

TECHNOLOGY ASSESSMENT ACTIVITIES IN THE INDUSTRIAL, ACADEMIC, AND GOVERNMENTAL COMMUNITIES

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TUESDAY, JUNE 8, 1976

CONGRESS OF THE UNITED STATES,  
TECHNOLOGY ASSESSMENT BOARD,  
OFFICE OF TECHNOLOGY ASSESSMENT,  
*Washington, D.C.*

The Board convened at 10 :05 a.m., in room 2318, Rayburn House Office Building, Hon. George E. Brown, Jr. (member, Technology Assessment Board), presiding.

Present: Representative (Charles A. Mosher; Emilio Q. Daddario, member ex officio and Director, OTA; Daniel V. De Simone, Deputy Director OTA; Ronald R. Davenport, member, Technology Assessment Advisory Council; John Davis and Dennis Miller of the staff.

Mr. BROWN. This hearing will be in order.

This morning we are beginning 3 days of hearings here in Washington and another day in Los Angeles next Monday, for the purpose of exploring what has happened to the Concept of technology assessment. I would like, without objection, to include in the record at this point a statement by the chairman of the Technology Assessment Board, our distinguished colleague, Congressman Teague, which describes the purpose of these hearings.

[The statement of Congressman Olin E. Teague is as follows:]

STATEMENT OF REPRESENTATIVE OLIN E. TEAGUE, CHAIRMAN,  
TECHNOLOGY ASSESSMENT BOARD

The hearings beginning this morning are designed to provide the Board with an updated view of the mission, utility, methodology, and state-of-the-art of technology assessment. We also hope to determine the degree to which the public and private sectors participate in technology assessment.

In the larger context technology assessment is one of the keystones of the structure of a national science policy. We now have the beginnings of such a policy, the latest ingredient of which, Public Law 94-282, the National Science and Technology policy, Organization, and Priorities Act of 1976, became effective as of May 11 this year. In addition to this law, the Technology Assessment Act of 1972, the National Science Foundation Amendments of 1968, the environmental policy laws, the energy research and development laws, and several others are all a part of the overall picture.

Science policy per se has been nurtured by our own Committee on science and Technology since the mid and late 1960's when the

Daddario subcommittee addressed both the issues of technology assessment and of science policy. It was furthered when the same subcommittee under John Davis put the Technology Assessment Act into law. And it reached an even higher level of influence when our full committee considered the new Science Policy Act during the period 1973 through 1976.

At the same time, the Senate was making similar contributions through a variety of efforts by the Muskie, Jackson, Magnuson, Moss, and Kennedy committees or subcommittees. The Kennedy committee was particularly active in pursuing new roles and missions for science and technology both through the National Science Foundation and by supporting the technology assessment concept. Without the efforts of these Senate entities, as well as those of the House, we would not be here today.

The practical application of technology assessment is still in its formative stage with many unknowns. It is anticipated that these hearings will focus on the as yet unsolved problems, and provide the light of knowledge necessary to speed their solution.

Mr. BROWN. To many of you, technology assessment (TA) is a familiar subject and a useful technique when used in planning and decisionmaking. We appreciate your willingness to share in some detail your views and experiences on this subject with us. We hope to open communication on this subject within Government and to establish a dialog with business, local governments, and other institutions. We trust that these hearings will illuminate a variety of ways in which a TA can be done.

Furthermore, if through these hearings we become aware of some of the problems other sectors have faced and resolved in conducting assessments, we may be able to help each other in resolving some of the very complicated societal issues that confront this Nation both today and in the future. Our primary concern is with the future, with the encouragement of anticipatory planning, and with the development of various concepts similar to TA that may be useful in anticipating, planning for, and managing the future.

The Office of Technology Assessment (OTA), which has been in existence for 2½ years, is still in the process of institutional development. The participation of the many distinguished witnesses in these hearings will be helpful in providing additional thought concerning that process of institutional development.

The Organic Act that established OTA is perhaps the best point of reference, and I quote from it:

The Congress hereby finds and declares that:

(a) As technology continues to change and expand rapidly, its applications are

(1) large and growing in scale, and

(2) increasingly extensive, pervasive, and critical in their impact, beneficial and adverse, on the natural and social environment.

(b) Therefore, it is essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems.

(c) The Congress further finds that:

(1) the Federal agencies presently responsible directly to the Congress are not designed to provide the legislative branch with adequate and timely information, independently developed, relating to the potential impact of technological applications, and

(2) the present mechanisms of the Congress do not and are not designed to provide the legislative branch with such information.

(d) Accordingly, it is necessary for the Congress to-

(1) equip itself with new and effective means for securing competent, unbiased information concerning the physical, biological, economic, social, and political effects of such applications; and

(2) utilize this information, whenever appropriate, as one factor in the legislative assessment of matters pending before Congress, particularly in those instances where the Federal Government may be called upon to consider support for, or management or regulation of, technological applications.

We hope that you have drawn upon examples of TA from your own experience as a focal point for your testimony. We also hope that you will provide some discussion of how your organization views TA in comparison to other policy-planning tools, such as environmental impact analysis utilized in environmental impact statements, cost-benefit analysis, future market research, and general futures research, especially as these relate to the policy and decisionmaking processes. An important question involves the role of public participation. Should the general public or selected publics be involved in TAs? If so, how?

In regard to the role of TA in the planning and decisionmaking processes, there are several questions that should be raised. For example, how does one decide to conduct a TA-and of what scope-as opposed to some other kind of analyses? This is an important decision, especially in terms of the allocation of organizational resources, the kind of the results desired, and the understanding of what level of the organization should do the actual work.

Beyond these broader questions, many specific questions arise about individual assessments. For example, what event suggested or initiated the TA? Was the study projective, evaluative, or directive? Was the TA connected with any other TA efforts? It is anticipated that these and many other questions will assist us to better define and chart the course on which we are embarked in the Office of Technology Assessment (OTA).

While these hearings have no connection with pending legislation, we believe that they will be of significant benefit to the (congressional Board and OTA. We expect that the hearings will provide perspectives and insights into the role of TA in long-range policy-planning in both government and business.

This morning we have three distinguished witnesses, starting with Dr. H. Guyford Stever from the National Science Foundation (NSF). We welcome Dr. Stever here. It is particularly appropriate that we start with the NSF because it was there that we probably had the earliest examples of TA, at least as specifically identified as TA, within the Federal Government. The Foundation continues to provide leadership in the development of the science and art of TA.

We are glad to have you here this morning, Dr. Stever. If you wish to bring any of your colleagues up to the table, we would be more than happy to welcome them.

Dr. STEVER. Dr. Eggers, why don't you come up?

Mr. BROWN. We also welcome Dr. Eggers. Glad to have you here. You may proceed with your statement, Dr. Stever, in any way that you wish.

[The biographical sketch of Dr. H. Guyford Stever is as follows:1

**DR. H. GUYFORD STEVER, DIRECTOR, NATIONAL SCIENCE FOUNDATION**

Dr. H. Guyford Stever assumed the post of Director of the National Science Foundation on February 1, 1972. In addition to his duties as NSF Director, he

has been named Science Adviser and Chairman of the Federal Council for Science and Technology by the President. He also serves as Chairman of the Energy R&D Advisory Council; Chairman of the Technical Advisory Committee on Research and Development, National Power Survey, Federal Power Commission; U.S. Chairman of the U.S.-U.S.S.R. Joint Commission on Scientific and Technical Cooperation; and Chairman of the Board of Governors of the U. S.-Israel Binational Science Foundation. He serves on a number of additional committees, including National Science Board and the President's Committee on the National Medal of Science.

Born in Corning, New York in 1916, Dr. Stever received his A.B. from Colgate University in 1938 and his Ph.D. in Physics from California Institute of Technology in 1941. He has received 12 honorary degrees and other honors, including the President's Certificate of Merit in 1948.

Prior to his appointment as NSF Director, Dr. Stever, had served as President of Carnegie-Mellon University and, before that, Carnegie Institute of Technology, since 1965. During his presidency, Carnegie Tech merged with Mellon Institute to form Carnegie-Mellon University with a total endowment of almost \$120,000,000. Before going to Carnegie Tech, Dr. Stever served on the MIT faculty for more than 20 years, including the positions of Head of the Departments of Mechanical Engineering, Naval Architecture, and Marine Engineering. He is an internationally known expert on aeronautical engineering and space technology.

Among other organizations, Dr. Stever is a member of the National Academy of Sciences, National Academy of Engineering, Institute of Aeronautical Sciences, American Physical Society, American Institute of Aeronautics and Astronautics, and Phi Beta Kappa. He is married to the former Louise Risley Floyd and has four children.

STATEMENT OF H. WYFORD STEVER, DIRECTOR, NATIONAL SCIENCE FOUNDATION; ACCOMPANIED BY ALFRED J. EGGERS, JR., ASSISTANT DIRECTOR FOR RESEARCH APPLICATIONS, NSF

Dr. STEVER. Mr. Chairman, and members of the Board, I am pleased that you have asked me to participate in your important hearings on technology assessment (TA), and I hope that my observations of the experience of the executive branch in this area will be useful to the Board.

I would like to do two things today. First I will summarize information now being developed regarding TA activities in the Federal executive branch. Then I will discuss the TA activities of the National Science Foundation (NSF). I interpret the growing interest and activity in TA as indicating that a broad consensus is emerging regarding strategies for problem solving. In turn this consensus is resulting in a series of new commitments and perspectives within virtually every sector of our society.

Let me offer some examples:

First, our perspective of the global environment is changing to recognize the complexity of nature's ecology and the human place in it.

Second, a worldwide commitment to bring about a balance between population and food supply is growing.

Third, a realization that our primary reliance on fossil fuel exploitation for energy must be shifted to renewable resources is increasing.

Fourth, although not as strongly felt as the pressure upon energy resources, a perception is growing that material resources also must be wisely managed.

Fifth, a recognition is emerging of the necessity to make significant economic and social adjustments in response to questions of worldwide equity within a feasible time.

And sixth, underlying all of these is a realization that our success in facing all the challenges elicited by these new outlooks depends on a vast growth in human knowledge and its prudent application.

It is within this framework of new perceptions of problems of the human condition that I believe the concept of TA will prove to be an essential contribution to wise decisionmaking. Let me now give you some impressions of the extent of TA activities in the Federal executive branch. NSF, in its Research Applied to National Needs (RANN) program, is currently supporting a study designed to identify in detail the scope and content of TA activities in the executive branch. Since the study is not yet complete I will not be able to give you the entire picture, but I believe that what has been developed to date is quite informative. The study will involve up to 700 interviews, and will cover a full range of executive branch activities. The interviews are designed to reach down into individual agencies and offices in sufficient depth to obtain project-level detail.

Two years ago, I indicated in hearings before this Board, that the pace of interest in TA had accelerated and expanded throughout the executive branch. Our preliminary findings now indicate that this interest is being turned into real assessment programs and projects. While it is too early to confirm any precise measure of the extent of the growth of TA, I do believe I can illustrate by example the nature of the movement toward comprehensive TA among various Federal agencies.

Mr. Brown, I know that you are often interested in changes and comparisons, in the different ways that our society is going. TA was invented just 2 or 3 years ago when we gave our first reports on it. This Board was established a short time ago, and now we are beginning to count the TAs. One of the objects of TA was to make sure that we did not go too fast into various technologies. I am a little concerned that we may have to start worrying about whether we are not going too fast into TA. So we do have immense progress in the small number of years that we have been working.

Within the Department of Agriculture, several important new activities related to TA have taken place. A preliminary TA of minimum tillage was conducted in 1975, and in April of this year a weeklong workshop on TA was held. These TA studies are conducted in the Economic Research Service, the Forest Service, and the cooperative State Research Service. The Department of Commerce has shown an interest in the concept. I will not go into detail here since the Department is to participate in these hearings. However, it is worth noting that the Maritime Administration (MA) has shown continuing interest and has supported assessments of ocean shipping and offshore industry. In addition, the MA also provided partial support for a Conference on Assessment of Marine Technology, Man and the Ocean, sponsored by the International society for Technology Assessment and the European oceanic Association.

The Council on Environmental Quality supported a TA of Outer Continental Shelf (OCS) oil and gas operations. In this case, the initial assessment activities by the NSF on the topic led to the follow-up work in this other agency. Although the Department of Defense (DOD) conducts a wide range of assessments, our initial impressions are that most DOD studies do not include the full range of considera-

tions envisioned in the TA concept. An exception is the Corps of Engineers which conducts studies on the social impact of its planned projects and is applying the concept of TA, although not using the term.

Data from the Energy Research and Development Administration (ERDA) indicate that several TA studies have been undertaken. The Division of Conservation supported a TA of alternative fuels and an impact study on the use of electric cars. In addition, the Division of Biomedical and Environmental Research, the Office of Planning and Analysis, and the Division of Solar Energy, together with the Federal Energy Administration (FEA) are pursuing activities that closely relate to TAs.

Major TAs are being conducted by the Environmental Protection Agency (EPA). This Agency uses the term integrated technology assessment (ITA), for its assessment projects. The Office of Energy, Minerals, and Industry is supporting two studies: a technology assessment of the electrical utility sector, and a technology assessment of western energy resource development. The FEA is also scheduled to participate in these hearings so I will not go into detail on its activities. However, I would like to point out that FEA is partially supporting an NSF-awarded TA of telecommunications-transportation interactions.

Within the Department of Health, Education, and Welfare (HEW), several activities of a TA nature have been identified. The National Heart and Lung Institute has produced three assessments relating to heart and circulatory disease programs and the National Center for Health Services Research is currently in the process of designing a TA program. The Department of Housing and Urban Development (HUD), has conducted a TA of modular integrated utility systems and has supported an assessment by the National Academy of Sciences of the implications of an earthquake prediction capability.

The National Aeronautics and Space Administration (NASA), has been active in the area of TA for some time. Assessments of alternate transportable energy sources for aircraft and intercity transportation technologies have been performed. The intercity transportation TA is a joint project with the Department of Transportation. NASA is also participating with NSF in a jointly supported TA of large-cargo-aircraft technologies. The U.S. Postal Service supported a study on technology forecasting and assessment of alternative modes of mail delivery. The Department of Transportation (DOT) has supported a number of TA studies. A study of the secondary impacts of highway projects for example, is an assessment of a specific highway project. It also will provide some guidelines for conducting impact assessments. Our initial data suggest that the interest in TA is growing throughout a number of individual agencies in DOT.

These are some preliminary impressions from our continuing study of TA activities in Federal agencies. The study is being conducted by the George Washington University and will be completed early in 1977. We expect that a much more definitive picture of TA will result. One of the members of the oversight committee for the project is on the OTA staff. The Office will therefore be continuously involved in the project and will receive new information as it is generated.

It is interesting to note that even though a number of agencies have not used the term "technology assessment," efforts such as en-

vironmental impact studies, national assessments, future studies, planning studies, social impact analyses, the development of social indicators, et cetera, are going forward. These demonstrate a commitment and attitude toward the systematic and comprehensive examination of the consequences of technological change. I also note an important tendency for interagency cooperation in these endeavors. The joint effort of DOT and NASA in the area of interurban transportation is an example. As I indicated, NSF is currently engaged in two jointly funded assessments. And NSF is planning a joint project with OTA on future uses of the automobile.

Since I last reported to you we have established an interagency technology assessment coordination panel for the NSF technology assessment program. Currently, members from 16 agencies participate on the panel. We expect that several additional agencies will be represented during the next few months. This panel meets quarterly. It is briefed on plans and activities of NSF and it serves as a major coordinating body among executive branch agencies.

Let me turn now to a more detailed discussion of NSF activities in TA. The NSF program is predicated on the belief that the assessment process is a valuable way to meet a national need to provide better information regarding our decisions and policies on the use of technology. Here I would like to stress an important dimension of TA. While there is general agreement that assessments are conducted to inform a variety of decisionmaking elements of our society, I believe we should carefully distinguish that TA per se does not make either policy or decisions. It provides information for these activities. The central question facing the purely decision situation is: "What is best to do?" But the focal question of pure assessment is: "What if we do any one of a number of things?" Both of these questions require comprehensive, systematic analyses if we are to deal effectively with our problems. My point is that it is the location of agency interest along this "assessment-decision" dimension that conditions the scope and focus of a given study. I will return to this point later when I discuss the NSF role in supporting TAs.

From the beginning, our TA efforts in RANN sought to accomplish three specific objectives. The first is to provide substantive policy information through support of TAs in selected areas. Here a central question for the NSF technology assessment program has been the selection of topics for assessment. In selecting research topics, we have followed a mixed approach that combines sources of public concern, government interest, and professional input.

Our Interagency Technology Assessment Coordination Panel, for example, has provided information about the concerns of other agencies and is being apprised of current and planned NSF activities. Several studies supported by the RANN program have provided professional inputs on topics that are candidates for TA. The experience gained in supporting a number of studies is currently helping us to define some larger themes and categories of concern that will shape the program in the coming years.

The scope and role of TA at NSF is being shaped to emphasize:

First, an early warning function underlining the possibility of scientific breakthroughs, for example, the assessment of life-extending technologies, which in addition to conventional disease-control methods, also considers technologies that may alter the aging process.

Second, the technologies of a cross-cutting nature that span several missions and agencies and accentuate interactive processes and cross-effects.

And third, situations where there may not be a specific agency dealing with a given problem, or where the boundaries of responsibility have not been clear. For example, we proceeded with TAs of energy options before ERDA was established, and more recently, a study of electronic funds transfer predated the creation of a commission to handle this program.

Considerations like these tend to locate NSF activity in TA more toward the "what if" of pure assessment. Since 1971, we have made more than 60 awards for TA-related projects. I would like to summarize our program activity since the first of our TA awards were made. In fiscal year 1970, the first award for TA was made with a \$133,000 grant to George Washington University for a study on implementing TA. Since then, awards have been made as follows:

TABLE 1

	Number of awards	Award total
Fiscal year:		
1971	13	\$1,530,717
1972	5	421,888
1973	9	661,252
1974	13	1,996,935
1975	15	2,029,940
1976 <sup>1</sup>	7	861,595

<sup>1</sup> The 1976 data represent the awards made as of June 1, 1976, 9 new awards are being processed that will contribute to the final fiscal year 1976 expenditure of \$1,400,000.

TABLE 2—TECHNOLOGY ASSESSMENT AWARDS MADE BY THE NATIONAL SCIENCE FOUNDATION (SINCE JUNE 1, 1974)

Institution	Title	Starting date	Duration (months)	Amount
Cornell University, Ithaca, N.Y.	A Technology Assessment in the Area of Mobile Communications.	July 1, 1974	30	\$297,000
University of Washington, Seattle, Wash.	Technology Policy Assessment: Refinement and Evaluation of Methods.	do.	18	51,500
University of Utah, Salt Lake City, Utah.	A Western Regional Workshop on Technology Assessment.	Jan. 1, 1975	18	27,300
Texas Tech University, Lubbock, Tex.	Technology Assessment: Human Rehabilitation Techniques.	May 1, 1975	18	226,600
Gellman Research Association, Jenkintown, Pa.	The Higher Order Consequences of Scientific and Technical Information as a Regulated Public Utility.	do.	12	81,600
Battelle Memorial Institute, Columbus, Ohio.	Technology Assessment of Information Networking.	May 15, 1975	12	37,928
Forecasting International, Ltd., Arlington, Va.	Assessment of the Effects of Major Innovations in Scientific and Technical Information Transfer.	do.	15	82,350
Xerox Electro-Optical Systems, Pasadena, Calif.	Technology Assessment of Technological Advances in Scientific and Technical Information Services.	do.	17	50,490
Systems Control, Inc., Palo Alto, Calif.	Stratospheric Chlorofluoromethane (Freon) Accumulation: A Preliminary Technology and Policy Option Assessment of the Consequences.	do.	12	46,200
Stanford Research Institute, Menlo Park, Calif.	A Technology Assessment of Telecommunication-Transportation Interactions.	June 1, 1975	12	271,039
International Research and Technology Corp., Arlington, Va.	Assessment of Controlled Environment Agriculture Technology.	do.	18	309,500
The Futures Group, Glastonbury, Conn.	Technology Assessment of Life-Extending Technologies.	June 8, 1975	18	294,993
National Council for the Public Assessment of Technology, Washington, D.C.	Technology Assessment for the Citizen.	June 15, 1975	9	50,000



TABLE 2.—TECHNOLOGY ASSESSMENT AWARDS MADE BY THE NATIONAL SCIENCE FOUNDATION  
(SINCE JUNE 1, 1974)—Continued

Institution	Title	Starting date	Duration (months)	Amount
George Washington University, Washington, D.C.	Retrospective Technology Assessment: Submarine Telegraphy.	June 1, 1975	15	\$99,700
Carnegie-Mellon University, Pittsburgh, Pa.	Retrospective Assessment of Waters and Wastewater Quality Technology, 1865-20 and 1965 to Present.	July 1, 1975	15	66,300
Forecasting International, Ltd., Arlington, Va.	Retrospective Technology Assessment on the Application of Systematic Management Techniques to U.S. Industry.	July 15, 1975	15	105,600
Massachusetts Institute of Technology, Cambridge, Mass.	Retrospective Technology Assessment of the Telephone.	Sept. 1, 1975	15	88,900
J. H. Wiggins Co., Redondo Beach, Calif.	Risk to Structures from Natural Hazards: A Technology Assessment.	July 1, 1975	18	239,500
University of Illinois, Urbana, Ill.	Hail Suppression: A Technology Assessment Study.	Aug. 1, 1975	15	290,500
Gellman Research Association, Jenkintown, Pa.	An Assessment of Large Air Transport Technology.	-----do-----	12	138,883
George Washington University, Washington, D.C.	Technology Assessment in Federal Agencies, 1971-76.	Feb. 19, 1976	12	75,100
University of Michigan, Ann Arbor, Mich.	Factors Affecting Utilization of Technology Assessments in Policy Making.	May 15, 1976	18	274,400
Stanford University, Stanford, Calif.	Utilizing Environmental Assessments in Public Works Planning: Organizational Structures and Processes.	-----do-----	12	75,100

These awards have been made to both academic institutions and private research organizations, profit as well as nonprofit. I think it is noteworthy that the TA program is one area where small business firms have been quite successful. During a competitive solicitation last year, small business firms received 40 percent, that is 6 out of 15 of the awards totaling more than \$900,000.

The second objective of our program is to develop and extend the methodological state-of-the-art. Here our efforts are focused on developing the scientific methods needed to conduct effective and efficient TAs. Many of the problems of TA challenge our analytical capabilities and often must be dealt with by less than satisfactory approaches. The key aims of this part of our program are to enhance the tractability of the problems, develop appropriate strategies for the overall assessment process, and improve the overall validity and reliability of the results.

The final objective of the program is the stimulation and enhancement of a comprehensive capability to conduct and utilize TA. This entails support of organizations, both public and private, that engage in TA efforts. Grants and contracts for TAs have served indirectly to improve the capability to carry out this type of work. Sponsorship of seminars, public meetings, agency briefings, and cooperative international TA projects, on the other hand, are examples of direct capability support. We also have an extensive and growing distribution list for our TA reports. In addition to more than 1,400 domestic names in virtually every State, it includes 38 persons in foreign countries, with Japan having the highest number. About 500 addresses are for academic institutions, with the rest distributed among individuals and organizations, profit and nonprofit.

We are keenly aware that our projects must be well-grounded in reality. In each TA award, the issue of effective final use has provided the impetus for requiring a clear linkage between the assessment activities and the potential parties-at-interest. Thus in addition to the critical appraisal of prospective awards by means of proposal review,

we also make provisions for an 'oversight committed' to be associated with each assessment. This arrangement is designed to provide interaction with a set of interested parties throughout the assessment process, to increase sensitivity to the problems at hand, and to alert the research team to potential users and uses of the study findings. one of the lessons we have been learning is that a balanced and active oversight committee makes a major contribution to an effective result.

In looking toward future activities, let me reemphasize my initial remarks that we are undergoing some fundamental transformations in our outlook and activity in science and technology. These changes are being manifested in studies with more holistic analyses, taking a more comprehensive look at nature; with a new understanding of international interdependence; and with a growing emphasis on bringing the future into sharper focus. At NSF, the TA program will continue to support studies of this nature. We see some emerging broad themes for TA activities in the coming years. Among these are: problems of a resource constrained economy; environmental restrictions on technological opportunities; rearrangements of work and social activity patterns; technologies that affect biological systems; and questions of automation, cybernetics, and information flow.

There are a number of ways to approach both organizing categories of concern and specifying significant areas with potential for research and analysis. We have been proceeding with a combination of sensitivity to expressed social concerns and practical experience gained in doing a variety of studies, and are pursuing a flexible format that permits exploratory research with alertness to breakthroughs and potential future issues. We have also emphasized interdivisional linkages with a variety of programs at NSF, for example the other RANN divisions: Resources; Environment; Productivity; and Intergovernmental Science.

At this point, Mr. Chairman, I would like to summarize some general insights that are further helping to shape the TA program. Technology assessments will be more credible and have more impact if a wide spectrum of alternatives is communicated to affected parties before they become committed to specific courses of action. Interagency cooperation will enhance comparability, evaluation, and integration of TAs for the use of decisionmakers. We are at present incorporating these points into current as well as envisaged program efforts.

Finally let me point to some of the problems and challenges that our program experience indicates are realistic constraints on TA: limited resources and expanding costs; availability of human resources, including appropriate talent, experience, and skills of the assessment teams; bottlenecks resulting from insufficient data and unsatisfactory methodologies; intrinsic limits in our ability to integrate all essential impacts and consequences; difficulties in involving all social groups likely to be concerned with an emerging issue; limits and ambiguities involved in the difficult task of communicating the results of assessments; and issues of integrating new knowledge into complex policy-making processes.

These difficulties are not new. They are part of the scientific endeavor. They also express the difficult problem involved in delineating the full range of direct and indirect consequences of technological change and in equitably implementing new public policies. We believe

that our program is now entering a phase in which methodological improvements, expanded capability or conducting a TA, and an enlarged pool of information will encourage and strengthen the Federal Government's ability to fulfill the mandate to carefully examine the effects of technology on society when making policy.

I believe that TA activities in the Government will become a valuable part of the larger processes for examining alternatives in the resolution of critical and emerging national and international problems; for identifying future areas of concern; and for articulating the far-reaching consequences of technological opportunities. But life, no matter how perfect we try to make it, will always contain risk, trial, and error. Although we know that we can never create a no-fault existence, I believe TA is one mechanism to help steer society toward the more desirable choices for the future.

Mr. Chairman, this concludes my prepared remarks. I will be pleased to answer any questions that you and the other members of the Board may have.

Mr. BROWN. Thank you, very much, Dr. Stever.

We are going to modify slightly our procedure this morning. We had originally thought we might ask each of the witnesses to participate as a panel after his prepared remarks, but in view of the fact that one of the witnesses has had to be rescheduled, and that there are time pressures on others, I think we will proceed in the more normal fashion of questioning the witnesses immediately after their statements. I would like to call upon our distinguished ranking Republican Member from the House, Congressman Mosher, to make a statement or ask any questions that he might like to ask at this time. I might point out that the Technology Assessment Board is one of the relatively few congressional organizations that is non-partisan or bipartisan. It is equally balanced between Republicans and Democrats, and we are very happy to have members of such outstanding ability as Mr. Mosher, who we will be losing when he retires at the end of this year.

Mr. MOSHER. This is a very useful summary that we have just heard from Dr. Stever. Perhaps I can make a comment. I am aware of a study that the National Science Foundation (NSF) has commissioned with a group at the University of Michigan where they will try to determine or at least tentatively identify, those characteristics of a technology assessment (TA) that apparently are essential to the usefulness of the assessment.

In other words, assuming that there is no particular reason to do a TA unless it is effectively used, what are those characteristics which will best assure that it will be put to good use and that the user will take advantage of it? This study is just beginning and I have no idea of what its conclusions will be. But I understand that one of the initial hypotheses is that the producer of the assessment and the potential users shall be involved from its inception in a two-way communication with coordination and cooperation. In other words, this is just the opposite of the approach in which the producer of the study tries to keep as distant as possible from the potential user, in order that he not be influenced by the potential user in any way. This produces a pristine type of study that is then handed over to the user when completed. The user is then expected to immediately pick it up and

make effective use of it. The supposition is that this approach to conducting a study does not work as well as when the user is involved from the very start.

This troubles me some when I think of Congress as the potential user of a TA. It is the very essence, it seems to me, of life here on Capitol Hill that it is very difficult for Members of Congress to participate in a TA. I do not think it is a matter in which you, Dr. Stever, are prepared to give us any insight at this moment, but in this audience there are many people interested in this matter. I think this is a very basic problem. Perhaps it is the most basic problem facing Congress given the nature of the job, the changes taking place in the job, the complexity and volume of information that Congress requires, and the conflicting and complex information that Congress must process as compared with, say, 20 years ago. Given all that plus the antiquated structures and procedures with which we operate here, how are we ever going to begin to develop mechanisms, and most of all the time and the chance in a Congressman's life, to consider good information while at the same time we are part of the process by which we get that information. Do you want to comment on this?

Dr. Stever. Mr. Mosher, the rule at NSF is I speak first, while my team thinks out the right answer.

Mr. MOSHER. There is no right answer. I don't expect it.

Dr. STEVER. Let me speak and then call on Dr. Eggers. We here, this group and the others who are interested in TA, have been involved in an activity that is only a few years old. You described one instance of TA that looks to me like a two-player game. If the techniques of such a TA can be worked out, I can see many places where it would be of great value. For example, if an industrial company wants to go into a new process or a new product, and pays a group to make a TA for it with the express purpose of making sure that they do not get caught later on not having thought about something, then I think an interaction is perfectly reasonable. Provided of course, that the group with the initial interest just does not run things completely but that it is a dual mode. And in fact, I think if that kind of TA is carried out often, more frequently than is now the case, I think it is a very worthwhile process.

You are talking about something else however, when you talk about Congress being involved in TA. There I think you are dealing with more complex social issues in which perhaps not a single industry but a group of industries are moving in a given direction. The question then arises of whether the legal framework, the governmental regulatory framework, is set up to handle that? There TA would help the Congress. I think that here it is a three-player game, and in this case you would want responses from all sides. I am quite sure you are going to get them too. No TA is going to be given to you without the other sides. So I am not so sure that we should not look at both of these aspects as acceptable elements of TA.

Let me tell you about a third type, one in which NSF may be involved. This is essentially a TA that springs from the science as it develops before there is a user and before the Congress sees a purpose for it. In this case, if the scientific community is alert to the TA process, it may come up with something that society can use and adjust to more

quickly and more readily. So I am not so sure that you don't have several different TA gains to consider.

Mr. Mosher. Well I am very sure that there are indeed several.

Dr. STEVER. Dr. Eggers may be able to say something about the Michigan study.

Mr. MOSHER. I welcome that. But going back to this one-to-one relationship, the producer and the potential user, the word "potential" suggests that from the very start the users may not be identified. I suppose the essence of a TA is that potential users are identified in the assessing process. If Dr. Eggers wants to make a comment, I would be glad to hear it.

Dr. Eggers. I am going to approach this matter cautiously, Mr. Mosher~ because as you have already pointed out there is no correct answer. I could perhaps make a couple of remarks, however first let me make the following observation. There are all manner of activities that we don't call TA but which in one way or another are. As a matter of fact, when I was educated as an engineer a number of years ago, good engineers were supposed to do good TA when they designed something. I mean that literally in almost the dictionary definition of engineering as the application of new technologies for the benefit of society.

When I think about this matter under discussion I am not so sure that we are always considering something new. I think maybe we are rediscovering some things. For example, I think it has been known for a very long time that there is a lot of merit in having people who are developing something new, whatever it may be, and people who are going to use whatever gets developed, being in reasonably close contact if in fact what is being developed is going to be used. There are a number of reasons why this is often true. These can vary from event to event depending on whether a new technology development will ultimately be used by somebody, or whether the assessment of such a development will ultimately be used by somebody. I think in general, history says with a good deal of consistency that the relationship between the persons carrying out the development effort and the persons Or institutions that are going to use it, should be reasonably close. As a matter of fact this was expressed by Bacon several hundred years ago.

I don't want to say too much about the Michigan study, because it is just getting underway. It is studying this issue in somewhat greater detail in terms of specific experience in TAs gained to elate. I think the point you made, Mr. Mosher, about the uncertainty of who the users are or will be is a sound one because it gets into the question of what are the second-, third-, and fourth-order effects of new developments. This in turn relates to who are the ultimate users. The Electronic Funds Transfer Study that we recently completed illustrates that point rather well.

I would like to make one last point because you are raising a fundamental issue. I don't think we are now or will ever be very smart with respect to long-range projections because of the uncertainties of the consequences of new developments. This ought not bother us too much in my opinion because it is not only true of social, economic, environmental, and other similar consequences of a new technology but it is also true of much narrower factors. What we usually learn once

we recognize that we are not so smart, is not to take too big a step at any one time, or in other words to provide an opportunist to reevaluate. This means that once an assessment has been made it indicates ways to go with their associated consequences and we choose one of the ways, then we had better be prepared to make a reassessment fairly soon after starting on the basis of what new we have learned.

I will finish my comments with this point, since this is the Bicentennial and I have always enjoyed reading The Federalist Papers. I have been struck by the fact that one of the best concepts for reassessment and feedback in decisionmaking is in the way our Government is designed. I think that the Congress as well as other governmental elements reassesses yearly what has happened as a result of decisions made the previous year. I think that this is extremely important. Sometimes when I hear conversations about multi-year authorizations or appropriations to move ahead on an activity, I am very dubious because this begins to eliminate the reassessment function that is crucial on the part of the Congress. It is one aspect of the larger issue of reassessment that I think has to be considered in evaluating technology or anything else we decide to move ahead with as a Nation.

Mr. Mosher. Thank you.

Mr. BROWN. Dr. Stever, there are some broad questions about TA that have bothered me and I think other members of the Board. We hoped that we could explore at least some of these briefly during the hearings. One such question concerns the limits that might be drawn around the concept of TA. It may be however, that we don't want to draw hard and fast limits. I'm not trying to over-define this concept. It is a commonsense sort of idea to try to anticipate the results of one's actions, either personal, corporate, or societal. Any tools that are helpful shouldn't be beaten to death in an effort to make them too precise. In your experience, and the experience of the agency, has there been any effort to narrowly define the TA concept or to narrowly define the time frame in which an assessment should be made? Should this time frame be 20 years in the future, or 10, or 50? Is an assessment the kind of study requiring the exploration of all options? How do you limit the second—or third-order consequences and is such a limitation necessary?

I'm reminded of Dr. Egger's statement that TA is a commonsense approach inherent in the definition of engineering. Did Henry Ford make an assessment when he started developing the assembly line production of automobiles? It seems like a normal engineering thing to have done. But would we expect him to have analyzed the effects of intercontinental highways, suburban sprawl, and call the other by-products of the automobile? Is that a normal engineering function, Dr. Eggers? Do I make myself clear in this effort to try to put boundaries around the concept?

Dr. STEVER. One of the best consequences of having an Office of Technology Assessment within the Congress is that we in the Administration can watch you go through the problems of setting priorities on these issues. This is a tough one. But let's return to the better ideas that come out of TA. If the ideas of the potential outcomes are broadly based, then if scientists in doing fundamental research give it a little thought, they will think ahead, which is in fact what they do. After all, consider what the consequences of the research on genetic change have been; how responsible many people have been, and how groups

of basic researchers have been moved to ask—what will this work mean downstream? The accuracy of their predictions way downstream may be quite wrong, but at least they are thinking in the right direction.

Then I think there will be some matters for which TA is very obvious. Offshore oil drilling seems to be a good example. There is high pressure on the *one* hand for energy and high pressure on the other hand to preserve our environment. I think that this kind of issue is obvious. So I am not too sure that you are ever going to put hard and fast boundaries around the TA concept. I believe that your job is to develop some ways of thinking about scientists? engineers, Congressmen, industrialists, and others, so that all of them can make these priority decisions along the way. How much TA should *go* into this problem? I don't think it is the kind of subject that is going to be written into a textbook or a handbook that will give you the coefficients of TA required by a given problem. I think we are struggling through a different way of approaching this issue.

The first part of my statement lists six points. I used these also in a graduation speech recently. My object was to tell young people that the world was quite different today from what it was not so very long ago. I brought out the differences in the way society was thinking today about its life versus 10 or 15 years ago. I believe that the TA way of thinking is one of the new factors that has entered our way of life. I don't believe however, that you are going to be able to constrain it by means of a textbook. It's a way of thinking.

Mr. Brown. Well it is a way of thinking. May I suggest a parallel and get your reaction to it? I was struck by a phrase in the written testimony of the next witness referring to the newly developed procedure in the Department of the Interior that he calls the programmed decision option document. I guess option is the word that struck me, because each of us has been confronted with a changing world in which we are constantly required to make decisions among options, to make choices. The effects of these options have to be thoroughly documented. We then choose a path or make a move as in a chess game. You make a move which then gives you certain other options and a number of branches develop six moves down the road. This is similar to the way we make decisions about most policy matters. There is always the possibility that you will go down one path and reach a boundary or a limit where the purpose is no longer being served. At that point you have to rethink the options.

It seems to me that the process we are looking at is one in which we try to keep within acceptable boundaries in we proceed *into* the future. At each decision point we need these kinds of assessments in order to ascertain where our road is taking us. Sometimes they are not what might, be considered precisely a TA. Technology assessment is one kind of assessment however, that has to continually be made in order to develop the best possible options for making decisions.

In a democracy such as ours, the fundamental decisions on social policy have at least to be acceptable to the people. We then get involved in the question of whether the public needs to be engaged in structuring the options as well as choosing among them. Is there a role for the public in the assessment as well as in the decisionmaking process? Obviously there is. I'm attempting in this monolog to re-

fleet my own efforts at clarifying my thinking about what we are doing here and also to stimulate a reaction from you on this subject.

Dr. Stever. I believe your thinking is accurate on the process. But as you know, society sometimes backs up after having taken a series of options and reached branching points. This has happened in our own time. For example, the restructuring of some of our rivers so that fish return to them. That is an instance of society backing up on some previously chosen options. Cleaning the air is another example. I agree with Dr. Eggers that you cannot look too far downstream. There are, as you know, people who derided the concept of TA when it first appeared. It was called "technology arrestment." Critics implied that its aim was to stop progress-progress as interpreted by technologists. I don't believe that it has to go that way. I think that we must make it clear that it does not have to happen that way.

Mr. BROWN. I would like to explore this at greater length, but I do want to leave time for our remaining witnesses, Dr. Stever. We have a number of other questions that we would like to submit to you, some detailed and some general. I wonder if we could ask you to respond to them in writing?

Dr. STEVER., We will be glad to.

[The following questions were submitted by Congressman Brown to Dr. Stever and his answers thereto:]

**Question 1.** Since The National Science Foundation (NSF) is the lead agency for technology assessment (TA) in the executive branch, would it be beneficial from a communications standpoint for NSF to publish and distribute to all levels of government a bibliography of TA reports written throughout the executive branch?

Answer 1. I believe that this would definitely be beneficial. As I indicated in my statement, we are seeking to provide an information inventory and clearinghouse function for TA activities. As a first step in this direction, we have initiated a study to prepare analytical bibliography covering substantive TAs that have been supported by NSF/RANN. Furthermore, in conducting the survey of Federal activities in TA that I referred to, we will prepare an inventory of TA projects. Both of these activities are designed to lead to a comprehensive bibliography that should be available during fiscal year 1978.

**Question 1a.** Would this bibliography be helpful and cost-effective in avoiding duplication of effort?

Answer 1a. Since the cost of the bibliography will be modest, I believe it will be cost-effective. It also should be very useful in avoiding unnecessary duplication. Because of the wide differences among agencies, however, it is quite possible that some overlap of assessment activities will occur. Thus I believe that the main benefit of the bibliography will be to facilitate well-designed assessment projects around common topics that supplement and complement studies by different agencies.

**Question 1b.** In this regard, what value do you see in having closer relationships between the public and private sectors and even between the State and local levels?

Answer 1b. Currently we see four general categories of organizations that have interests and activities in TA. These are: government, private industry, academic, and other. During fiscal year 1977, we will complete a series of four regional seminars begun in fiscal year 1975 that are intended to inform State government officials of the uses of TA. As currently planned we anticipate that we will be examining activities in private industry during fiscal year 1977, find in the academic sector and other categories in fiscal year 1978. Under the category other, we include private and public foundations, non-profit activities of public interest groups, international organizations, and ad hoc assessment activities by various organizations. We see our main function as a clearinghouse activity to facilitate the communication and sharing of information among the organizations in each of the four category. Thus the thrust of the program is to direct efforts toward providing outreach and linkages among organizations involved in TA.



**Question 1c.** How can greater communication between producers and users in and out of government be facilitated?

**Answer 1c.** This is a very important aspect. anti we are currently supporting a study to explicate this problem in some detail. This is being carried out by the Institute for Social Research at the University of Michigan and will explore the main elements that contribute to and define producer capabilities. And at the same time it will also explore in some depth the precise needs of TA users. We expect this project to result in knowledge that can be useful in helping to match analytical capability and decision-related information needs.

We also expect that this study will help provide better means and mechanisms for communication between producers and users of TAs. Specifically it should help to improve the situation in the user community so that requests for TA are timely and well specified. And it should help the producer community to develop research that will meet the real needs of policy-makers.

**Question 1d.** Is there a need for some coordinating body that would encourage and develop greater communication on TA in the Government and elsewhere?

**Answer 1d.** As I indicated in my statement there is growing activity in 'the area of TA throughout the Federal executive branch. The NSF currently has in process an Interagency Technology Assessment Coordinating Panel to help guide and coordinate activities in NSF and to assist other agencies in areas of their interest. At the present time, it is unclear whether there is a need for a separate coordinating body to *encourage* and develop communication. However, as indicated by the answer to the previous question, we should soon be developing some new information in this area. At that time NSF will initiate whatever new coordination arrangements are necessary.

**Question 1e.** Has NSF given assistance to Federal and State agencies on methods to assess the societal impact of their technology R&D program and regulations, and any second-order consequences these might have on the environment ?

**Answer 1e.** In the fiscal year 1976 Budget to the Congress, NSF indicated that the environmental impact statement process in fact constitutes a partial TA and therefore NSF indicated an interest in assisting this effort.

Activities in NSF have involved coordination with the Council on Environmental Quality, with the National Academy of Sciences, with the Environmental Protection Agency, and a recent initiative has been taken to conduct a workshop on precisely the nature of the questions that are being asked. We expect that as a result of this workshop we will have a series of research specifications that will lead to improved methods to assist agencies in efforts to assess social and environmental impacts of their technology, R&D, programs and regulations.

**Question 1f.** How do you involve the public?

**Answer 1f.** As I indicated we typically make provisions for an oversight committee to be associated with substantive TA. This arrangement is designed to provide Interaction with the interested parties that are likely to be affected by a given technology. In addition to this, we are just completing a study on the utilization of public interest group inputs into the TA process. Since this project is not yet complete, we do not have any definitive findings.

**Question 2.** What are the limits that might be drawn around the TA concept?

**Answer 2.** As we all know, the concept of TA focuses on better understanding not only the direct but also the indirect consequences of technological opportunities. I think there are two clearly distinct functions that can be associated with this concept. First, there is an early warning function; this is the "look before you leap" issue. And second, there is the design of several options before the choice of any one specific action; this is more in the area of long-range strategic or contingency analysis. As to the limits, I believe we can look at several real-life elements. First, there is a client who provides a need limit. How much information of what nature does a client have a need for? Here, a principal dimension concerns which of the two major functions is of primary interest to the client. There are quite different needs from a private enterprise perspective than from a long-range government policy perspective. A second area would be the nature of the technology or problem at hand. This typically puts a time limit on the assessment process in terms of forecasting including forecasting not only effects but also capabilities. Finally, there is a real-life constraint in resources or budget. How much effort can be allocated to dealing with the broad, long-range consequences ?

**Question 3.** At the interagency policy level, is there any formal structure for conducting or encouraging the use of TA?

**Answer 3.** Since the National Science and Technology Policy Organization and Priorities Act of 1976 has been signed into law, I believe some important new TA initiatives are very likely. With the establishment of the new science advisory structure in the Executive Office of the President, specific provisions have been made for conducting and utilizing TA. I believe this question will be answered in the near future as the new Office of Science and Technology Policy becomes organized and is placed into operation.

**Question 3a.** You state that 16 agencies are represented in the Interagency TA Coordination Panel. When was this panel formed?

**Answer 3a.** The panel was formed under the aegis of the RANN Interagency Coordinating Committee and the first meeting was held in February 1975. Subsequently, at approximately quarterly intervals, we have held Panel meetings.

**Question 3b.** How does it function, and how often does it meet?

**Answer 3b.** Since its inception it has met at approximately quarterly intervals. The functioning is primarily around coordination activities in which the NSF apprises members of the panel of activities in process and planned. In addition, we try to provide briefings of completed or near-completed TAs that may be of interest to the agencies represented on the panel in their planning and research activities.

**Question 3c.** Do any legislative branch agencies or committees participate?

**Answer 3c.** The interagency coordinating function of the TA program at NSF is designed to keep only executive branch agencies thoroughly informed. However, the director of the RANN program has indicated to OTA that the panel will include them in future meetings either as members or in an advisory capacity, depending on whether constitutional issues pose membership constraints.

**Question 3d.** Would you supply us with a listing of the representatives to this TA Coordination Panel?

**Answer 3d.** The current roster of representatives as of the most recent meeting of the Panel is listed below:

Mr. Carl Gerber, Associate Assistant Administrator for the Office of Research and Development, Environmental Protection Agency, 401 M Street, SW, Room 911, Mail Code RD 672, West Tower, Washington, D.C.

Dr. Paul F. Bente, Jr., Council on Environmental Quality, 722 Jackson Place, NW., Washington, D.C.

Dr. Daniel J. Edwards, Chief, Supply-Demand Analysis, U.S. Bureau of Mines, Office of Economic Analysis, 2401 E Street, NW., Washington, D.C.

Dr. F. W. Niedenfuhr, Director, Technology Assessment, Defense Advanced Research Projects Agency, 1400 Wilson Boulevard, Arlington, Va.

Mr. Hugh Loweth, Office of Management and Budget, Executive Office of the President, Science and Energy Technology Branch, Washington, D.C.

Dr. Edward A. Brown, Harry Diamond Labs, 2800 Powder Mill Road, Adelphi, Md.

Dr. Alan R. Siegel, Director, Division of Community Development and Management Research, Housing and Urban Development, Washington, D.C.

Dr. John McKinley, National Bureau of Standards Program Office, U.S. Department of Commerce, Washington, D.C.

Mr. Robert Rollins, Study Analysis and Planning Office (Code RX), Office of Aeronautics and Space Technology, Headquarters, NASA, 600 Independence Avenue, SW., Washington, D.C.

Dr. David B. Chang, Deputy Assistant Secretary for Science and Technology, Room 3864, Main Commerce Building, Office of the Secretary of Commerce, Washington, D. C.

Dr. Leo S. Packer, U.S. Department of State, Code OES/APT/SA, Room 7823-NS, Washington, D.C.

Dr. William B. Back, USDA-ERS-NEAD, Room 190 GHI Building, 500 12th Street, SW., Washington, D.C.

Dr. Vincent Sardella, Office of Telecommunications Policy, Executive Office of the President, 1800 G Street, NW., Washington, D.C.

Mr. Paul Casscarano, Law Enforcement Assistance Administration, 633 Independence Avenue, NW., Washington, D.C.

Mr. Alfonso B. Linhares, Chief, R&D Policy Analysis Division, Department of Transportation, 400 Seventh Street, SW., Washington, D.C.

Mr. Richard I. Gerson, U.S. Energy Research and Development Administration, 20 Massachusetts Avenue, N.W. Washington, D.C.

*Question 3e. Does the Panel publish an annual report?*

Answer 3e. The Panel circulates meeting notes and abbreviated minutes of each of its meetings for record purposes but does not publish an annual report. However, each member of the panel is provided with a panel notebook that includes a compendium of information regarding the technology assessment program as well as cumulative meeting notes.

*Question 3f. What has the Panel done to date?*

Answer 3f. The Panel's activities to date have been advisory to the NSF program. The first meeting of the Panel was very much an organizing and orientation meeting. Subsequent meetings included panel assistance in a survey of topics of concern for assessment that would reflect specific interests of each agency. These were organized into general topic areas and recirculated to the panel for consideration and are used in program planning as we move ahead.

*Question 3g. Are its meetings and records open to the public?*

Answer 3g. The meetings are open to the public. The records and notes of the meetings are available on request.

*Question 3h. How would you rate its effectiveness?*

Answer 3h. After several meetings, the Panel appears to be moving toward becoming an effective coordination mechanism. At the last meeting, the Panel proved to be very useful in providing details of agency activities for the statement on TA in the Federal executive branch given at these hearings.

We attempt to keep each representative current on technology assessment activities initiated by NSF and are beginning to formalize procedures for apprising members of other agency initiatives in TA.

*Question 3i. To whom does the Panel report?*

Answer 3i. The Panel reports to the Director, Division of Exploratory Research and Systems Analysis.

*Question 3j. What could be done to improve its operation and effectiveness throughout the Federal Government?*

Answer 3j. As I indicated, the Panel has been quite useful in providing the NSF program with information and interests for other agencies. I believe we can improve the operation and effectiveness throughout the government by developing better mechanisms for feeding back to each of the agencies, at a variety of levels, information about TA both at NSF and from among the other agencies. We intend to attempt to do this in the future with information papers prepared by the NSF program that can be readily circulated throughout other agencies by Panel representatives.

*Question 3k. Does the Panel try to interface with the private sector?*

Answer 3k. As currently constituted, the Panel is a coordinating activity among Federal agencies. The interface with the private sector is not explicitly within the charter of the Panel at this time. However, as the NSF program develops its program element in capability-building, we expect that the interface activities will become an important component of the Panel's activities.

*Question 3l. How is the public involved?*

Answer 3l. The public is not directly involved in the Panel. However, as I have indicated, in each of the substantive TA projects supported by the NSF there is an oversight committee which does represent a wide range of interested publics.

As information is developed on each of the projects, it will be fed back to the Interagency Coordinating Panel so that a mechanism does exist for including public concerns in the coordination activities of the Panel.

*Question 4. How can greater use of TA in the planning and decisionmaking processes be encouraged in the Government?*

Answer 4. As I indicated in my remarks before the Board, TA in a relatively short period of time has grown quite respectably. It thus appears that there is a general orientation to use TA in a large number of Federal agencies. I think the crux of the question however, is in effective use of TA in our planning and decisionmaking processes. To that end I refer to question one and the research project being conducted by the University of Michigan. The title of this project is "Factors Affecting Utilization of Technology Assessment in Policy-making." As we develop information in this project, I believe it will guide us in both encouraging greater use of TA among planning and decisionmaking activities of the Government and in enhancing its effective utilization.

*Question 4a. Is its use widespread in NSF?*

Answer 4a. The TA program in NSF is designed to interface with other activities at the Foundation. Particularly, the program is designed to interface

with other elements of the RANN program as I indicated in my statement. As examples of this interface, let me cite two current TAs. The first is an assessment of controlled environment agriculture technology that is supported by funding from the RANN Resources Division. Another example is a study entitled "Risk to Structures from Natural Hazards: A Technology Assessment," that is designed to provide information not only useful to local and regional governments, but also closely related to activities of the RANN Environmental Division.

**Question 4b.** What methodologies have been developed in the last five years to give us understanding of decisionmaking under conditions of uncertainty and risk?

**Answer 4b.** This is a very important area for TA. There is a large compendium of research on decisionmaking under conditions of risk and uncertainty, however, to date, this research has been only very little utilized in TA. A planned activity of the TA Program at NSF in its methodology development element is to devise ways in which the findings of this body of analytical knowledge can be incorporated into the TA process.

**Question 4c.** What NSF sponsored activities were designed to develop and enhance this area of TA methodology?

**Answer 4c.** In fiscal year 1971 the NSF supported a colloquium on benefit-risk relationships for decisionmaking. This resulted in a National Academy of Engineering report on the TA topic. Since that time another award was initiated by the TA Program on risk-benefit analysis for large-scale technological development. This is being conducted at the University of California at Los Angeles.

**Question 5.** In your opinion, can we expect to measure the cost and benefits of a TA?

**Answer 5.** It is a difficult task to attempt to measure precisely the cost-benefit relationship for any research activity. However, I do believe there are ways to estimate the approximate return e.g. information value theory in decision analysis. Again, the TA Program in its future methodological development intends to attempt to provide ways in which such measures can be reasonably approximated.

**Question 5a.** Would you give us an idea of how you go about deciding how much to invest in TA?

**Answer 5a.** In budgeting for TA, we have proceeded on the idea that a certain fraction of the applied research program should be directed to looking out at the implications of new technologies. Thus, we have set a TA Program budget level that represents a fraction of the overall research funding available for the Directorate for Research Applications at NSF. Currently, this amounts to approximately \$2,000,000 per year. As to how much to invest in a specific TA project, we have generally considered two types of projects. Preliminary TAs are those in which a technology and its implications are not well understood and for which preliminary analysis is indicated. These, typically run in the range of two to three person-years of effort. This translates to \$100,000 to \$150,000 per project. Our experience to date indicates that for a comprehensive TA in depth, an effort on the order of five person-years is required, this averages to about \$300,000 per assessment. To date we believe that substantive useful information can be developed from both types of projects at these levels of effort. I would like to indicate that one objective of our methodology development effort is to attempt to provide better and more efficient mechanisms for conducting the assessment so that these figures can be kept to the minimum consistent with good scientific practice.

**Question 6.** In your testimony you seem to suggest that there will be some improvements in TA methodology. What defects in the current techniques would you expect these improvements to overcome?

**Answer 6.** As I indicated in my statement, I believe there are a number of defects that our TA methodology program will help to overcome. The first has to do with the answer to the previous question. With limited resources and expanding costs, we need to improve the efficiency of conducting TAs. The second area is associated with the skills, experience, and talent required to conduct such assessments. Here our capability-building program comes to the front with its objective of encouraging the development of appropriate talent. A third area is associated with the general issue of data and methodology. While a wide range of data on many social, economic, and environmental issues are available, it is often difficult to compile, codify, and analyze such data. We are exploring methods that will facilitate this activity. In the general area of methodology, we must in many cases deal with problems by methodologies that are far from optimal.

We plan to develop, in addition to methods of uncertainty and risk analysis, structural modeling procedures, cross-impact analysis techniques, and improved methods for identifying higher-order impacts more comprehensively. A fourth area is associated with limits in our ability to integrate impacts and consequences in a concise and meaningful manner. Here, we are supporting research on the process of conducting TAs that seeks to identify barriers to communication among the multiple disciplines required for a TA. Another area has to do with involvement of groups and organizations likely to be concerned with an issue yet to become visible. Here we intend to explore ways to encourage participation by a wide variety of groups. Another area of need concerns the difficult task of communicating results of complex scientific analyses. This is an area for experiment during fiscal year 1977 in which several modes of communication will be examined. And finally, we are probing the central problem discussed earlier, of integrating the results of analyses into the very complex policymaking processes. As I indicated, the research at the University of Michigan is directed primarily at this question.

**Question 7.** Has NSF discovered ways of improving the quality of empirically validated information about the societal impacts of technology?

**Answer 7.** *Currently* we have two projects under consideration that are associated with this issue. In one of these it is proposed to explore a new technology associated with rearrangement of working conditions. It will be based on empirically derived evidence as a means to estimate validly the effect of the technology on the social system that it impacts. Another empirical study currently under consideration has to do with the examination of how a technology and a specific segment of society interact. This is focused on the question of changes in social arrangements that are influenced by new technology.

**Question 7a.** What techniques have been developed to generate this kind of data?

**Answer 7a.** Since these projects are either new initiatives or are under consideration, we do not have techniques available. However, both projects are rigorous social science research emphasizing indicators of social change.

**Question 7b.** Has NSF done anything to encourage the use of social impact data in TA?

**Answer 7b.** As previously indicated, the two projects under consideration will in fact incorporate, in a rigorous manner, measures of social change based on data, observation, and interview techniques. If successful, these projects promise to provide an improved model for integrating social impact data into the TA process. I think it is important to emphasize that the very process of TA has always attempted to incorporate general social impacts as a part of the effects that result from any technological development. Still we believe that improvements in this area are needed and possible.

**Question 8.** Has the NSF TA Program actually examined and evaluated the present status of the environmental impact statement process and its consequences for society?

**Answer 8.** The NSF TA Program initiated a study of the impact statement process with a recent award to Stanford University to study the environmental impact statement process at the field agency level. This project is designed to assist in providing information on how environmental information can be effectively and appropriately used in planning. It is focused on public works activities. In addition to this, as I indicated in the answer to question one, we are in the process of planning a workshop that will clarify and provide the indicators for future research in this area.

**Question 9.** Do you think it is important to support and track research on multiple impact and partial TAs?

**Answer 9.** Yes, I think it is a task that should be conducted.

**Question 9a.** If you have any awards in these areas, how are they administered?

**Answer 9a.** Currently the only award in this area is the project that I indicated in my statement, in which we are attempting to survey rather comprehensively, the full range of TA activities in the Federal Government. This award is administered similarly to other TA awards, i.e., it is monitored by a program manager and has an oversight committee to guide and advise the research.

**Question 9b.** Are reports generated available to other agencies?

**Answer 9b.** A report on TA activities conducted in 1972 has been made available to other agencies. Since our current activities are still in process, we do not have any new reports. When completed, reports will be published and made available to other agencies.

**Question 9c.** Does NSF still sponsor preliminary TAs? If so, how many have been done since 1972?

**Answer 9c.** Yes (See Question 5). There are currently three PROJECTS either completed or in process. The First was an assessment of earthquake prediction techniques and their applications. The second is a joint project with the National Aeronautics and Space Administration on the effects of large cargo aircraft technology. A third project under consideration involves the effects of quality of work-life technologies.

**Question 9d.** How useful has this technique been?

**Answer 9d.** It appears, from our present knowledge, that the preliminary TA concept is useful when we have very little information about the technology.

**Question 9e.** How many have gone into full-scale TAs?

**Answer 9e.** The only one that involves a full-scale TA is on the topic of earthquake prediction. However, it did not stem from the preliminary TA on the subject but was concurrently awarded. The objective was to examine the differences between a TA with a very low budget and one funded at a comprehensive, in-depth level.

**Question 10.** How much time elapses between submission of proposals and decisionmaking on the proposal?

**Answer 10.** A typical time between submission of a proposal and an award is approximately six months for a TA project. In some cases however, since several major questions may be raised in peer review, this time has been extended to up to one year.

**Question 10a.** How does NSF identify peer reviewers?

**Answer 10a.** NSF maintains a file of qualified persons organized according to expertise and experience. The Technology Assessment Program has TA reviewers available as well as persons with expertise in specific topics. In addition to this file of reviewers, the program manager typically uses a procedure where experts are identified and asked to identify other experts. From a pool of such names, those most often recommended as having expertise in the subject matter are solicited for review.

**Question 10b.** Is public participation at this juncture utilized as part of peer review?

**Answer 10b.** In each TA on a substantive topic, some of the reviewers are people who are likely to be affected by or who may implement the technology.

**Question 10c.** If so, how effective has this procedure been?

**Answer 10c.** Many of the insights of the users and potentially affected parties have been quite valuable in orienting the originally proposed TA in a more useful and effective direction.

**Question 10d.** Has there been a noteworthy improvement in the review process as a result of public participation?

**Answer 10d.** In view of the foregoing, it seems apparent that the process has been considerably improved by increasing sensitivity to a wider range of problems as well as to potential utilization and integration of our assessments. Accordingly, we do not have any plans to modify this public input in the review process at this time.

Mr. BROWN. Our next witness is Dr. William L. Fisher, an Assistant Secretary of the Interior. We are very pleased to have you here, Mr. Fisher. I apologize for having to leave briefly, but Mr. Mosher will preside while I am gone.

Mr. MOSHER. Will you proceed?

[The biographical sketch of Dr. William L. Fisher is as follows:]

**DR. WILLIAM L. FISHER, ASSISTANT SECRETARY, U.S. DEPARTMENT OF THE INTERIOR**

**Dr. William L. Fisher, Assistant Secretary for Energy and Minerals, U.S. Department of the Interior.**

**Born September 16, 1932, Marion, Ill.; married; three children.**

**B.A. geology, Southern Illinois University, 1954; M. S., 1958; Ph. D. geology, University of Kansas, 1961.**

**Military service, U.S. Army, Korea, 1954-56 (and inactive reserves); hard-mineral exploration ALCOA, 1958; research scientist, Bureau of Economic Geology, University of Texas at Austin, 1960-68; professor of geological sci-**

ences, University of Texas at Austin, 19(34; State geologist of Texas and director, Bureau of Economic Geology, Texas State Geological Survey, 1970-75.

Frequent testimony before standing and interim committees of the Texas legislature in areas of minerals, energy, land, water, marine resources, and natural hazards. Limited testimony before U.S. congressional committees.

Approximately 250 invited lectures presented to professional and lay groups over the past five years, chiefly in areas of mineral, energy, and environmental resources, including an international tour as Distinguished Lecturer of the American Association of Petroleum Geologists, and as lecturer as part of continuing education programs of national professional organizations.

Advisory activities include serving on numerous international, Federal, State, university, and professional committees and councils, chiefly in the areas of mineral, energy, water, marine, and coastal zone resources, as well as public policy, and education.

Elective offices in most national and several regional geological, mining, and mineral professional societies in which is a member or fellow.

Publications include approximately 80 books and articles, chiefly on energy and mineral resources, environmental and water resources, land resources, and basic and applied geology.

#### STATEMENT OF WILLIAM L. FISHER, ASSISTANT SECRETARY FOR ENERGY AND MINERALS, U.S. DEPARTMENT OF THE INTERIOR

Dr. FISHER. Mr. Chairman and members of the Board; I am pleased to be here today to discuss the experience of the Department of the Interior (DOI) with regard to technology assessment (TA).

As you are aware, formalized TA, as we understand it today, is of relatively recent origin; it emerged in its present form with the passage of the Technology Assessment Act of 1972. As an analytical art, it is still evolving and subject to much more study and refinement.

Our own use of assessment techniques and our understanding of assessment concepts, have gone through a constant evolution. This began with our first chance to stand back and examine our programs, to see both, if they were meeting our goals and how they could be improved. Since those early attempts, our techniques and understanding have matured significantly. This has been primarily due to the refinements placed upon us by the increasing complexity of our job as managers of much of the Nation's natural resources. Probably the most significant events initiating this maturation process occurred when the Department began in 1934 the series of river basin studies in which the old Biological Survey (forerunner of the Fish and Wildlife Service) made limited assessments under the River Basins Act, and in 1946 when the Coordination Act mandated the first "systematic cost-benefit analyses. With the passage of the National Environmental Policy Act (NEPA) of 1969, we moved a major step in the direction of assessment. This legislation prompted assessments of the projected results of certain future actions.

The latest and most significant step in the evolutionary process has been in the institutionalization within 1)01 of the Program Decision Option Document (PDOD). The PDOD is a decisionmaking paper that guides the discussion before the Secretary as he makes the final decision on significant matters, particularly on matters that could have an impact on the social and natural environment. The PDOD summarizes the major options open to the Secretary. It, includes the various alternatives, analysis of those alternatives, and

the implications within each option. In each case, the anticipated impacts of the options are spelled out to wide discussion. Before the PDOD itself comes into play however, briefings are held with various members of the Secretariat who analyze the results of the independent assessments that lead to the conclusions set forth in the PDOD.

I think, Mr. Chairman, the diverse missions of the Department of Interior assure that a wide range of options are presented and defined. This process is one that embraces a number of considerations and alternatives, and is actually utilizing concepts and methodologies of TA. We are very pleased with the success of the PDOD mechanism in guiding the decisionmaking process. We have found it a very effective approach for the presentation of alternatives in the very complex decisions that we and the Secretary make.

Although assessments such as these have utilize many of the elements of a formal TA, they have not systematically involved all of the steps of a modern TA, as described by Mr. Joseph Coates in the Journal of the International Society of Technology Assessment, June 1975. While the Department has never undertaken a formal TA, it has produced a number of studies, and its agencies regularly justify and develop their various projects using methods comparable to those of TA that embrace its basic methodologies and processes. I have attached to my testimony examples of departmental programs that utilize elements of TA.

[The attachments referred to above appear in appendix A, exhibit 1, of this report.]

Assessment efforts are also well-illustrated by the studies performed in analyzing the proposed Trans-Alaska pipeline. These studies, which went into creating environmental safeguards and into feasibility assessment and risk analysis, are similar to the multi-faceted investigations of a TA. The study of the proposals to deliver natural gas from the arctic is even more recent. Interior's environmental analyses, environmental impact statements, capability studies, risk analysis studies, and economic and comparability studies have all been made available to the Congress, some in formal reports. It is my understanding that they have been well-received and that they will be useful to the Congress in its deliberations on the Arctic gas delivery issue.

Over the years, the Department has built data gathering and information development capabilities in several important natural resource areas. The Geological Survey and the Bureau of Mines have developed computerized systems covering geological and hydrological resources, mineral and energy reserves, and mining operations. Information concerning multiple use of Federal lands is available from the Bureau of Land Management, wildlife information from the Fish and Wildlife Service, reclamation feasibility from the Bureau of Reclamation, and the minerals industry health and safety data from the Mining Enforcement and Safety Administration (MESA). Analytical capability exists within each of these agencies to aid anyone interested in using these data to solve specific assessment problems. The examples of technology related activities that I have attached to my statement, Mr. Chairman, illustrate the variety of efforts to which this combination of data and analytical capability lends itself.

The Department's approach to program and project evaluation has reinforced the development of both a strong data base and a strong



analytical capability. In our role as public lands manager, the DOI must take a comprehensive view of the primary and secondary results of any contemplated action. We are responsible for both protecting the public lands, and encouraging their use in a variety of ways. Decisions involving minerals production, grazing, wildlife protection, outdoor recreation, and water use often revolve the limitation of competing land uses for long periods of time. The broadest view of specific programs and projects must be taken, both for departmental decisionmaking and to assure that our NEPA responsibilities are met. Program and project ramifications are assessed on both micro and macro scales as a matter of course, with only the most trivial problems being examined as individual or isolated events. As you can see, Mr. Chairman, we believe that the DOI has developed a capability for performing the many types of analyses that are required by a formal TA and has, in fact, utilized many of the elements of TA for a number of years in performing its primary function of managing and providing policy for the public lands and for the Nation's natural resources.

At this point, Mr. Chairman I would also like to add that for the last 4 years the Department, has been conscientiously fulfilling its responsibility under the Technology Assessment Act. Last year the Department detailed Dr. Dennis Cox from the Geological Survey to the OTA. Dr. Cox has returned and Mr. Stanley Schweinfurth of the Survey is currently detailed. Also, at the beginning of this year Dr. Robert Kaplan of the Bureau of Mines was detailed to OTA. Of similar importance has been the furnishing of critical analytical data and the analysis and interpretation of that data for the Office. The particular OTA studies for which we have furnished data, interpretation, and analysis include: an Assessment of Economic Stockpile Policy; Technical Assessment of Material Information Systems; and an Interim report on Mineral Accessibility on Federal Lands. The Department has been very pleased with the results of our interface and exchange, and looks forward to the continuation of this working relationship.

Mr. Chairman, I would be happy to respond to my questions you may have at this time. Thank you.

Mr. Mosher. Thank you, Dr. Fisher. Your testimony is very helpful. In this evolving concept that you mentioned, you say that you think it actually became a conscious process as early as 1934. Has your awareness of it greatly increased in the last 4 or 5 years?

Dr. FISHER. Unquestionably, Mr. chairman. I would say, certainly.

Mr. Mosher. You referred to a number of studies produced by DOI, and that Interior agencies regularly justify and develop their various projects using methods of comparable complexity and sophistication. In using the word justify, do you mean that you have an internal mechanism, or rather a system, by which you test the value of your Own studies and procedures ? Is there some formal review mechanism established within the Department that requires the justification of projects ?

Dr. Fisher. It varies from agency to agency within the Department, Mr. Chairman. In degrees of how formally this process is gone through however. some of the agencies have gone much further with this than others. At the departmental level the main process has now

been institutionalized, as I indicated, with the PDOD which is very much a formal mechanism to insure that a wide range of options are defined and presented. These are usually based on some fairly expensive analyses that may have taken place within the agency. It is a self-process. Ultimately the data, information, and analyses that lead to the decisionmaking process are incorporated into the various options. At that point they would be subject to a kind of justification and evaluation just on the strength to which they support various alternatives presented.

Mr. Mosher. I suspect there would be some people in the public and certainly in the Congress who would be skeptical of all this sort of folderol, which for instance they might call your PDOD system. Obviously such a system takes time, energy, and manpower. My prejudices are all in favor of it. I am assuming that it is worthwhile. But, what if you had a Congressman sitting here who thought that in relation to cost, it was a lot of nonsense. Could you really justify it?

Dr. FISHER. I think so, Mr. Chairman. Primarily because of the kinds of complexities that Dr. Stever mentioned just a moment ago, such as the exploration and development on the Outer Continental Shelf, which it had foreseen from a variety of concerns, all the way from rapid development to nondevelopment. The kinds of complexities that now get into natural resource issues I think compel an examination of the alternatives and their implications. I cannot perceive that we could go ahead with any kind of sophisticated process without a very thorough examination of these options. This takes both time and effort. But it assures that all of the facets have been considered, and evaluated, and that they are a part of secretarial decisions. So I would say that we probably could not even move forward on a decision and take a defensible position on that decision, unless we did expend the time and effort to go through this process. Although it takes time and effort, it is still the most expeditious way of making decisions that we have. I think we have to do this now with the kinds of complexities we are facing.

Mr. Mosher. I suspect you are right. However, I cannot help being aware from day-to-day of the increasing number of people in this country, and they are reflected in the Congress, who represent a rather persistent and profound strain in America. They are skeptical about sophisticated procedures, intellectual expertise, articulation of ideas and so forth. I think there are still a lot of us who believe that seat-of-the-pants instinctive decisions are perhaps better.

Dr. FISHER. I think definitions are involved in this, Mr. Chairman. Obviously we do not apply the PDOD process to every decision made in the Department. Major decisions, such as a decision to hold a lease sale or the adoption of major regulations, would go through this particular kind of process. If you carried this on to a ridiculous point of course? then that would perhaps be the kind of reaction some people would have, that you analyze to death before you ever make a decision. Yet I believe that the gravity and the complexity of many of the elements that go into decisions mandate and require this approach. I would argue that it is probably the most expeditious way to get through the decisionmaking process, as well as being the most direct way to do it.

Mr. Mosher. Well I think you are right, and I hope so. What about people from your Department who were on loan to OTA? I suspect that Mr. Daddario and others would testify that they have been

very helpful to OTA but has there been a mutual value? Since being employed for awhile at OTA and then returning to the Department are they considered to be more useful because of that experience!

Dr. FISHER. Very much so. Some of the people that have been involved are at the present time trying to evaluate what is the state-of-the-art of the more formalized TA going on within their agencies. So this is helpful. I have met with and carried on discussions with Dr. Cox of the Geological Survey since he spent time detailed to the OTA. So yes, I think it is a mutual exchange and helps us appreciate in a much better way what OTA and the Board are trying to do. I think by the same token it aids the Office's appreciation of what we are trying to do in this process and I think we have reached a great deal of commonality, largely because commonsense leads you in that direction. Whether we produce reports that have TA in the title is less important than whether these reports embrace the fundamental issues. This kind of interchange that gives us a better appreciation of both sides is, I believe, very helpful.

Mr. MOSHER. I have been one of the Members of Congress, and there have been quite a few of us, who have had the privilege and the very useful opportunity to have in our offices on our own staffs, and in some cases on committee staffs here, very competent people on loan from various executive agencies. They have come as fellows for sometimes as long as 10 or 12 months. It is an extremely useful device from our standpoint. I hope and expect that these people go back to their agencies with a better understanding of the congressional process and the decisionmaking process in general. I am a believer in these exchanges.

Thank you very much for your testimony, Dr. Fisher. Congressman Brown has some additional questions he would like to have you reply to in writing for the Record.

[The following questions were submitted by Congressman Brown to Dr. Fisher and his answers thereto:]

**Question 1.** You state that technology assessment (TA) in a formal sense is not utilized by the Department of the Interior (DOI), but that several kinds of analysis similar to TA are used. How then would you define TA's use in the Department? How do the results of this kind of TA enter into the planning and decisionmaking processes at Interior? How has it changed the decision process in the last 5 years? What are you doing differently now?

Answer 1. We have yet to find a generally accepted definition of TA. There is a divergence of opinion within the DOI about its definition and its use. For example, the staff who prepare the Environmental Impact Statements (EIS) do not distinguish between TAs and EISs because they believe that EISs are a form of TA. (See answers to questions 9 and 10.)

**Question 2.** You mentioned that at the Department level you make use of some elements of TA. What elements do you use and which elements do you not use? In regard to the missing elements, how do you think these missing elements affect the Department's decision and policy making and planning processes? Has the use of TA affected the way you do business?

Answer 2. Without a generally accepted definition of TA it is a little difficult to determine which of its elements are missing.

The DOI has produced about 500 draft EISs. The Council on Environmental Quality recently released a year-long study of the experience of Federal agencies with EISs. (Environmental Impact Statements-An Analysis of Six Years' Experience by Seventy Federal Agencies, March 1976). We have not attempted a thorough analysis of all EISs for this request. By one definition of TA, we believe that many of our EISs are relatively complete TAs. That definition is as follows:

"Technology assessment evaluates all the significant impacts, both beneficial and detrimental, of a technology. This systematic analysis will usually require

illuminating secondary and tertiary effects. For some technologies, TA might include an analysis of psychological impacts."

However, if we take one set of components of a TA, such as presented on page 6 of the June 1975 Journal of the International Society of Technology Assessment and referred to in our testimony, we may be able to illuminate some areas for improvement.

"COMPONENTS OF A TECHNOLOGY ASSESSMENT (SLIGHTLY MODIFIED FROM COATES)

"1. Definition of the problem, technology, issue or project to be assessed (proper focus for study).

"2. Examination of decision apparatus relevant to the problem or technologies involved.

"3. Identification of alternative programs, strategies, or systems to be assessed (system alternatives).

"4. Identification of parties of interest and their goals or values.

"5. Identification of possible impacts of alternative strategies.

"6. Evaluation of the significance of impacts in terms of parties of interest.

"7. Development of policy options for decisions apparatus.

"8. Identification of exogenous factors or events which might affect 1-7. Exploration of macro system alternatives.

"9. Formulation of conclusions and recommendations."

Our impression, without the advantage of a detailed analysis, is that items number 4 and 8 might need improvement in some EISs. Even with a thorough analysis of these possible areas for improvement it would be close to impossible to know how our decision, policy-making and planning processes would have been affected, if some specified definition had been adhered to.

**Question 3.** Do you probe TA studies that are not in accordance with the Department's position? What specific methods have you used in assuring length, breadth, and depth in your TA and related studies? How do you generate dissent and alternative and conflicting points of view? How is it presented to management?

**Answer 3.** We attempt to evaluate as full a range of alternative views as possible. As far as we know, our staff has reviewed any TA study that was both available and relevant to a departmental issue. The production of our EISs is generally considered to have included length, breadth, and depth. By evaluating as full a range of relevant alternative views as possible we attempt to generate dissent as well as alternative and conflicting points of view. These alternative points of view are part of the creation of a Program Decision Option Document (PDOD).

**Question 4.** How do you obtain the participation of private industry? Do you involve the public, and advisory panels in planning your TAs? Do you see any value in the Department having closer relationships with the private and public sectors and with state and local governments? How do you advise the public ahead of time about impacts?

**Answer 4.** Again, the Department is not conducting any studies considered to be TAs at the present time. Knowledgeable experts are sought from the private sector to participate in our EISs and similar projects. The Department continues to develop closer relationships with private and public sectors. For example, the Bureau of Mines developed a State Liaison Program just a few years ago. Alerting the public to specific impacts depends on the subject under consideration. For some issues involved in this area, see recent "Environmental Impact Statements—An Analysis of Six Years' Experience by Seventy Federal Agencies," Council on Environmental Quality (CEQ), March 1976.

**Question 5.** How does the Department generate and analyze assumptions about the future state of society? How does the Department analyze such studies and how are the results used? Please give an example.

**Answer 5.** The Bureau of Mines (BOM) Publishes "Mineral Facts and Problems" at about 5-year intervals. This publication includes forecasts of sources and uses of mineral and energy commodities through the year 2000. The Bureau's Division of Economic Analysis evaluates alternative scenarios for economic conditions through the year 2000. These evaluations are both presented to and discussed with commodity experts. The Office of Mineral Policy and Research Analysis also evaluates alternative scenarios in monitoring their contracts and for use in their staff evaluations. Departmental staff members belong to various organizations such as The World Future Society and the International Society for Technology Assessment.

**Question 6.** When conducting TAs, do you have a mechanism for coordinating and exchanging TA information with other agencies, particularly with those in the DOI? What about communications and exchanges of information with the National Science Foundation (NSF) and the Office of Technology Assessment (OTA)? Of the many TA studies generated at NSF that were mentioned by Dr. Stever, has the DOI made use of any of them? Is TA activity published in any of your reports?

**Answer 6.** When conducting TA-type studies, there is no formal mechanism for coordinating and exchanging TA-type information. Nevertheless the informal channels are quite open. Staff members belonging to organizations such as those mentioned in question 6 alert and cooperate with each other. The DOI recently had a member join NSF's Interagency Technology Assessment Coordination Panel. As stated in our testimony, we currently have 2 staff members detailed to OTA. Another staff man was selected to follow the current BOM staff man when his assignment is completed. It is likely that some of NSF's technology assessment studies have been used by staff members, because these studies have been read. However, no tracking system exists to list how they have been used. The BOM's, "Mineral Facts and Problems", was one of the first U.S. Government publications to evaluate and report systematically and routinely on technology. Although these are not full TAs, they were unusual when introduced, in their discussion of technology.

**Question 7.** You state that Interior has benefited from having people at OTA? Has the Department made any attempt to utilize the experience of those who worked at OTA by having them, for example, give seminars, briefings, etc.? How has this kind of TA training been done at Interior? How successful do you think this has been?

**Answer 7.** Both the BOM and Geological Survey staff are discussing the possibility of having TA seminars and briefings. Besides on-the-job training at OTA with our detailed staff, staff has attended TA courses. No evaluations are available on the degree of successful feedback from these courses or from staff participation with OTA. It should be noted in passing that OTA is requesting, and we are complying with their requests, to continue to detail selected staff members to them.

**Question 8.** How does your use of TAs and EISs compare? What features of the EIS process are not handled well at Interior that would be dealt with much more effectively if you used TA? How do these deficiencies relate to the TA process? Do you see a difference or similarity between the two processes? How do they relate to the PDOD? How were the results of the EIS on the Trans-Alaskan pipeline related to the PDOD?

**Answer 8.** We do not distinguish between TAs and EISs since EISs are a form of TA. Moreover, the scope of EISs covers most if not all of the probable consequences of proposed actions in natural resources management. On the other hand, there are two areas that we generally believe are outside of the scope of an EIS; these are the economic justification of a proposal, i.e., the public and private investment criteria, and the national security analysis of a proposal. Where these are important considerations to a decision, separate analyses are performed. Under present procedures the results of all related studies including the EIS are summarized and integrated into the PDOD. At the time of the Trans-Alaskan pipeline decision however, the PDOD included only the non-environmental factors, and the decision process reviewed the results of both the PDOD and the EIS.

**Question 9.** What lessons were learned from the work that went into the EIS on the Trans-Alaskan pipeline? Are there monitoring EISs on its progress? How do such results feed into the decisionmaking and planning processes in the Department? Would you say the EIS process has affected decisionmaking and planning in the Department? Please explain how.

**Answer 9.** Notwithstanding the Department's desire to keep proposals within existing management channels, we recognized in 1969 that the Trans-Alaska pipeline proposal was so large and complex that a special management arrangement was necessary. This arrangement allowed the immediate high-level consideration of study results as they came available. This arrangement is currently under review to determine whether it will continue to be necessary upon completion of the construction phase of the pipeline. EISs are only prepared on major proposed actions having significant environmental impact. Thus there are no EISs monitoring the pipeline's progress. The EIS process has had significant effects on the Department's planning and decisionmaking. Although impossible

to quantify, we believe that the greatest effects are at the field level in initial planning stages of proposals. Some of the more obvious effects have been in our Outer Continental Shelf (OCS) activities, master planning for parks, Private initiatives on public land, mineral leasing on public and Indian land, and in implementing Section 17(d) (2) of the Alaska Native Claims Settlement Act. These have been reported to the CEQ in its questionnaire of last year.

Question 10. Will your newly created Office of Program Development and Evaluation and its division of planning and evaluation be in fact an institutionalization of TA in the BOM? Is this function separate from Your EIS activities? How will the results of TAs provide input to the policy and decision-making process in the Bureau? How will they have an impact on policy-making in the Department?

Answer 10. The Office of Program Development and Evaluation and its Division of Planning and Evaluation do not represent an institutionalization of TA in the BOM. Rather, they represent a determination by the Bureau management to make better use of relevant Bureau expertise on mining and minerals problems and technologies. This includes TAs, in developing plans for future Bureau programs, and evaluating the results of ongoing programs to assure that the Bureau is making the best use of its resources to effectively and efficiently address the most important problems within its area of responsibility. The function of this Office is separate from the Bureau's EIS activities.

Technology assessments will highlight emerging problems and promising new technologies in the minerals area, enabling the Bureau to direct its attention to the emerging problems in time to alleviate them before they reach crisis proportions, and to investigate promising new technologies for solving existing or emerging problems. The problem as we see it, is not a lack of knowledge or foresight within the Bureau, but rather a need to focus that knowledge and foresight into the development of clear, coordinated, and comprehensive Bureau-wide efforts to solve major national minerals problems. That is a major role of the new organization. It is expected that improved planning and evaluation activities within the BOM will provide better information to guide policy decisions in the DOI, many of which must address minerals problems beyond the scope of Bureau responsibilities as well as those within the Bureau's mission areas.

Question 11. How is TA defined in the Office of Biological Services, and the Fish and Wildlife Service?

Answer 11. The Office of Biological Services (OBS) has not adopted a formal definition of TA. However, a key responsibility of the OBS is to develop methods for assessing the impact of various technologies, such as coal extraction and conversion or stream channel alteration, on fish and wildlife resources and their supporting ecosystems. In order to accomplish this, we must understand the characteristics of the ecosystem concerned, the characteristics of the developmental processes involved, and how these processes effect the ecosystem. The program's emphasis is on the ecological aspects, but in order to understand and predict the impacts we must understand the nature of the technology as well.

In developing such analysis, we are concerned with second- and third-order effects as well as with immediate impacts. For example, in the case of coal mining in the Western United States, we are interested not only in the impact of surface disturbance and the rehabilitation potential of strip-mined lands; we are also concerned with identifying changing transportation and population patterns and their ecological impact.

Question 12. Is there a TA Team?

Answer 12. There is no TA Team as such, but there are four National teams associated with specific environmental problems. These are the National Stream Alteration Team, Power Plant Team, Coastal Ecosystems Team, and Western Energy and Land Use Team. TA as described above is an important function of each of these teams.

Question 13. How does this activity differ and/or compare to the EIS activities of the OBS?

Answer 13. This activity differs from EIS activities in that it focuses on developing insights and information upon which more effective environmental analyses can be used, as distinguished from EIS drafting or review. Participation in the drafting or review of EISs is a small part of the OBS's responsibilities for the Fish and Wildlife Service. The principal responsibility involves improvement of the information base and analytical capability. This will be useful in environmental decisionmaking, including the EIS process.

**Question 14.** How many TAs has the OBS conducted?

**Answer 14.** We cannot isolate individual TAs as a separate activity because they are an integral part of the overall work as described above. We do have activity underway in the following problem areas, each of which involves some elements of TA:

<i>Activity</i>	<i>Fiscal Year 1976 dollars</i>
Coal extraction and conversion.....	\$2,170
Outer Continental Shelf development and coastal modifications.....	1,500
Powerplants .....	1,001
Stream alterations.....	861
Geothermal development.....	200
Oil shale development.....	800
Western water allocation.....	350
<b>Total .....</b>	<b>6,882</b>

126 in-house full-time positions are involved in administering these activities. However, a substantial portion of the work is done by contractors. Some examples of individual contract studies that we would consider TA-related are:

<i>Activity</i>	<i>Title</i>	<i>Organization</i>	<i>Amount (thousands)</i>
OCS.....	Analysis of the onshore estuarine, and marine effects of coastal and OCS oil and gas development.	Conservation Foundation.....	\$222
Oil shale.....	Oil shale development impact on 4-Corners Region.	University of New Mexico.....	189
Geothermal.....	Geothermal development ecological implications.	RFP.....	
Western water allocation.....	Instream flow strategies.....	RFP.....	

**Question 15.** How are the results fed into the DOI decisionmaking and planning processes?

**Answer 15.** The results are fed into the Department's decisionmaking and planning processes through direct Fish and Wildlife Service participation in these processes. An important functions of OBS has been to improve the Fish and Wildlife participation in these decision processes at both Headquarters policy and field levels. Examples of recent institutional improvements are Secretarial Order No. 2974, which provides for Fish and Wildlife Service participation in the OCS development process; a Memorandum of Understanding with the Bureau of Land Management and the U.S. Geological Survey concerning implementation of Fish and Wildlife Service responsibilities in the OCS development program; and a Memorandum of Understanding with Bureau of Land Management and the U.S. Geological Survey concerning Fish and Wildlife Service participation in the geothermal leasing program. We also have a formal information transfer activity to assure that the results are disseminated to users as widely as possible. This is being done through information transfer specialists located at our Headquarters and national teams.

Mr. MOSHER. Mr. Monte C. Throdahl is our next witness.

Mr. THRODAHL. If I may, I would like to have two associates join me please.

Mr. MOSHER. will you please identify yourself and your associates?

[The biographical sketch of Mr. Monte C. Throdahl is as follows:]

Monte C. THRODAHL, GROUP VICE PRESIDENT, MOONSANTO COMPANY

Mr. Monte C. Throdahl, group vice president-technical staff, a member of the Board of Directors of Monsanto Company, and a member of the Corporate Administrative and Executive Committees. Member of the board of directors of Monsanto Research Corporation, St. Louis; and vice president and a member of the board of directors of Monsanto Triangle Park Development Center, Inc. Durham, N. C., both subsidiaries of Monsanto Company.

Born March 25, 1919, Minneapolis, Minn.; married; two children  
B.S. chemical engineering, Iowa State University, 1941.

A research chemist Monsanto Company, Nitro, W. Va., 1941; subsequently management positions in the former Organic *Chemicals* Division, i.e., director of commercial development, 1956; director of research, 1960; and director of marketing, 1962; elected a corporate vice-president and transferred to Monsanto's European headquarters in Brussels, Belgium, as general manager of the International Division, 1964; elected a member of the company's Board of Directors, and to its Executive and Technical Committees with responsibility for worldwide technology and research, Monsanto Company, St. Louis, 1966; and appointed to present position, 1973.

Director of the Boatmen's National Bank of St. Louis, director and executive committee member of Webster College; board member Salzburg Seminar in American Studies, and the St. Louis Symphony ; and a commissioner of the Museum of Science & Natural History; a member of the State Mental Health Commission (Me.).

Other memberships include: American Association for Advancement of Science; American Chemical Society; American Institute of Chemical Engineers; Society of Chemical Industry; Commercial Development Association; the Patent and Trademark Office Advisory Committee; and a fellow of the American Institute of Chemists.

Numerous technical articles authored, and patents held from the United States and five foreign countries.

STATEMENT OF MONTE C. THRODAHL, GROUP VICE PRESIDENT  
AND A MEMBER OF THE BOARD OF DIRECTORS, MONSANTO CO.,  
ACCOMPANIED BY FRED D. WHARTON, JR., AND J. KENNETH  
CRAVER, MONSANTO CO.

Mr. THRODAHL. Yes, I am Monte Throdahl. I am a group vice-president of technology, and a member of the Board of Directors of Monsanto Company, headquartered in St. Louis, Mo. With me, on my right, is Mr. Fred D. Wharton, Jr., who is manager, environmental affairs Cycle-Safe® container group, and on my left is Mr. J. Kenneth Craver, who is manager, futures research, corporate plans department. They are here to support me in any line of questioning that might come later. We will shift gears a bit. We are here to present our observations on the practice of technology assessment (TA) in industry. We propose to use two specific examples within our own corporation; the Cycle-Safe® container, and the use of chlorine in the synthesis of organic chemicals.

I would like to start by pointing out that the enterprise system, and particularly the chemical industry from its earliest beginnings, has been attuned to providing the market with what the consumers wished. This has been the strength of the industry, and it has also been its success. Intelligent suppliers in the chemical industry have been able to anticipate shifts in market demands, and position their products and services. They position their products and services in time to satisfy these newly emerging market requirements. This is how suppliers keep their customers, and grow as the market grows.

Implicit in these statements is a concept of TA. We are a technology based company. We began in chemistry many years before chemistry was a familiar American production technique. As the American chemical industry grew, we grew along with it. We built engineering strengths, developed new areas in materials science, have gone heavily into both pure and applied mathematics, and have branched out into electronics, medicine, and veterinary science. Over the world we have more than 6,000 employees who are occupied full-time in various science-related careers. We were doing a form of TA



as a result of market needs that I spoke of earlier, and scientific curiosity, even before this term had been coined.

As Dr. Stever mentioned the scientific mind begins by asking questions that begin, "What if . . . ?" These range from, "(What properties would a chemical product like this have?" to, "What will happen when this product reaches the garbage dump?" I cannot stress enough what a powerful force this scientific conscience has been within Monsanto over the years. Our young people coming in with new knowledge have challenged our senior people time and again on matters of this kind. Members of our technological community, and particular the younger members, support the TA concept. At their request I have formed what we call a Young Turk Committee within the company, so that there is some mechanism through which to forward their suggestions and ideas to top management.

I should add here that one member of the Young Turk Committee is in his early 60's and another is in his late 50's. Both of these individuals are as young in heart as anyone else on the committee, and both have been taking constant advantage of our tuition refund program to keep their knowledge up-to-date. The Young Turk Committee has found out that it is unusual for management to accept their ideas. When that does happen, it tends to build a number of credible responses.

In recent years we have witnessed a new dynamic in the areas of what have been referred to as second- and third-order effects. The commercial development arms of firms such as ours are in close and constant touch with their markets as they seek to develop new products and improve existing ones. The commercial development groups compete with each other in anticipating future market needs. They learn to live 5 to 10 years in the future since it may take that long to build a major product change into the productive machinery of our system.

So for over a decade our commercial development activities have detected the emerging trends of environmental protection, of consumerism, and of energy conservation. In terms of providing products to meet market requirements, these three forces have all pushed in the same general direction. At times some of these forces seem to be in opposition, but these differences can be resolved. We have found that TA is a technique both for resolving the differences and for measuring progress.

We have actively participated in the professional activities of the TA movement almost from the very beginning. Our people, particularly Mr. Craver, have organized programs, contributed papers, and encouraged other individuals, both private and public, to employ TA methodologies. The First International Technology ("conference in The Hague, the Engineering Foundation Research Conferences on Technology Assessment, the First International Conference on Marine Technology Assessment in Monaco, and the forthcoming Marine Technology Conference at Texas A. & M., are a few of the major meetings where Monsanto has contributed professional support.

So here we have the three elements of what we feel is a winning combination: First, a growing market need as perceived by what we call commercial development; second, an in-house mechanism to channel energies to meet the same objectives; and third, the active

professional support of both public and technical organizations dedicated to TA. It is my opinion that TA at Monsanto is hereto stay.

Now turning from the general to the specific, I would like to briefly review how we responded to all these forces that I described in reparing to introduce the Cycle-Safe® container that is now available in parts of New England as the new Coca-Cola "Easy-Goer" bottle. The development began with the discovery in a Monsanto laboratory of the excellent barrier properties of a class of polymers with a high nitrile content. Without going into some of the finer points of container requirements for carbonated beverages, these high nitrile polymers keep oxygen out, which is good, and keep carbon dioxide in, which is also good. It appeared that at long last we had found a way to make a major contribution to the beverage container business, a market of several billion dollars in the United States alone. We knew that organic polymers could be produced with the aesthetics and the transparency of glass. We also knew that these polymeric containers would be lighter than lass and offer a safety factor of better break-and shatter-resistance. It was the lack of barrier properties that had thwarted our earlier efforts in this direction.

This development of what we now call Cycle-Safe® began back in the 1960's, when the can uses were in ferment, and when the environmental movement was beginning to take form. Responding to both the external and the internal concerns that I described earlier, the Monsanto management decided to subject Cycle-Safe® to an examination, which at that time went far beyond the technical aspects of the matter. We knew that in a soft drink container we were placing a new object directly into the hands of the general public, and we believed that the public would expect us to have the answers to any potential problems before they arose. The manner in which we did this has been detailed in man papers and presentations, and we now submit to the committee a full text of all the test data that we have publicly reported.

Mr. BROWN. Without objection, that will be made a part of the committee record.

[Information on where to obtain copies of the material referred to above is found in a p. A, exhibits 2,3, and 4 of this report.]

Mr. THRODAHL. Thank you, Mr. Chairman. To begin with, we subjected the Cycle-Safe® project to three successive cross-impact studies. Cross-impact analysis is a technique that we at Monsanto use extensively, and which we have helped to develop. Let me explain.

Cross-impact analysis tries to identify interactions among events or developments by specifying how one event will influence the likelihood, timing, and mode of impact of other events in associated fields. It is useful in uncovering not only direct impacts, but also secondary and higher order effects as well. We consider it a highly effective TA technique, and have used it rather extensively in perhaps more than 35 other large projects comparable in nature to the complexity of the Cycle-Safe® case.

We even went to such lengths in Cycle-Safe® as assuming that some people would find that the empty bottles were flammable and would use them to spice up a barbecue fire. So for 4 weeks we fed rats a 100 percent hamburger diet with the hamburgers cooked over a fire of cycle-Safe® bottles, and the test data showed that the rats suffered

no ill effects. Finally when we had completed our TA of the product, we scheduled a symposium to which we invited over 70 potential critics. We paraded our suspicions and our test results before this qualified audience, and asked them if we had overlooked anything. We did this in Hartford, Conn., and again before audiences in Chicago, New York, and Washington. The results can only be described as flattering.

I do not want you to get the impression that we only use TA when a highly visible product such as Cycle-Safe® is involved. We even extend the method of self-analysis to our chemical processes and we take action based on our conclusions. Here is another example. The element chlorine must be handled with care. It does a good job of killing germs in drinking or swimming-pool water, but when it gets loose in the environment it can cause problems, especially when it is combined in an organic molecule.

Following more than a year of TA of all Monsanto recesses involving chlorine, and we have a lot of them, a review of the subject was presented just 2 weeks ago to the company's top administrative committee. That committee voted that from now on new Monsanto production units involving the chlorination of organic materials will not be located solely on the basis of production economics. Instead these new units will be located at those plants where the best waste-stream control, and chlorine recovery techniques are available. This also implies more of a critical mass than if they were scattered about only on the basis of production economics. These plants are in four locations; Illinois, Louisiana, Missouri and New Jersey. We have a total of some 50 plants in this country. So we may pay a price in extra transportation, raw material, or labor charges as a result of this decision, but we think the environment will be protected, and we should recover additional elemental chlorine for re-use in our own system over time. We are also searching for alternative processes in a number of cases so as to bypass the use of chlorine itself as a reactant.

This is the sort of responsible corporate decision that many in industry are making today. We believe that it is in harmony with the new climate that exists. In many companies, including Monsanto, this sense of corporate responsibility is formalized through policies that are approved at the highest levels of the corporation, and procedures to carry out those policies are developed at the working levels of the firm. I think my presence here today would testify to that.

Turning now to the last point we wish to make, the Office of Technology Assessment (OTA) has played a definite role in helping us make these decisions by bringing the subject to the attention of the Congress and the State legislatures and by alerting the thinking public to the complexity of the situation. Policy decisions have to be made in which the demands of the ecology, consumer protection, and energy problems must be balanced against each other. TA provides the thought process through which these difficult value judgments can be made. Your Office is to be commended for its work in the frontier of this effort. At the same time, we feel you face a challenge in the political process itself, as determined by the questions you gentlemen have asked this morning. The subject is so complex and the competing values so charged with emotion that TA could be a fertile field for those who would like to distort, subvert, and confuse. You will have to

guard against this. I sincerely hope your Office can remain strong, independent, and staffed with capable people. There is a great deal to do in this area and little time in which to do it.

For each member of the Board we have a kit containing the statement that I have just made, and a copy of the procedures of the symposium on the environmental and societal impacts of the Cycle-Safe® container. There is also a paper describing in detail how TA was applied in directing the development of that container. So Mr. Chairman, if I have moved too quickly in covering either the approach to TA or the Cycle-Safe® issue, my two associates are here to help me answer your questions.

Mr. BROWN. Thank you very much, Mr. Throdahl. Your testimony is extremely useful to the Board and we hope to find other corporate entities which have as forward-looking a position as our company has in this field. I was struck by your comment that a "Young Turks" committee has been created in your operation. It reminded me of a paper I read by a sociologist, who described his view of how corporate change occurs. Basically, the picture he presented was one of younger executives coming into a company imbued with a new set of values, similar to some of the points you made, who would rise in the hierarchy and transform the company from within. This model is in contrast to some of the more radical or destructive models that are advocated from time to time. I am wondering whether this "Young Turks" committee has been valuable to you in decisionmaking or in getting new insight into policies that ought to be followed. From the fact that you mention it at all, I infer that you consider it a useful device within your company.

Mr. THRODAHL. Let me illustrate with an example. Four years ago we knew that the medical clearance procedures for our new products wasn't as good as it should be. Some of the more conventional wisdom felt that a change would not be appropriate. I had the same assignment as I currently have and had been privileged to work with a number of fellows under 30--over 30 you know, you never get a new idea. I went to a group of people themselves in their 30's with whom I had worked on another project just to sample their thinking. I asked them what they would do to provide an appropriate medical clearance for every new product we intended to market, and what they would do to make sure that everything we were doing could meet those criteria?

I did not say any more than that, but told them to come back when they thought they had some responses. I did not tell them who should be chairman. They selected the man from among themselves, five in all, I believe. Their first thought was to shut down everything. Then they realized that this action would benefit no one, not the customers, not society, and least of all, not themselves. After several weeks of wrangling they finally came back with a proposal. The proposal was tempered only to the extent that one of them who was slightly older had said in effect that if we really want to sell something we will have to put a little sugar on it, which they did. Much to their amazement we accepted their recommendations almost verbatim and installed the new policies with the approval of the appropriate administrative committees. They were taken aback that it was so easy. It wasn't actually that easy because they had worked very hard. Also, what they had to say was very worthwhile.

We have since subjected a similar but different group to similar kinds of questions. Surprisingly enough they responded. The reason we think they did is that they knew we would listen. But more importantly, a young man coming out of the scientific graduate fields these days has been exposed to kinds of thought processes and has knowledge that those of us who are much older do not have. We are trying to listen to him without subverting our entire existing organizational structure.

Mr. BROWN. I notice that you list a futures research operation within the corporation.

Mr. THRODAHL. Yes, sir, that is correct.

Mr. BROWN. You have Mr. Craver here who is manager of that program?

Mr. THRODAHL. Yes, he is.

Mr. BROWN. I am interested in how futures research relates to the TA process. In a sense they are similar, since they have similar goals. How would you distinguish between them?

Mr. THRODAHL. Let me ask Mr. Craver to respond to that question, but before he does, let me tell you that the ideal size of any group is one. After that everything goes downhill. Ten years ago we assigned Mr. Craver to a committee of one to do futures research, I would like him to describe it briefly if he would, please.

Mr. CRAVER. This job grew out of a technological forecasting operation. It very quickly had to encompass all kinds of forecasts—societal, economic, and legislative—in order to begin to consider the future business environment that Monsanto would have in the next decade or so. This is the simplest statement of what futures research is about. What is it that we will be facing? What are the opportunities and threats that we will have to face 10, 12, 15 years ahead. We do this not because we want to make an accurate forecast of the future, but because we want to bring to our decisionmakers the kinds of options and threats that they have about making decisions now. Our purpose is to affect the decision in such a way that we will proceed into the future in as orderly as possible a fashion.

Along the way we have had to explore a variety of forecasting and analysis techniques. It was during this time that we developed cross-impact analysis as a tool that was particularly well-suited to our needs. We also began to perceive that the TA movement was something that we should pay attention to, one that Monsanto should be involved in. I took it upon myself to play a part in this movement. Futures research is a very flexible operation, much is left to my decision, but a great deal of it is influenced by my management.

Mr. THRODAHL. Mr. Chairman, we started this when Mr. Craver was part of a corporate research organization that was at that time a central research group. We put it there because it would perhaps have a less hostile environment in which to operate. For about the last 3 years he has been part of a corporate group called Corporate Plans. So now he is a, functioning entity that the senior management utilizes on a frequent and regular basis. It is not an activity we have to be very careful to keep well-hidden. It is very accessible.

Mr. BROWN. I have one further question before I turn to Mr. Mosher, on your Cycle-Safe® container development. You went through a rather unusual public participation process apparently in order to get outside input. You indicated that the results seemed to be entirely

favorable. Are you telling me that you got no adverse response in this highly critical period? That nobody could find any fault with what you were doing?

Mr. THRODAHL. No? sir, we received constructive responses. If you don't mind, I would like to have Mr. Wharton answer this. He was the creator of the symposium that produced this result.

Mr. BROWN. May I say that we are interested in the symposium model as a way of getting input into the TA process. The Technology Assessment Board is interested in how we can get a reasonable, reliable cross-section of views about particular types of TAs that are being undertaken.

Mr. THRODAHL. We honestly were trying to make a case for credible behavior. Since it was really Mr. Wharton's idea to do it this way, I would like to have him describe it very briefly. If you would please, sir.

Mr. WHARTON. Frankly, Mr. Chairman, what we did was to first go through the internal operation of the TA of the impact of the container. Having done that, we developed research and set guidelines, priorities, and criteria for the research effort. In other words, the type of container that was developed was to some extent determined by a potential impact it would have on the environment. We wanted to assure that the adverse effects would be minimized if they could not be entirely eliminated. When all of this information had been collected we felt that it should be exposed to review by the scientific and environmental community that was qualified to judge and make judgments. Since we are not infallible we wanted a critique that would point out impacts we had minimized, had not attached sufficient importance to, or that we might have totally overlooked.

What really was meant by saying that the results were flattering is that we did get responses. There were criticisms of some of the things we had done, there were instances where people pointed out that we ought to put more emphasis on certain aspects of the research we had conducted, and there were areas that we had not considered which were brought to our attention, and have been subsequently looked into. These procedures were current and up-to-date as of 1973 when the symposium was held. As a consequence of the symposium additional studies were conducted, and we now have more data bearing on the environmental and societal impact.

Mr. BROWN. Did your analysis or TA of the container include such factors as changes in job structure, displacement of certain skills, creation of additional job needs and so on that might result from the introduction of a new kind of container. This is an issue that comes up when we talk about the container industry switching from glass to tin or tin to glass or whatever. It seems to be a matter of considerable importance to the unions that organize the industry. To what extent were these factors considered?

Mr. WHARTON. We looked primarily at the impact on Monsanto's employment in terms of the employees that would be required to execute this project to produce the container. I don't believe our evaluation looked into the total effect on employment in the container industry. I am not sure that this is appropriate for a co oration such as Monsanto to look into inasmuch as new technology always makes old technologies obsolete. This competition is the way progress is made.

Mr. BROWN. I would tend to agree with you that this kind of impact goes beyond your immediate corporate responsibility. It may, however, be the kind of issue that an organization such as the OTA needs to look at from the standpoint of public policy. I am not saying that it should, but I imagine that it would in some circumstances where the public policy implications are extremely broad. Mr. Mosher.

Mr. MOSHER. Mr. Chairman, when Mr. Throdahl be an his testimony, I was somewhat concerned because he was emphasizing that private enterprise, and the chemical industry in particular had been attuned to providing the market with what the customers want, and had been able to anticipate shifts in market demand and then position their products and services in time to satisfy newly emerging market requirements. He commented that TA was implicit in this process. I was fearful that he was going to define TA as merely satisfying what consumers want. I am delighted that the rest of his testimony indicates a far more extensive understanding of what the term means. I am impressed.

At the end of your testimony, sir, you said that the subject is so complex and the competing values are so charged with emotion that TA could become a fertile field for those who would like to distort, subvert, and confuse. I would like to have you say more about that. You are suggesting I judge, that perhaps all of us have to guard against being used. Is that what you mean, or do you mean something else?

Mr. THRODAHL. No, sir, I mean exactly that.

Mr. MOSHER. Do you mean that the OTA Board and Office must guard against being used? Do you want to say more about that?

Mr. THRODAHL. I think that in some other areas of the public domain that very kind of thing is occurring. If I may say so, It is occurring over the issue of toxic substances. There is t merit in much of what is being done. But the inconsistency will benefit no one. Some of the inconsistency is caused by very well-meaning and sincere groups that apply intense pressure to achieve only one objective at the expense of almost everything else. The whole idea of TA is to weigh an balance without distortion and without subversion of the truth, insofar as is humanly possible. It seems to me that you have a group that has been assemble for a very brief time, who are verty able people that have done very able work, and you are saying, "Great, let us make sure that we do not get under the same pressures that EPA is under." It is that simple.

Mr. MOSHER. I think that is a wise warning. Congress is always faced with choices of various options. More often than not Congress responds to crises or to strong fashionable impressions that distort our decisions. We tend to swing back and forth in distorted ways. Hopefully, this new emphasis on systematic analytical procedures when considering our choices will keep us from making such distortions and the cycles we go through of overemphasis and readjustment.

Mr. THRODAHL. If I may say so, sir, I think that you just gave another answer to the question you asked of Dr. Fisher, about colleagues who are either derisive or fearful of the kind of approach typified by the TA concept. Decisions are sometimes made based on very fashionable but false ideas. The record is replete with them. Here is an opportunity at least to begin to turn it around somewhat.

Mr. CRAVER. One of the main strengths of TA is that it assumes some standards of value, some objectives. Certainly within Monsanto these objectives are made eminently clear to us; we know the directions that the company wants to go, and the policies that we are to follow. When strategies, tactics, directions, and policies are weighed against established objectives, you tend to take a longer—rather than a shorter-term view of them. This is a real strength. You do not make a quick decision. You tend to take a longer term attitude.

Mr. MOSHER. To re-emphasize the warning in your closing remarks, you are suggesting that these new systematic, analytical processes can be extremely useful, and they are necessary. However you suggest that we must all guard against their being manipulated to do just the opposite of what we would like to have them do.

Mr. THRODAHL. I think we are on record with Mr. Daddario that upon our knowledge of his appointment to this office, and the formation of the OTA we have followed the whole idea. We look to the OTA to spearhead and lead in the development of better methodologies, for example. We are proud to stand ready to be of any assistance we can, insofar as our resources permit.

Mr. BROWN. If I may follow up for a moment along that line. Congress is a little sensitive about the point that Mr. Mosher has brought up about political influences that develop. They are very strong here. One of several devices that the OTA has tried to use is the creation of external panels to review the work that might be done, and in many cases to actually do the work. Of course the problem becomes one of securing a panel that is properly balanced to appropriately represent the various points of view. I gather that this same sort of thinking is what led to your use of the symposium.

Mr. THRODAHL. Absolutely.

Mr. BROWN. There is a great deal more that we would like to explore with you and your colleagues, Mr. Throdahl, but we will be interrupted: now by the House, which has gone into session. I would like to ask if some additional questions could be submitted to you in writing. The answers would help us complete the record.

Mr. THRODAHL. It would be our pleasure.

[The following questions were submitted by Congressman Brown to Mr. M. C. Throdahl and his answers thereto:]

Question 1. Do you have a formal structure for technology assessment (TA) at Monsanto? How does it relate to the planning and policy process? What steps have been taken to integrate TA in your company's activities? Has TA affected your way of doing business? Please explain and illustrate with a few examples.

Answer 1. Not in the sense that all projects and businesses are subjected to a TA. Those projects that have major funding and that can have large impacts on the Corporation's future and its environment are assessed as a part of our long range Corporate Planning process. This service is available to any business manager who cares to use it, however. Over the past 6 years we have done formal TAs on more than 35 projects or businesses, large and small. Based on these assessments, in conjunction with other studies (i.e., economic, technological, and strategic) we have made decisions and commitments that have had and will continue to have major effects on our business.

Question 2. How is TA activity incorporated into reports?

Answer 2. TA is not considered an isolated activity. It is part of our overall continuing planning process. The contribution of TA appears in our long-range planning documents along with other inputs of an economic, financial, or strategic nature.



Question 3. You mentioned a high degree of success with symposia while explaining the Cycle-Safe@ 1'A. Have there been any further attempts to involve the public in the TA process?

Answer 3. As a community service we have made our TA capabilities available to Webster College, a small liberal arts college located in Webster Groves, Mo. Over the years the Administration of Webster College has been able to define a policy and a posture for their institution that has brought new vitality and growth to them. Dr. Leigh Gerdine would be pleased to discuss it in detail, if requested.

Question 4. How do you handle impact statements? How do you discuss impacts to the public ahead of time and educate it about the meaning of impacts?

Answer 4. Impact statements that are not a part of the public record are for internal use at Monsanto. However, the data they contain are used by public relations people of the firm in compiling preparedness material used in making major announcements. In this way, through the investigative activity of the press, the information is made available to the public in an interesting and therefore enlightening manner. The material is also used in speeches, by-lined articles, and other public statements by company executives. Raw data are rarely employed because these documents are suspect in the public mind as corporate propaganda and without the mediating influence of the media, they may miss the public concerns that the media can voice.

Question 5. What value do you see in having closer relationships and improved communications between the public and private sectors? Do you see any difference between executive and legislative branch agencies? What about the value of Monsanto having closer relationships in the area of TA with State and local governments?

Answer 5. Monsanto feels strongly that improved communications between all sectors of society is essential to progress. In the government-private business interface however, it is important to maintain on both sides the check-and-balance relationship that litigation can provide when either corporate or agency abuses occur.

There are differences between executive and legislative branch agencies that reflect the different objectives of top officials. This is again a part of the check-and-balance mechanism of the American system. We strongly favor a continuation of this system.

TA is a powerful tool. It involves the use of logic and cost-benefit analysis for varying parts of the ecosphere. Unfortunately, not every individual is capable of following such a complex thought process. Wherever possible, we use TA data and findings in our relationships with local, State, and Federal Governments as well as with various segments of the general public.

Mr. 13 BROWN. Thank you very much gentlemen, all of you, for being here this morning. The hearing will be adjourned until tomorrow morning, June 9, 1976, at 10 a.m. when we will return.

[The hearing was adjourned at 12:02 p.m.]