following remarks at the European Parliament in Strasbourg:(13)

"We need not remind ourselves that the greatest leap forward in aeronautical technology, namely, the Concorde aircraft, has been copied in almost every detail by the Russians. That stems from the fact which I am sure nobody can deny that copies of blueprints, copies of designs -- the product of research of the [European] community -- have been handed over in totality to the U.S.S.R."

Other examples are contained in recent articles by "Foreign Report", published by the London Economist. One such issue deals with the KGB (Soviet Secret Police) activities relating to multinationals. "The KGB delegates who sit in on the Soviet Council of Sciences regularly point out -- when the discussions turn to the purchase of technology from the west -- where techniques can be stolen more cheaply than bought. (KGB spies in

West Germany succeeded in 'borrowing' the most sophiscated railway computer technology on offer.)"[14]

f. The required publication of patent applications in western patent offices often signals to observant Iron Curtain technologists important directions being taken by the west.

g. The talk of a "Technology Gap" has encouraged and justified to some inaction regarding prevention of the leakages of technology as described herein by propagating the idea that Robin Hood should get technology from the richer nations and give it to the poor!

Plugging the Leaks

This being the case, how can the leaks be plugged more effectively than they are at present? Here are some recommendations:

1. The American government should encourage the writing of contracts by private companies for license or sale of American technology to foreign entities that include a clause prohibiting the sub-licensing or further transfer by the licensee or purchaser of technology in the same field as the subject licensed. There are too many cases known to exist today where the foreign licensee, through an affiliated or associated company, alleges to have developed an independent source of technology similar, if not identical, to the acquired American ~~technology~~,

cases known to exist today where the foreign licensee, through an affiliated or associated company, alleges to have developed an independent source of technology similar, if not identical, to the acquired American technology, which it proceeds to sell behind the Iron Curtain and elsewhere. Actually, our government should prepare detailed recommendations and warnings to private companies regarding all the security problems mentioned herein.

2. Efforts should be exerted, by treaty and otherwise, to strengthen trade secret rules and judicial precedents and practices; talks should be undertaken with foreign governments to suggest improvements from our own experiences in the loose legal protection provided to trade secrets and patents by much of foreign law. Even in the United Kingdom, for instance, there is very little restraint on an individual who works for a company which may itself be obligated to secrecy. Perhaps international courts with expertise might be established to deal with technology matters. It is not illogical that "knowhow", which originated as an American concept, should also be followed by an international legal doctrine which adopts some of our experiences for the benefit of the more orderly international flow of technology.
3. Government bureaus abroad should be better staffed so they can feed to American industry and the various governmental

agencies at home commercial intelligence concerning technology flow, and trade opportunities.

4. As a corollary to the above, the government could give a great deal more general help to private business in all of its international affairs, without getting involved in the business itself. The current philosophy of some government agencies -- and too many government personnel, including some Congressmen and their staffs -- is that any government help to private industry under any circumstances is per se bad. This all-too-prevalent attitude presents a marked contrast to that obtaining in the foreign ministries of most of our allies and certainly of our opponents. These ministries are regarded as essentially organs of business and government in promoting international trade to the maximum possible extent. One of the biggest changes that can be brought about under any administration is to help develop a clearer understanding of the vital role of private business in creating and maintaining our technological lead. And, it would help if younger engineers, businessmen, and the like would vie for election or placement with the (mostly) lawyers who are active in the political process.

5. A "Robin Hood" type of problem has arisen among some friendly countries of the third and fourth worlds, who are insisting that the price they pay for modern technology is too high (the President of Mexico, for example). But no

one questions that they should pay prevailing interest rates for monies. Why this discrimination? Our friends in these countries should be helped to understand that because of the limits of skilled U.S. manpower, and the initially small scale of their requirements, the time and cost required to transfer the technology are often inordinately high, and the compensation must be equally so. The risks of leakage to third parties must also be evaluated.

6. A more flexible policy could be adopted by U.S. sellers of technology regarding the kind of information which might be exported as part of a knowhow sale in selected cases. For instance, detailed equipment drawings might be excluded from being supplied with the equipment bought (catalyst manufacturing information is already prohibited from being exported to certain countries, but exports of the catalyst itself are allowed).
7. Particular attention should be called to enterprises that are established and owned by some of our allies and friendly countries. These organizations sometimes evidence a cavalier disregard for the origin or protection of knowhow when they determine to use such knowhow for political or commercial reasons. An example of this type of opportunism is found in the recent agreement between some American companies and the French aviation industry with regard to data on swing wing design. The British were more than slightly

disturbed because they cooperated with the French in the development of the swing wing designs and they felt that much of their knowhow was incorporated in the material which the French proposed to sell to the U.S. This example demonstrates that other countries have sensitivities which could be utilized in developing much more carefully thought out trade secret and export policies than now exist. Our government can be more effective here than most private companies.

8. It might be possible to develop patent doctrine in treaties with friendly countries which would prevent the export of technology (and sometimes products) to the Iron Curtain as well as countries not covered by an adequate system (as mentioned before), where the technology is protected by patents in the allied country. Many American companies do not obtain patents in the Iron Curtain countries because there is considerable doubt that these have any value, or in other countries because of the lack of an organized patent system. Consequently, companies in allied countries, utilizing disclosures in patent applications filed by American companies, proceed to develop technology for export to these other countries. Such technology would not be saleable in the exporter's own country because of the American's patent protection. Perhaps this anomalous situation might be changed by appropriate treaty.

9. Additional efforts might be made to permit action against American individuals who transmit valuable knowhow (even though they have personal secrecy agreements) while working for foreign entities.
10. A new problem has recently surfaced: the strong possibility of control being acquired in American companies with a strong technological base by foreign countries which have gained great wealth, beyond their own needs. This is a most complex question that is beyond the scope of my remarks here, but, again, one must not oversimplify. If government is to oppose such take-overs, it must also provide alternate financial mechanisms to compensate the shareholders involved -- a most difficult task.

I have devoted a perhaps inordinate amount of space to the issue of protecting American technological knowhow because it really underlies all decisions which private companies and our government must make each day in the many areas of activity touched on at this seminar. It is important to understand the nature of this problem, and my long experience in it may be of value to the further studies this Academy may undertake.

In conclusion, I want to reiterate my feeling that the role of government must not be that of a top centralized administration overseeing our technological posture. Let us avoid the mistake the Soviet Union has made, and which keeps it in the position of seeking our knowhow.[15] However, in a true complementary

relationship between private industry and government may be found the American way to maintain a proper and long-lasting preservation of the dynamics and statics of our technological leadership.

Apropos of this conclusion, when I had finished my prepared speech, I was delighted to read President Ford's remarks on April 18th, mostly in connection with the opening of our Bicentennial celebration, which express admirably some of the basic motifs presented in this paper. Here are a few pertinent extracts from The New York Times of April 19, 1975:

"Speaking in the Statehouse in Concord beneath portraits of George Washington, Abraham Lincoln and Daniel Webster, Mr. Ford asserted that the United States government could not go on making promises and increasing spending. 'The heart of our financial dilemma', he said, 'is the endless stream of promises made to the American people in the last generation and this, that the government can and will satisfy most of their needs and their wants.' He added, 'The American people cannot live on promises: we must live on production.'

"Mr. Ford attacked the federal regulation of business and industry and said, 'We must reassess the archaic and rigid regulations which hamper the United States economy and directly affect the American consumer. In far too many cases, government regulation has become counterproductive and remote from the needs of businesses and consumers alike.'

"But the thrust of his remarks was that the government should do less, not more, to regulate business. 'An outdated

view of business as the oppressor, which must be controlled by the government, has also contributed to the failure to tackle reform,' he said. 'The relationship between the government and business is a relationship between government and consumer, and this must be the spirit behind re-evaluation and reform. The producers and consumers in our system are not enemies, but partners.'"

NOTES

(1) R. Landau, *Chemical Engineering Progress*, 68, June 1972, p. 9

(2) Speech by Edward M. Giles, F. Eberstadt & Co., Inc., before St. Louis Society of Security Analysts, February 27, 1975

(3) *Chemical Week*, February 19, 1975, p. 11

(4) *The Wall Street Journal*, March 24, 1975, p. 14

(5) R. Landau, *Chemistry & Industry*, February 2, 1974, p. 96

(6) D. W. Collier, *Chemtech*, February, 1975, p. 90

(7) R. Landau, Testimony, *Hearings before the Joint Economic Committee*, Subcommittee on Economic Growth, U.S. Congress, October 2, 1974

(8) W. D. Carey, *Science*, April 4, 1975, p. 13

(9) *The Economist*, February 22, 1975, p. 92

(10) *Harvard Business Review*, January - February, 1975, p. 18

(11) *The New York Times* , February 21, 1975, p. 30

(12) L. Barzini, *The New York Times Magazine*, February 13, 1966, p. 44

(13) T. Normanton, *Report of Proceedings*, European Parliament, Tuesday, July 8, 1975, p. 52

(14) *Foreign Report*, October 15, 1975, "The KGB and the Multinationals"

(15) *New Scientist*, January 23, 1975, p. 195

CASE STUDIES

ELECTRONICS: JAPAN

William P. Doolittle

In many ways, the experience of my company, Hewlett-Packard, parallels that of Varian Associates, discussed by Dr. Ginzton. During 1974, our sales on a worldwide basis approached $900 million and 48 percent of this business came from customers outside the United States. During the first quarter of 1975, our international business exceeded our domestic business for the first time. Approximately 70 percent of our international business is in the form of exports of finished goods from the U.S., while the remaining 30 percent consists of value added at our various factories around the world. One out of every three of our manufacturing employees here in the U.S. owes his job to orders which we obtain from foreign customers. The more rapid rate of growth of our international business, compared to our domestic business, has been a prime factor in our ability to maintain full employment in our U.S. manufacturing facilities despite the current economic difficulties.

Our experience in manufacturing abroad has changed considerably over the years. Fifteen years ago, we started our first foreign manufacturing program in West Germany largely because we were not competitive with our German and Common Market competitors. American

goods entering Germany and the Common Market faced high duty rates, transportation costs were expensive, and German labor rates were about one-quarter that of the U.S. It was obvious that if we were to compete effectively in such markets, at least a minimal assembly/manufacturing effort would be required; unless, of course, a particular product had technological advantages sufficiently extensive to overcome these disadvantages.

Little Cost Advantage Abroad

World conditions have changed remarkably, especially during the past five years. Higher inflation rates abroad, the realignment of the U.S. dollar in relation to many world currencies and the lowering of duties through the implementation of the Kennedy Round, have enabled U.S.-produced goods to obtain a more competitive position in world markets. Today we find little, if any, cost advantages in manufacturing in foreign locations.

Instead, we find that a local manufacturing presence benefits us in other ways. In Germany, the United Kingdom, Japan and France, where we have major international manufacturing activities, we are considered part of the local community. As a result, customers in these countries are no longer concerned if a Hewlett-Packard product is produced locally or elsewhere, and sales have increased remarkably with exports of finished goods from the U.S. growing at rapid rates. In Japan, for example, our business has increased some twenty-fold since we established a joint venture manufacturing/marketing subsidiary in 1963, and today 66 percent of the products we sell in Japan are exports from the U.S. and only 34 percent are

manufactured locally. This volume of U.S. exports would not be possible without a strong local manufacturing/marketing presence.

A manufacturing presence abroad has also allowed us to tap local technological skills, complementing those available here in the U.S. Each of our overseas manufacturing facilities has its own research and development activities which yield products complementary rather than competitive with those developed and manufactured in the U.S. These unique products enjoy world-wide distribution and make up 30 to 50 percent of the manufacturing volume of each of our major foreign manufacturing subsidiaries.

No U.S. Monopoly on Technology

The U.S. has no monopoly on technology. Recently, we entered a new product area and, because we did not have in-house technological expertise, we decided it would be best to acquire an existing firm. We looked very carefully at a number of firms in the U.S. and in Europe and, finally, because European technology was superior, acquired a European firm as our vehicle to enter the new market.

During the 1950s and the early 1960s, the Japanese purchased an extensive amount of technology from U.S. companies. Although at the time I am sure the sale of such technology appeared to be a good deal for the U.S. companies, in retrospect the Japanese seem to have gotten the best of the bargain. For quite a time, the fruit of much of that technology came back to the U.S. in the form of Japanese products manufactured at much lower labor rates. However, this situation no longer exists. Fully-loaded Japanese labor rates are now quite comparable to similar U.S. labor rates

and we now see Japanese companies, such as Sony, manufacturing here. Recently, Motorola sold its television line to a Japanese company which believes it can run the line more profitably. The picture is beginning to change.

It has been Hewlett-Packard's policy to refrain from licensing the use of its technology by unrelated parties. We feel that licensing an unrelated party only builds a future competitor, and we already have enough competitors without developing more! However, as we view some of the newer market opportunities, particularly the communist countries, we feel it is going to be more difficult to control our technology.

Chapter VIII of the President's International Economic Report, transmitted to Congress in March, 1975, highlights some of the problems of science, technology and the international economy. In this chapter, the President refers to the major program of cooperation in the field of science and technology agreed to by the U.S. and the U.S.S.R. in May, 1972. As a result of the signing of this major governmental agreement, the Hewlett-Packard Company and a number of other U.S. firms in the field of high-technology, have entered into protocol agreements requiring reciprocal cooperation.

The word "cooperation" seems to lose something in the translation from Russian into English and vice-versa. To many of the Soviets it seems to mean a unilateral willingness on our part to supply a wide variety of high-technology. I can assure you this was not, and is not, our intention, and I am sure it was not our government's intention when the original agreement was concluded three years ago. We want to be responsive and cooperative, but only

when our mutual interests are served. In this connection, I believe this is an area where U.S. companies, such as ours, need governmental assistance and guidance. We appreciate that U.S. technological leadership has an important impact on our country's military capability and believe the government should find some means whereby we can receive prompt advice as to the specific areas of technology in which it believes it is appropriate to cooperate with the U.S.S.R. Hopefully, the problems we currently face in the area of technological exchanges with the communist countries will find some resolution within our government in the very near future.

EXPORT-IMPORT BANK

Raymond J. Albright

Not long ago the Deputy Chairman for the Soviet State Committee of Science and Technology announced that his country had signed about 170 scientific and technological agreements with industrial corporations in the west. Thirty-eight were with American firms, and he hopes to sign more. We at the Export-Import Bank, in our contacts with industry, have heard that this sort of arrangement becomes the door-opener to a sale. A company's first step is to have an agreement on cooperation within a fairly broad framework. This agreement then becomes the door-opener for the Soviet side to negotiate for the specific technology it wants. In many cases this is not just raw technology of the hardware type, but is in the design or managerial area--what you might call the software. Certainly, in terms of management of its economic facilities, the U.S.S.R. is as interested in this type of knowhow as it is in the harder scientific technology.

Now, what is the Ex-Im Bank trying to do about this? Actually, we are just one of the governmental instruments involved in the whole detente policy, and we operate in line with government foreign policy. However, as a bank we also have a charter from Congress which tells us to be an independent agency; to make our credit judgments, and evaluate on economic grounds the merits of particular transactions that are brought to us.

To be clear, we are not an instrument of the State Department or AID or any other U.S. government agency, but, as a part of the U.S. government, we obviously work within the framework of what is current policy. I don't want to go into the details of the various techniques for export control, but I shall point out that Ex-Im Bank does have to rely on the Export Control Act administration by the Department of Congress and Munitions Control in the Department of State which develops these control decisions. Other agencies participate, such as Defense, the Atomic Energy Commission, or whoever may be involved.

We do not try to duplicate the technical evaluations these agencies make on what could be of strategic importance to our country or in the national security interest to deny. However, we will not finance exports the control procedures say should not be exported.

Where we become involved with the Soviet Union and Eastern Europe in technological exports is usually through technology that is incorporated in machinery and equipment being sold with our support. We do not provide financial credit support for software (knowhow and licenses) alone. In many cases, some of this software is incorporated in a major project transaction in which we are participating, so it will be part of the total financial package, but we are not out trying to promote exports in software alone through our programs at this time.

I mentioned that we have a charter from the U.S. Congress, and, if you have been following the recent debates in the Congress

on the Trade Act and our Export-Import Act, one of the great concerns is trade with the U.S.S.R. There are also some other considerations in this technology area which are of growing interest to us and which are of growing Congressional interest also.

The whole question of economic impact, the possible adverse effects on the U.S. economy, has received considerable attention and is now reflected in some very specific provisions in our latest legislation. Among the criteria our Board of Directors are supposed to examine in reviewing an application for credit support, are any serious adverse effects of such loans or guarantees on the competitive position of the U.S. industry, the availability of materials which are in short supply, and possible effects on employment.

Some Delicate Tradeoffs

We have a general injunction here which involves some difficult tradeoffs. On the one hand, our charter says we are to promote exports, help the U.S. economy develop its productive resources and help employment. At the same time, we are not to do this in a way which creates competing productive facilities overseas that would have these other adverse effects. So, we want to help our exporters compete in the face of financial support which governments of other countries give to their exporters, but how do we do this while minimizing the adverse effects at home? We are currently trying to devise ways of dealing with these tradeoffs.

There is a similar injunction to watch the impact of our export financing in the energy field. Again, we must strike a balance between helping create energy resources overseas which could benefit the U.S., and exporting technology or materials in short supply so that we somehow damage Project Independence or the development of resources at home. Again, we have a delicate tradeoff.

These energy considerations came into focus in the discussions relating to the Soviet Union. There have been two large natural gas projects under consideration in Siberia, and Congressional debate was very clear on this is issue: the Ex-Im Bank is not to go beyond the research and exploration phase in financing any one of these projects without coming back to Congress to approve the funds which could be involved if these projects went on into production.

This is a major area of debate that is going to emerge, I think, and it is related to the technology transfer issue. To what extent is it in the interest of the U.S. to develop energy, or other raw materials overseas, that would be accessible not just to itself but to other nations as well?

East-West Policy Committees

Our government has set up joint committees, and there are also trade and economic councils at the businessman's level, which meet regularly to deal with trade matters. Governmental policy decisions are made by an East-West Trade Policy Committee,

presently chaired by the Secretary of the Treasury, in which the Bank has been a participant since the Trade Act was passed. This committee has been composed of representatives of Treasury, Commerce, State, the Council of International Economic Policy, and the President's Economic Assistant, now Mr. Seidman. It is now being transformed into an East-West Foreign Trade Board, which was set up under the Trade Act, Section 411, and generally charged with monitoring the trade, including technology and credits, between persons and agencies of the U.S. and the non-market-economy countries. The Board will become the senior policy forum in which the questions discussed at this seminar will be debated and the policy line set among the executive branch agencies. The Act calls for regular reports to the Congress on the activities of these agencies.

Of course, the decision-making process does not always go up to this East-West Trade Policy Committee, or even its working committees. We, as a bank, work with Commerce and with State on individual cases which come to us. The Bank's approach is, basically, a case by case approach. On each application we evaluate the merits and take into account our legislative charter, and the policy framework set in these east-west policy committees and councils. Also, as we analyze a case, we seek ad hoc advice, guidance and information as we need it.

Issues for the Future

Issues which appear to me well worth future attention include

one which has been touched upon here in a general way. How do we appraise regularly the two-way benefits which are supposedly embodied in this reciprocal exchange of east-west trade, particularly in the technology area? We hear about Polish and Soviet processes of coal gasification. Are these likely to benefit us, should we test them and how do we incorporate them into our programs if they are of value?

The question of whether our credits should be used to help the Soviet Union's gas production will become the focus of considerable discussion if and when Bank credits are made available to the Soviet Union. We are temporarily out of business there because of the Trade injunction concerning freedom of emigration. The Soviets have not been willing, or able, to satisfy those requirements in the legislation. Until they do, or until the Act is changed, the Bank is prohibited from extending further credits to the Soviet Union.

Another question is how to appraise, on a governmental level, what is really going on in technology. I have participated in some discussions in which it becomes a delicate matter whether to require American firms to report in great detail on all of their discussions with communist buyers, even in these technical cooperation bilateral agreements. Do we require a company to report each conversation where the exchange of information obviously goes ahead? How do we monitor visiting groups? One can see the potential for U.S. governmental intervention in great detail into the industrial sector and this raises some difficult questions.

Outside of Eastern Europe particularly, the question comes up whether a sale we are making permits technology transfer which will enable foreign firms to compete in selling back to the U.S. or in third markets which could be potentially damaging to U.S. exporters. I agree with the thought that services and technology are going to be a major growth area in future exports. It becomes a question for our financing. Should we be financing more of such services and technology without concurrent equipment sales, or should we be limiting our financing to areas where we can see that there is a productive employment and job creation in the U.S., and not just a software financing?

All I can say is we do have some difficult tradeoffs to make in maintaining our mission of promoting exports, without at the same time, damaging the economy we are trying to help. We are watching technology in this more economic sense. We leave the strategic and military appraisals principally to other agencies.

PANEL PRESENTATIONS:
MECHANISMS FOR POLICY CONCERNING INDUSTRIAL TECHNOLOGY

STATEMENT BY

Michael Boretsky*

As a social scientist I am concerned about the present state of industrial technology in the United States for five reasons.

First, at the time this is being written we are witnessing a rather drastic decline in the economy's rate of productivity growth -- both of labor and capital -- relative to the nation's past performance and relative to the current performance of most other industralized countries. To be specific, since the middle 1960s, the U.S. economy-wide output per man-hour has been growing only about half as fast as it did during the preceding one hundred years or so, while output per dollar's worth of capital input (in constant prices) has actually been declining in contrast to the positive, albeit small, growth in the past. In contrast, productivity growth in most other industralized countries, both of labor and capital, has been accelerating, at least through 1973.

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*The views expressed here are strictly those of the author and not of the Department of Commerce.

Inasmuch as some two-thirds to three-quarters of the historical growth of productivity in U.S. and other countries is attributable to technological improvements, the current decline in our productivity growth must at least in part be attributed to the relative decline in the overall rate of U.S. technological advance.

There are many people who disagree with this proposition. To prove the contrary they invariably cite the fact that all other countries eagerly import U.S. industrial technology and that the use of the most novel technology -- computers, information processing devices and photocopying machines -- is growing unabatedly.

Regarding these arguments I should like to note that, first, foreign imports of U.S. technology are irrevelant to any judgment about whether the rate of U.S. technological advance is up or down. These imports merely indicate that we still have some technology which foreigners like to buy. With respect to the impact of computers, copying devices and the like, we must bear in mind that these largely affect the productivity of only managerial, clerical and technical personnel which represent only about 17 percent of the total employment in the private economy. Although in the last 12 years or so the productivity growth for these people has tended to be about twice the rate as that for nonsupervisory production personnel (3.5 percent and 1.8 percent per year, respectively), the net contribution to the total growth of productivity for all employees has averaged only 0.3 percent per year.

Since productivity growth is for all practical purposes the only source of growth in real income and material well-being of society, the decline to which I address myself has been a major factor in inflation as well as the cause of the lag in the growth of our standard of living and the resulting pressure for income redistribution. Continuation of this decline will, most probably, exacerbate these problems.

The second reason for my concern over the state of our industrial technology is the deterioration in the competitive position of domestic industry in world markets. This deterioration has been underway since the early 1950s, but it greatly accelerated in the 1960s. By 1971 it had produced a string of devaluations of the dollar, despite the fact that throughout the post-World War II period our rate of inflation has been appreciably lower than that prevailing in all other industrialized and trading countries. These devaluations have greatly worsened our "terms of trade" and thus added to the decline in the growth of our standard of living as well as to greatly accelerated inflation. I estimated that by now the two and one-half devaluations of the dollar that we have had so far cost us at least $12 billion worth of national sweat per year.

The third reason for concern is the lamentable state of affairs in the technology for producing alternative (to OPEC and domestic oil and natural gas) energy sources. How bad the situation is may be best indicated by the government's failure to come up with the guaranteed floor price for "synthetic fuels"

which was debated in the context of Project Independence and the international negotiations of oil-consuming countries for a common position vis-à-vis OPEC. The reason for the failure is that the current knowhow for producing synthetic fuels would call for a guaranteed price of about $15 per barrel of synthetic oil or barrel-equivalent quantity of synthetic gas. This is probably more than twice what the governments of all oil-consuming countries would be willing to subscribe to.

The fourth reason is the high cost of technology for pollution abatement and control in compliance with the standards already enacted into law. In 1972, one of the first years these programs were implemented, the economy's expenditures for this purpose amounted to $18.7 billion, or 1.6 percent of GNP. This is 65 percent more than we spent that year on civilian industrial R&D. If the technology currently at hand were used for full compliance with the standards to be achieved over the next ten years or so, the cumulative cost of this compliance would amount to some $400 billion or $500 billion, which is appreciably more than the $250 billion to $350 billion that is likely to be the net cost of Project Independence.

Finally, I am concerned over the continuation of our rapidly declining technological defense capabilities vis-à-vis the the huge "overruns" associated with DoD's attempts to maintain the qualitative technological edge in the face of the Soviet quantitative edge, and our society's growing disenchantment with the defense effort. Should the combination of these trends

continue for a few more years, the U.S. will become a second-rate military power unless the adverse forces are offset by an increase in technological sophistication of civilian industrial technology.

Needed: A Council Of Science And Technology Advisors

There has been extensive public debate during the past year or so over the kinds of policy mechanisms needed to improve this situation. The result seems to be a rather strong consensus that some sort of Council of Science and Technology Advisors is needed, most likely patterned after the Council of Economic Advisors. I agree with the general idea of a science and technology council, provided, it is composed of people having different disciplinary backgrounds, and -- even more important -- that its charter include a statutory mechanism for coherent long-term economic and technological policy planning.

There are at least two reasons why I say this. First, I believe that the time is long past when important science and technology policy initiatives could be promulgated merely on the basis of recommendations by outstanding scientists and/or engineers. Today such initiatives must be rationalized by compelling and expertly articulated economic and/or social needs. However, our present economic policy mechanism is strictly short-term and ad hoc in nature. Science and technology variables, having as a rule only long-term economic implications, tend to be unappreciated and are usually ignored. They will continue to be ignored, to the nation's detriment, unless our economic policy-making looks

forward not only to the next calendar or fiscal year, but also to the next 20 or 25 years. In this kind of analysis most economic variables become simply functions of technology variables.

The second reason is financial. Any attempt to improve the situation in U.S. industrial technology will undoubtedly require substantial outlays of public funds. In my view, however, whatever new revenues the government may receive over the next ten years or so have probably already been committed several times over by social policy initiatives either enacted or likely to be enacted within the coming year. Consequently, the only way in which the funds for financing new science and technology programs can be obtained is by scaling down or eliminating some of the existing programs. Such changes in priorities can hardly be made without a clear-cut demonstration of the long-term national interest to do so and for this, too, long-term rather than short-term economic policies are necessary.

Long-Term Policy Planning

In considering long-term policy planning we must bear in mind that all kinds are obviously possible, from that practiced in the Soviet or even more rigid command economies, to the kind of "indicative" planning practiced by the Netherlands, Japan and many other market oriented countries which clearly tend to improve rather than handicap the performance of the market system. The planning mechanism I have in mind would merely be responsible for the development and continuous updating of a minimum set of

strategic technico-economic indicators. These indicators would permit the council (and, hence, the government) to formulate, institute and monitor the effects of what I would define as a reasonably comprehensive national technological policy consistent with the principal long-term goals of society within the constraints of available and/or accessible resources and a minimum interference with individual freedoms of the members of this society.

Given the type of socio-economic system we have, the technology policy planning would require:

1. Planning and continuous review of the nation's level of effort in developing its technology so as to achieve the desired improvement in productivity, international competitiveness of domestic industry, and so on.
2. Development of policy alternatives that would assure a supply of trained scientific and engineering manpower (including technicians and "craftsmen"), consistent with the nation's prospective long-term level of technological achievement.
3. Development of effective general incentives for an optimum level of private investment in economically relevant R&D.
4. Planning of an optimum level of investment in "social" R&D including that relevant to society's "quality-of-life", and in civilian-marketed-oriented technological opportunities where for various reasons (such as industry fragmentation and excessive risk) the market forces and

general incentives cannot assure an optimum level of effort.

5. Development of policy measures that would stimulate the use of new domestic and foreign technology. This requires adequate venture capital; incentives conducive to continuous modernization and investment in plant and equipment, which historically has been the chief vehicle for the diffusion of new technology; and the elimination of such institutional barriers to the use of new technology as restrictive work rules.
6. Mapping changes in the government's legal and regulatory posture that would stimulate rather than hinder the development and utilization of new technology. Such changes would include eliminating excessive barriers to cooperative R&D arising out of anti-trust laws and regulations, eliminating arbitrary pollution control and consumer protection regulations, and eliminating arbitrary rate setting in utilities and other regulated industries which inhibit the introduction and/or diffusion of new technology.
7. Development of a patent policy that would intentionally stimulate the development of new technology.
8. Mapping changes in the existing government procurement policy that would be conducive to more rapid diffusion of new technology.

9. Development of rational safeguards against the ill use of new technology, but without stifling controls.
10. Finally, the planning mechanism would have to develop sensible policy alternatives that would ensure that any technology transfer takes place at a price that reflects what the nation as a whole invested in the development of that technology and not just a company's private incremental cost for, say, a particular piece of equipment.

STATEMENT BY

Ellis R. Mottur

The Office of Technology Assessment (OTA) was started in 1974 within the Congress to help it wrestle with complex technology-related issues. The OTA is a non-partisan, professional institution that attempts to serve the needs of all parts of the Congress equally.

We are now in the process of launching a Program on Technology and International Trade, and we have other ongoing programs in energy, food, oceans, materials, transportation and health. We operate with a three-pronged approach, involving inhouse staff analyses, advisory panels and consultants, and contractors. We are just now at the point of forming our initial Advisory Panel on Technology and International Trade, and although we are just getting started I would like to explain the perspective from which we are approaching this problem.

The role of our agency is to help Congress in legislating more effectively. Therefore, the studies and analyses we do have to be very directly related to the legislative process or they are not going to be worth anything to the Congress. Thus, we are trying to look at the problem from a Congressional point of view, rather than from a technology point of view. Let me explain what I mean.

The Congressional Point of View

Rather than being concerned with the problem of how to facilitate the transfer of technology -- of U.S. technology, that is -- the thrust of our concern is: how do we maximize the economic and social return to the U.S. from its international trade in technology? When I say maximize that return, I mean maximize it over a reasonable period. When I say economic and social return, I mean not just dollars flowing into the U.S. -- which is tremendously important, obviously, in view of the money we need to pay for oil and other raw materials and commodities -- but I mean, just as importantly: how do we aid one nation in creating jobs, taking into account the quality of the jobs as well as their quantity? This is the broad perspective from which we approach technology transfer.

In addition, we recognize that although technology-intensive items constitute a major component of U.S. exports -- as some of the other speakers have pointed out in great detail -- in our view there is a vast potential for U.S. technology in international trade that is not being realized at all. I agree very much with Dr. Branscomb's remarks. I believe that the fundamental reason for the situation he describes is that we have a national policy vacuum with respect to technology and international trade. We do not have a national policy framework that is coherent and even remotely comprehensive; moreover, we do not have the institutional mechanisms necessary to formulate such policy. So, we think that there is a tremendous void here, and it is incumbent on the Congress to enact legislation that will shape not only those policies,

but the institutional structure needed for their formulation and implementation.

What we in OTA have to do for the Congress is to delineate the policy options which it must consider in trying to design such institutions and mechanisms. This is an extremely broad task, and I should mention that we do not have very much money to use in tackling it. The total budget of our Office is now $4.7 million, and, hopefully, over the next fiscal year it will be something on the order of $6.5 million. With these limited funds we have to cover the whole spectrum of issues with which Congress is confronted. Accordingly, it is unlikely we could allocate more than a few hundred thousand dollars at most to this area.

Broad Policy Areas

We tend to divide the kinds of policies needed in this field into two broad areas. One consists of policies aimed at strengthening the R&D capability of the nation *per se*, irrespective of whether it is going to flow into international trade. By this I mean our national R&D policy, government procurement policy, scientific manpower policy, and a number of policies referred to in the previous papers, including industry incentives, investment levels in civilian technology and the like. These are tremendously important policy areas aimed at strengthening R&D *per se*.

The other broad area consists of policies aimed at facilitating the beneficial export of U.S. technology products, and,

when it is clearly in the national interest, of U.S. technology knowhow. These policies include licensing arrangements, tariffs, export restrictions, taxation policies on U.S. operations abroad, turnkey arrangements, technical information transfer and so forth.

We are currently initiating programs in both of these areas. In April, 1975, our Advisory Council had its first discussion of OTA's program in the first area. We are starting what may become a long term, major program examining national R&D planning, policy formulation and the establishment of priorities.

In the second area we are launching a specific program in Technology and International Trade. Here, we agree very strongly with what Dr. David says about avoiding broad generalizations. Thus, we are attempting to shape a program that would look at these problems on a case-by-case basis. This is necessary because what might be advantageous in certain situations in east-west trade, for example, would not necessarily be applicable in dealing with the OECD nations. By the same token, one might want to deal with some OPEC nations, Saudi Arabia for example, differently from the way one might want to deal with Venezuela. These are but a few examples of the many kinds of differences involved. So we believe it is important to start out with a case-by-case approach.

I think Dr. Boretsky covers the range of institutions and mechanisms that are needed here magnificently, and I think he sketches out very well the goals at which those institutions and mechanisms are aimed. I am sure he, and all of us, recognize the great difficulty of accomplishing those goals even if we had

those institutions in being. But these are the goals we have to aim at. I would like to underscore the importance of the White House Science Advisory mechanism which he discusses, but unfortunately we do not have time to get into that at this seminar.

A Technology Export Corporation

I would like to suggest an institutional innovation which, I believe, illustrates the kind of institutional change that might be helpful in this field. A key problem which our speakers have talked about -- Dr. Ginzton, for example -- is the problem of how U.S. technology can compete effectively with countries that either have centrally controlled economies or have much more central planning of their economies than we have. Other speakers have mentioned how helpful it would be if our antitrust laws could be adjusted to enable us to compete more effectively in those kinds of situations. I, personally, do not believe it is realistic to expect the Congress, as it is presently constituted, to come near making any kind of change in the antitrust laws for this purpose. I do not, myself, have a strong view either way on the desirability of such changes. I can recognize the considerable advantages that would accrue to our international trade in technology through adjustment in the antitrust laws; but I also think there are disadvantages to such changes from the point of view of other national objectives. One would have to carefully assess the balance between these disadvantages and advantages before reaching a conclusion. In any event, I do not see such changes as a realistic possibility in this Congress.

The innovation I would like to suggest is put forth as a preliminary proposal which I would not want to defend in great detail. It seems to me one could think along the lines of establishing a Technology Export Corporation somewhat analogous to COMSAT. If you want to give it a name, you could call it TECHPORT for Technology Export Corporation. This would be a corporation chartered by Congress, which would have on its Board of Directors government-appointed members, and representatives of labor and of consumer interests as well as of the regular investment community. TECHPORT would obviously be subject to appropriate Government regulations and would be financed partially through a stock issue and also through other appropriate financial devices such as convertible debentures backed by federal guarantees. TECHPORT would have the function of buying U.S. technology under certain controlled circumstances and attempting to sell it abroad. It would serve as a sort of middleman -- in certain selected regulated situations -- wherein it would create a market for U.S. technology, and then serve as the negotiator and salesman for that technology abroad.

The scope of such an organization would have to be very clearly delimited. Perhaps it might be desirable to focus much of it in the east-west trade area, for example. Or one might want to give it exclusive rights to certain kinds of technology items and under certain conditions. One might want to focus it on dealing with OPEC nations relative to U.S. exports. Or one might want to have situations where there would be special incentives to industry to participate in the TECHPORT operation. In any event, one would have to carefully design the regulations

under which it would operate. Some of these constraints would be included in the statute, but primarily the power would be given to the President to assure flexible arrangements to suit changing international circumstances.

A number of advantages could flow from such an institutional innovation. In certain cases, we would be able to create much better international markets for U.S. technology, thereby stimulating its further development. This institution would also provide a knowledgeable and powerful negotiating instrument through specialized salesmen who could deal with the centrally-controlled and centrally-planned economies much more effectively than in individual U.S. corporation could because they would have much greater leverage. While the salesmen were making a particular deal with one of these countries, they would also be dealing in such a broad array of other matters that they would have the additional leverage arising from that total pattern. An individual corporation, on the other hand, would be limited to the particular negotiation.

Obviously, TECHPORT would operate within U.S. national security considerations and other national policy constraints. Being closer to those considerations, such a corporation, I believe, could serve the overall national interest in many cases better than an individual corporation could. TECHPORT would be able to take a longer view, in many cases, than the more short-term considerations likely from the vantage point of a particular corporation.

Also, by dealing at this interface between U.S. national policy and technology and international trade, TECHPORT would be in an ideal position to identify the key policy gaps in U.S. policy in this field, and, hopefully, to make recommendations to the Congress and the executive for ways of strengthening national policy.

Finally, as a specialist in this field, I believe such a corporation would better be able to identify international opportunities for U.S. industry and help it take better advantage of them.

I should emphasize that I suggest this TECHPORT idea only as an illustration of the kinds of innovations I think we have to consider. I believe we have much too limited a policy framework for dealing with technology in international trade. We have to create new institutions and policy mechanisms; to do so, we have to think hard and long about this field. On behalf of OTA and the Congress, I would hope that those of you who share this interest would join with us in trying to identify and assess our national policy options, and help Congress create the policies we need.

STATEMENT BY

Elizabeth R. Jager

One of the economic factors in technology, as well as in national policy, which often gets the least and last consideration is a factor called labor. Nevertheless, labor is fundamental to whether or not there is any technology.

Before discussing policy solutions, therefore, it seems necessary to mention that the statements so far show that the measurements of the results of technology transfer for labor are almost always general measures of the employment impact of technology outflows. These measures are vague, derived measures determined after macro-economic assumptions, foreign policy decisions, corporate management decisions, and all the other policy-making parts of the equation are determined. To the extent that the quality of the employment and its economic environment are ignored, to the extent that old-fashioned theoretical economic measurements are emphasized, we tend to lose sight of the overwhelming impact of the technology-potential lost to the United States from the explosive growth in technology transfer that has occurred over the past 25 years.

The AFL-CIO's concern with technology transfer has therefore been related to comprehensive national policy, which we have

elaborated in a variety of forms over many years. They add up to support for some of the ideas Dr. Boretsky has mentioned. While we would agree and disagree with different parts of this statement, the AFL-CIO has been saying, first and foremost, that technology is defined as the application of human invention and ideas, rather than the mere transfer of them. That includes labor. Dr. Boretsky's discussion of the misapplication of policy mechanisms was phrased far better than I can summarize in this extemporaneous statement.

An Outflow of Jobs

The AFL-CIO has been saying for years that the combination of foreign government's policies and U.S. foreign economic policies has encouraged an outflow of jobs. We think these are implicit in technology transfer -- not just in numbers of jobs, but also in quality. Also, the effect has encouraged the outflow of capital -- increasingly in short supply -- and the outflow of equipment needed to realize tomorrow's productivity potential. In fact, U.S. tax, trade and monetary policies encourage the outflow of technology by encouraging foreign direct investment.

It is, then, within this frame of reference that the AFL-CIO views the problem, and superimposed upon our objections to the way the conflicting and confusing policies are operating are the following three concerns.

First, the perspective of the President's International

Economic Report to me is an unhappy one, because it is not the perspective of the U.S. government; it is the perspective of a global economy, in theory. This does not mean that the AFL-CIO does not want to participate in a global economy. It means that, unlike every other nation, U.S. policy makers do not seem to know, for policy mechanism purposes, where the U.S. is. The only country that we have, the United States, has very specific borders. That is the only country for which this government can make policy. We can engage in policies with others. We can help direct them with others. We can influence them with others. But, to the extent that the U.S. starts with a global view, policy-makers miss the point of where we have to start so that we can see where we are going.

Second, it seems that the policy confusion is so great that the comments and perspective from the Export-Import Bank overlook the fact that there is, in fact, an overall national policy group called the National Advisory Council which has a very important supervisory power over the activities of the Bank.

Third, the perspective of a global firm is implicit in Dr. Branscomb's report. These perspectives conflict.

Regulating Trade Outflow

Briefly, AFL-CIO policy mechanisms involve regulating the outflow in trade -- even exports that are being promoted by various groups in the Administration. We are concerned about the outflow of capital equipment and of industrial products that are

in short supply. We do not seek prohibition, but regulation.

The AFL-CIO has consistently sought regulation of imports, not only because they displace jobs but also because they destroy technological potential. Further, we are disturbed with economists who analyze our exports with one set of data and our imports with another. There is no understanding of the dynamic trends: if a factory is exported to make trucks in the Soviet Union, which is an autarkic economy, the results of that production will not be contained within the Soviet Union, but will, in fact, become imports into other nations over time.

In short, we are saying that as a nation we have been exporting our production facilities and our comparative technological advantages while other nations have been exporting to us the products of these production facilities. To us this means what Dr. Boretsky has summarized as a problem in industrial technology growth; it means that we have experienced an erosion of the industrial base.

We do not hold that technology, trade or capital is free just because the U.S. doesn't regulate it. Every other country of the world regulates its flow of capital, technology and trade in one way or another through a variety of national policies. Therefore, we are seeking national policies not to be isolationists, but so that we can, in effect, know where we are going and thus cooperate with others.

It is this term, "freedom of economic interchange", that concerns us so very greatly, because we do not see that freedom. In our view, the "freedom" consists of a kind of a suction

effect which acts on the economic strength of the U.S. relative to the rest of the world -- labor, capital, technology, however you want to define it -- in a way that is jeopardizing our strength. We factor into this something we believe is important to technology: the freedom of people. That freedom seems to be left out of the equation, but I am interested to hear about the plans to sell more to the east bloc countries, because I am reminded of a very recent law review article in which a U.S. government employee said that the western firms are very welcome in Romania, because Romania seeks western technology, and the western firms are very happy to go, because a "dependable, controlled labor force" is anxious to learn the new skills from that technology.

I think that the "control" or "freedom" of the labor force should be of concern for both social and economic reasons. In the long run, and right now in the short run, the waste of the resource of labor and the repression of the development of adequate manpower skills is something that gets lost in the data currently used for analysis. The costs and benefits are not adequately measured. The cost of labor, and to labor, in a "controlled" labor force are different.

Another concern is with the national economic cost and benefit. For instance, a few years ago the U.S. exported virtually free to Japan advance rocket technology in the Thor-Delta rocket. That technology, the input to that technology, was largely paid for out of our space program, through expenditures by the taxpayers.

The benefit was returned to the McDonnell-Douglas Corporation in royalties, fees and sales. This firm had the right, evidently, to get payments for the technology and would supply some of the parts.

Six Proposed Regulations

What we would do about this, then, is change the pattern which, in the words of an Arab sheikh, applies to every other nation: "We want, one, your technology, and two, your markets." We would urge a series of regulations through legislation regarding taxes, trade and technology flow that would adjust the balance so that, over time, this country, with its huge size and variety of resources and labor skills, could have an industrial base that would have a future too. These regulations are:

1. The President should use his authority under the Trade Act of 1974 to immediately curb those imports which are adversely affecting employment and which are contributing to the huge balance of payments deficit.
2. The President should immediately curb the export of raw materials, technology and products, whose export adversely affect the national interest, as provided in the Trade Act and the Export Control Act.
3. Provisions for the deferral of tax payments on foreign-earned profits should be revoked.
4. The foreign tax credit, which provides the U.S. companies with a dollar-for-dollar credit against their U.S. tax

liabilities for their foreign tax and royalty payments, should be eliminated.

5. Sections 806.30 and 807 of the Tariff Code should be repealed; they encourage foreign production for shipment back to U.S. markets.
6. The export of American capital and technology which results in the export of American jobs should be regulated.

The AFL-CIO supports strong, vigorous and fair international trade. But the rising tide of restrictions abroad, the ever-increasing impact of the multinational corporations, the staggering balance of payments deficits and the depression-level unemployment at home, require emergency measures.

These specific policies cannot be enumerated in detail in this space, but they are based on the fact that the federal government does have a responsibility: one, to coordinate its 57 varieties of agencies that are competing with one another; two, to instill into the minds of the corporate community a responsibility not only for the micro-economic benefit of the global interests of the firm, but also, in a sense, for the long-term micro-economic danger to the people who are running the firm; three, to recognize that one of the basic components of technology development is a labor force which the U.S. has already affected adversely, by looking at last and least, through a series of policies over a long period. This labor force includes both skilled and unskilled. The latter are important to technological development because factories need these people, too.

Everbody is not going to be an intellectual giant.

In short, we would start with a comprehensive framework of mechanism whose focus would be looking outward from the U.S. and based on an assessment of our potential. Regulatory mechanisms by law and by administrative practice in taxes, trade, capital and technology flow need better coordination, and should not leave labor last and least as simply a set of digits to be put onto a chart. These measurements and mechanisms would recognize the economic and technological reality that an industrial system cannot exist if a labor force that can participate effectively in it does not exist.

SUMMATION

J. Herbert Hollomon

There are six central conclusions that derive from the preceding papers. Most significantly, there has been a radical change in the relative position of the United States with respect to its technological capability within the world economy during the last twenty years. At the end of World War II the U.S. was the most powerful military and political nation in the world. We were the richest country in the world and we produced well over half of the world's gross product. But today the U.S. is the strongest nation among many. We no longer dominate the world's technological activity, and we perform a relatively smaller fraction of the world's research and development. Our position now with respect to trade, to technology, to our competition, and to our security is fundamentally different from that of the years immediately following World War II. But even more important, the environment in which we as a nation, and our industry, operate, is far different from that of the 1950s. I believe this is the basic reason for the concern now being shown for technology transfer and international trade.

During the last 20 years there have been different policies in different western countries -- particularly the industrialized

countries -- governing the allocation of resources to national needs and requirements. These differences are illustrated by Michael Boretsky's analysis which reveals that many countries committed relatively larger amounts of technical resources to what he calls "civilian oriented" technology and industry than did the U.S. In the 1953-1967 period especially, we concentrated our technical resources on space and defense -- what I call sophisticated technology. By contrast, the commitment of technical resources, particularly in West Germany and Japan, has been to non-defense, non-space activities. As a consequence, these nations are able to compete with us technically, even though they have nearly equivalent labor costs.

Certainly there are areas in which the U.S. excels, but no longer can we be expected to maintain technological leadership in all fields, nor can we compete in every market.

Markets, Management and Resources

The discussion of technology transfer by itself is somewhat sterile, for technology must be considered along with the important question of markets, management and resources; that is, how a firm can exploit its technical resources and its abilities in the best way, whether it will manufacture at home and then abroad, or whether it manufactures wholly abroad, and the relative advantages of each.

Elizabeth Jager points out that one should -- and must -- consider the implications of technology transfer and industrial development, on the character, quality, and employment of labor

rather than discover these consequences after decisions have been made inadvertently by our relatively pluralistic, decentralized economy.

Social values as well are clearly involved in international trade. For example, some countries have entirely different rules and regulations with respect to the social consequences of industrial pollution, and the resulting difference in costs affects our ability to compete and to sell American goods abroad. In addition, social values have a fundamental impact on such decisions as where to locate plants, perhaps as much as labor rates did in the past.

Technology transfer has to be considered differently for each industrial sector. Questions concerning transfer of technology and manufacture of goods abroad for, say, the chemical industry, are different from those of the highly sophisticated electronics industry, and are clearly different from what I consider to be the most sophisticated technological enterprise in the United States -- agriculture. The conditions under which commodities are traded substantially affect whether or not we transfer technology, how we do the transferring, and how this transfer affects social questions of equity within the U.S.

My fourth general comment is that every other major country has been dependent on importing at least some raw materials and, therefore, requires exports to pay for them. Almost every country has some explicit government policies or programs that protect, encourage, develop and improve its industrial competition

relative to the U.S. and the rest of the world. In each of the major countries, the government participates with industry in much more symbiotic ways than in the U.S. In some cases, special taxes are rebated by the government. In other cases, as in France, major technological support for the development of goods that are intended for the export market are specifically encouraged by the government; in still others, such as Sweden, there is cooperation between labor, government and industry to develop specific ways of doing business that make them more cooperative in the world market. The point is that each of these programs is different for different countries and industries, and the policies and programs with respect to technology transfer and foreign trade are, in fact, adjusted to the particular industry and the particular circumstances of that trade.

Our Decline of Productivity

The fifth general observation -- and it is the one that seems central -- is that resolution of the problems associated with technology, international trade and balance of payments, depends upon the effectiveness of policies directed toward industrial development, economic growth and worker improvement within the U.S. The problem, in my view, of whether or not we transfer technology abroad would become substantially less important if we had maintained over the past 15 years the productivity increases enjoyed in the U.S. over the past 200 years.

The point is that the issue arises partly because of the failure of this country to recognize the importance of the decline over the last decade of the single quantitative measurement we have for the rate of introduction of technology into the economy -- productivity. Over the past 15 years, the U.S. had the lowest increase in productivity of any industrialized nation in the world, with the exception of the United Kingdom.

The General Economic Climate

Finally, I would point out that policies that affect the general economic climate probably play a greater role than those policies having to do exclusively with research and development. In this seminar, each speaker, in coming to grips with technology transfer, has always turned back to the question of how well we manage, support and encourage industrial technology at home and its application to specific circumstances.

Tax policy, antitrust policy, government procurement policy, export control policy and investment credit policy probably have more impact on how effectively we use technology for economic and industrial advantage than the indirect or direct support of R&D by the government (not that R&D is unimportant). It seems to me that the kinds of institutional rearrangements that are suggested in one way or another in these papers raise the following issues: how is it that we, as a nation, can arrange cooperative -- perhaps the word is consensus -- activities between market-oriented enterprises and the operations of the central government? Such

activities are presently chaotic; they lack any sensible connection and coordination, and, as a consequence, are depressive as often as they are encouraging to industrial, economic and social development.

A Sickness We Must Cure

How can such cooperation be arranged? Do we wish to establish -- and I suspect we do not -- an indicative planning system, as in France, or accept the dominance of a government-industry complex like the Ministry of International Trade and Industry in Japan? Or is there some way, in our larger, more pluralistic, and richer country, that we can develop the necessary analyses of the future and of the past so as to make more sense of how industrial, economic and social development take place; to better trade off, for example, the expenditure of hundreds of billions of dollars in developing indigenous energy sources versus the need to adopt environmental control systems and radical conservation measures?

It seems clear that the key policy questions have to deal with these central issues, and that they call for some new relationship between the industrial and economic private sector, the quasi-private sector, and the governmental apparatus in such a way that we can begin to know where we have been and where we are likely to go. There must be a better way of dealing with the future than applying bandages wherever we hurt. I believe that this seminar has identified symptoms of a sickness that we must cure.

NOBODY IN CHARGE

Harlan Cleveland*

I

The 101st birthday of the Marchese Guglielmo Marconi comes along at just the right time. We think about reality with symbols, and we are badly in need of a symbol for international interdependence.

This citizen of Bologna, who made it technologically possible for us all to be citizens of the world, seems to have been just as good at promoting his inventions as he was at inventing them. And the revolution he and his successors have wrought, assisted by God as they cheerfully acknowledged, is making the world a communications community whether its peoples like it or not.

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*Address delivered at the Annual Members Banquet of the NAE, April 23, 1975, in connection with the presentation of the First Marconi International Fellowship to Dr. James R. Killian, Honorary Chairman of the Board, Massachusetts Institute of Technology, with an associated research commission to Dr. Asa Briggs, Vice Chancellor of the University of Sussex. The Fellowship, administered by the Aspen Institute for Humanistic Studies, was created to commemorate the centennial of the birth of radio pioneer Guglielmo Marconi. Its purpose is to commission creative work that links science and engineering to the betterment of human life. As a special part of the Banquet program, the award was presented by the Vice President of the United States, the Honorable Nelson A. Rockefeller.

We inherit now the agony of his success. He made it possible to be heard from a distance, but could not make sure that anybody would be listening.

I doubt if Marconi worried very much about what would be said over what he called his "Apparatus for Wireless Telegraphy" -- that is, whether love or war would be most facilitated by his genius. But in each of the eight decades since Marconi's first patent, the moral issues for inventors have grown more obvious, more difficult for the scientist and technologist to hide from. Today, no person who uses his specially gifted brain in the service of science or engineering can kid himself that his theories or contraptions are ethically neutral. If I invent it, and it's dangerous, I had better ask myself at whom it is going to be pointed, for who knows better than I the dark side of my invention's potential?

The dangerous social fallout of science and technology is a familiar continuing tale in the National Academy of Engineering. But it was no big thing in Marconi's time. It came naturally for him to conduct some of his early experiments for the purpose of improving communications with warships at sea. In his distinguished tradition, we have educated visiting colonels and captains in military communications, and then watched them use their wireless systems to seize political power in a couple of dozen developing countries.

As recently as a generation ago, it didn't occur to the leadership of the Manhattan Project to hire a single person whose professional task was to consider the political and international im-

plications if the nuclear weapons project were a success. But today, we know that (for example) if scientists and engineers succeed in harnessing the weather to human commands, we had better be ready with a social and political system that keeps those commands humane. We do know that, don't we?

II

We also know -- and this is even harder to get used to -- that everything is related to everything else. It was bound to be, once Marconi had started us toward instant and pervasive communications. As we hesitantly raise our eyes and swivel our heads to take in the situation as a whole, and even more reluctantly widen our sense of moral responsibility to match what our wide-angle vision can see, the picture is embarrassingly clear:

- Present trends in population growth, urban immigration, inflation, unemployment, food production and distribution, energy demand and supply, pollution of the air, land and sea, military technology, restrictive ideologies and inward-looking nationalisms, all taken together, are clearly adverse to the self-fulfillment of nearly every human being, and to the survival of a very large minority of the human race.
- Even if commenced now or soon, the reversal or control of these trends will require enormous changes in attitudes and styles of living, giant cooperative

enterprises, and a generation of time.

- Meanwhile, shortages and the desperation and rivalries they intensify will provoke acute conflicts. The arms available for use in these conflicts, which are not only the conventional or exotic instruments of frightfulness but also economic and monetary and psychological and biological and meteorological weapons, will no longer be in the hands of an oligopoly of so-called "powers".
- Somewhere near the center of these multiple conflicts will be, as always, the ancient confrontation between rich and poor. Somewhere near the center of conflict resolution will be a planetary bargain that promises to define and provide basic human needs, and also promises to keep the "advanced" countries from advancing past prudent limits in using scarce resources.

For any of us who have to think or act on these matters, the scariest part of the story is this: these trends are so interrelated that relevant action on any of them requires thinking about all of them.

And who is responsible for doing that? Who is in charge of the planetary bargain? The answer, my friends, is blowing in the wind, and you have only to sniff it: we have achieved a world in which nobody is in charge. "Nobody here but us chickens", just as the old gag line suggested.

"We Mexicans", says the poet Octavio Paz, "have always lived on the periphery of history. Now the center or nucleus

of world society has disintegrated and everyone -- including the European and North American -- is a peripheral being. We are living on the margin . . . because there is no longer any center . . . World history has become everyone's task and our own labyrinth is the labyrinth of all mankind . . . ."

III

But wait a minute. That's not bad, is it? That's what we wanted, wasn't it?

It was, and it still is. Back when the United States was the only superpower and most of the world wasn't even "developing", we decided that we didn't want to be in charge of the world -- and that we didn't want anybody else to be in charge either. I think it's fair to say that since World War II it has been the central purpose of American foreign policy to reduce the comparative influence of the United States in world affairs. We seem to have succeeded -- maybe we even overdid it a little.

I am quite serious about the purpose. In a long line of quite deliberate choices, from 1945 to 1965, we tried hard to share with others the unmatched economic strength and unparalleled military power with which we came out of the Second World War.

We offered our atomic monopoly to the United Nations; that's hard to remember, but at the time we meant it. We helped Western Europe recover its health and its confidence. We established a new principle -- development aid for the less developed -- which has each year poured billions of dollars of economic strength into the weaker nations. We educated thousands of young people from all over the world, young people who now are leading or

advising the leaders in at least half of the world's 150 sovereignties. We built up military forces in Latin America, in South Asia, in Southeast Asia, in Korea, even in post-militarist Japan -- and inadvertently trained a good many military presidents and prime ministers. We pushed independence for two continents-full of colonies, even while our European friends were still not sure about it -- and thereby created a new majority in the UN. We went to work on social justice and racial equality here at home, and roused up expectations of justice and equity in international relationships by beginning to do something dramatic about those principles in the U.S.A. And when the Russians became a superpower, too, we negotiated with them to achieve, not superiority, but equality of overkill. (We have not yet reached the subject of disarmament.)

At the same time, events controlled by others were also strengthening the rest of the world by comparison with the United States. The emergence of the Soviet Union; the economic miracles in Japan and Germany (and on a smaller scale in South Korea, Taiwan, Israel, Brazil and Mexico), all the product of local leadership plus U.S. assistance; the success in self-reliance of Peking's China; the beginnings of unity of Western Europe; the development of an oil cartel; the coalescing of the developing countries as a force in world politics -- all contributed to the much-advertised polycentric trend.

And then we also did some things intended to enhance our influence, which went so sour that they reinforced the tendency to reduce it instead. We tried to manage the world's monetary system

with the dollar as its key currency (although that wasn't what was agreed at Bretton Woods), but inflation and dwindling productivity forced us to give that up in 1971. We put on in Vietnam a 10-year demonstration of the limitation of superpowers in local disputes. None of our allies thought we were committed to hang in there as long as we did, and by doing so we succeeded only in strengthening our adversary: North Vietnam's impressive military power is largely the result of having sparred so long with us.

Partly by intention and partly by inadvertence, then, we have helped create a world in which no nation, or even a group of nations, is or can be "in charge". Our task now is to participate, still as the most powerful single nation, in building the institutions of collective leadership in a leaderless world.

IV

The world is round, which makes it hard to find a handle on the situation as a whole. It is easier -- and that's why most of us do it -- to grapple with categories such as arms, food, population, energy, raw materials, environment, ocean resources, trade, investment and money.

Yet there are some cut-across categories that may get us closer to a reality which is as large and round as the only biosphere we know. And two of them, I think, are keys to the coming abrasions and reconciliations of the "planetary bargain". Both are global in reach, yet deeply involve the attitudes, standards, and aspirations of every human being. One is the notion of "outer limits"; the other is the concept of "basic human needs".

As a subject for international cooperation, "outer limits" is a natural. In the grown-up economies, the bloom is off "growth" as the central purpose of society. Notwithstanding the deceptively quantitative projections to which we are all exposed these days, none of us really knows the outer limits of the only biosphere we inhabit together. Indeed, they are inherently unknowable, because they depend on what we do about moving toward them. The physical potential of our natural environment is certainly finite and obviously fragile. But it is also ascertainable by people, and therefore analyzable by people, and therefore (up to a point) determinable by people. To put this another way: the "outer limits" of any resource are mostly determined by man's perception of how much exists, how much of it is worthwhile for him to get at, how much he really needs, how much he can reuse, and what other resources he can use instead.

Despite the analytical quagmire which a best-seller called *The Limits to Growth* led us all into, the notion that there is some limit, that exponential growth isn't forever, is now a widespread subject of professional attention and popular conversation. World food and world energy are topics for living room conversation; the simultaneous equations of population and environment are daily media fare. The other night a brave and skillful writer managed to combine birth control and the ozone shield in an episode of *All in the Family*. Mike didn't want to bring a baby into a world in which hair spray threatened to destroy the ozone and give everybody skin cancer. "All right," says Gloria at last, "Let's compromise. You let me have a baby and I'll let you have my hair-

spray....Michael, you just can't go on being afraid of life."

So outer limits are a universal. The experts may not know where they are, but people in general sense that they are somewhere and have to be taken into account -- not only in great decisions about public policy, but in all those personal decisions that reflect our individual expectations about styles and modes of life and work.

V

When it comes to "basic human needs", we are not nearly so close to perceiving their nature, let alone their political and institutional implications. One difficulty, I suppose, is that what human beings need is extremely relative -- to culture, to expectations, to time. Some third world rhetoric treats basic needs as if they are ascertainable and obvious -- but they are not.

Yet the fundamental idea, that the world community should so arrange its internal affairs so that every man, woman and child at least has life, and perhaps even a chance at liberty and happiness, is consonant with the declared values of most modern societies. It is reflected in the U.S., Meiji and Russian Constitutions, in the thoughts of Plato and Aquinas and Santayana and Mao Tse-tung, in declarations of independence by Indonesians and Africans, not to mention French and Americans, in the United Nations Charter and the Universal Declaration of Human Rights, in the Charter of Economic Rights and Duties of States drafted in Mexico City last summer. Americans will shortly be inundated with Bicentennial reminders of the comparable truths we hold to be self-evident --

self evident at least for Americans.

Every industrial nation has a government-guaranteed standard of "enough", expressed as guaranteed income, a minimum wage, a "poverty line", job tenure, unemployment compensation, and the like. Can the world community be equally civilized about all God's chillun'?

My own guess is that in this leaderless world, the development and distribution of resources to serve basic human needs will quite suddenly come to be a centerpiece of world politics. But what would it be about -- this international negotiation on how to meet man's basic human needs without transgressing Nature's outer limits? Certainly not about international standards in the abstract, but about standards to be applied within each polity, to each individual or family unit.

If the more affluent peoples are asked to modify their living standards and rearrange their priorities, which for most of them will require important changes in the purpose and nature of their "domestic" institutions, their peoples and especially their political leaders will want to know that the painful changes are worthwhile, that they really give promise of solving the "minimum needs" and "outer limits" problems. In other words, they are going to want to know what measures are being taken to reduce population growth to manageable proportions ("how much is too much" would again be a subject for negotiation), and that the arrangements inside the poorer nations are such that the profits of pain in the affluent regions do not inure to the benefit of the rich and powerful in the poorer regions.

At the same time in the poorer countries, the political courage and administrative drive to be self-reliant (get population growth under control, maximize food production, extend education, assure employment) will also depend on the larger bargain -- on assurance that the "advanced" economies don't advance past the limits of environmental prudence, and on large and assured transfers of resources and technology without political domination.

VI

The apprehension of the world's political leaders, as they face the prospect of planetary bargaining about survival and beyond, is very evident. It is also very natural. The leaders are educated experts on the issues involved, and we all know that gloom and reluctance are the hallmarks of expertise. A striking feature of the world political landscape is the almost total absence of national leaders who rise above their own constituencies to speak for mankind as a whole, and act on behalf of future generations.

The saving grace is recent evidence that the people who compose their constituencies are capable of changing their minds and discarding obsolete premises, often before their leaders do. In this country, it's clear that recent attitudes about family planning, environmental protection, and the Vietnam War developed from the grass roots, and came to be public policy only when the public had already made the policy.

So it will be, perhaps, in world affairs. People from societies at differing stages of development, professing competitive philosophies, growing up in varied cultures, practicing different

religions, speaking many languages, seem to be able to agree on what to do next together if they carefully avoid trying to agree on why they are cooperating.

In a world where nobody's in charge, each of us is partly in charge. And each of us can, as Guglielmo Marconi did, make a difference. The citizens of Athens vowed to "transmit this city not only not less, but greater, better and more beautiful than it was transmitted to us". There are far more of us now in our biospheric city-state. But if we try hard to think about all of it, we may find that the sum of our several actions is to make the world better, and even more beautiful. We had better hope so, anyway; for the currently popular notion that "there is no hope for man" is an unacceptable premise for the humanistic management of interdependence.