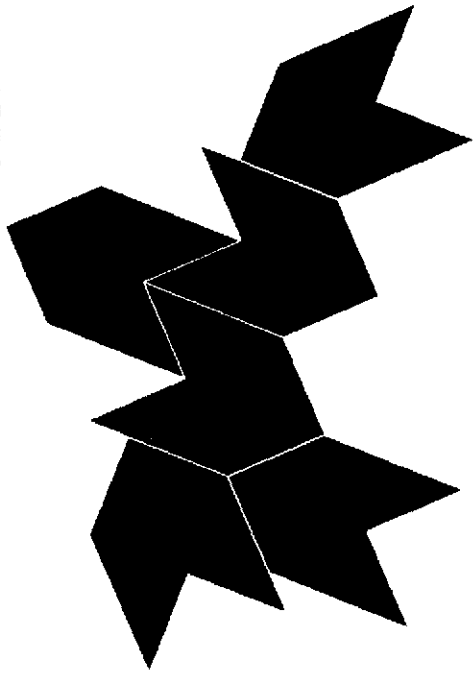
The Southern Regional Conference on Technology Assessment

Atlanta, Georgia **May 6-8, 1974**



SUMMARY OF A CONFERENCE

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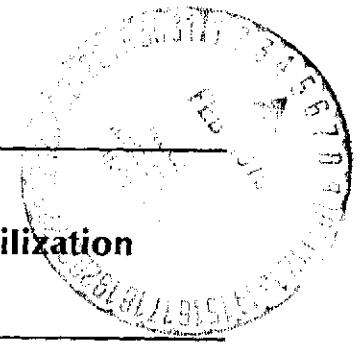

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Prepared by

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Associate Director
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October 1974

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FOREWORD

A three-day conference on technology assessment for State and local officials was held on the campus of the Georgia Institute of Technology, in Atlanta, May 6-8, 1974. Participants included scientists, engineers, planners, economists, and administrators from most of the Southern States and from many of that region's universities and research centers. The Conference was co-sponsored by the Governor's Science Advisory Council of Georgia and The George Washington University Program of Policy Studies in Science and Technology. The objective was to provide information about, and training in, technology assessment for those who must formulate policy and make critical decisions about technological programs and projects at the State and community levels, where the impacts of technological development are most directly felt. The Southern Regional Conference on Technology Assessment was supported by the National Science Foundation, Office of Intergovernmental Science and Research Utilization.

Technology assessment is applied, problem-oriented, multidisciplinary research which aims at anticipating and evaluating the consequences of a technological development in terms of its impact on the economy, the environment, the institutions, and the quality of life of a community or a society. Technology assessment is intended to inform and improve decisionmaking in the public and the private sectors, by broadening the considerations that go into that decisionmaking, giving it a longer-range perspective, and taking account of secondary, unintended consequences as well as immediate, direct costs and benefits.

Since Congressman Emilio Daddario first introduced the term "technology assessment" in proposing the establishment of a Congressional Office of Technology Assessment in 1966, the Federal Government has taken the lead in developing and using technology assessment. The National Science Foundation, over the last two or three years, has provided more than eight million dollars for comprehensive technology assessments in a wide range of technological and problem areas. An Office of Technology Assessment was established in 1972 (P.L. 92-484, October 13, 1972) to serve the U.S. Congress. But State and local governments also must grapple with the complex issues raised by science and technology as they impact on people's lives. Power plant siting, highway and airport construction, development of natural resources, cable T.V., and health care delivery systems—these and many other technological programs and projects require decision at the State and community level and raise complicated problems of equity and conflicting interests.

In 1971 a Working Conference on Technology Assessment was sponsored by the National Science Foundation and convened by the National Academy of Public Administration. From this Working Conference grew the State Technology Assessment Panel, which in 1972 produced a report which said:

> Technology assessment is a legitimate and necessary State function. To be most effective the technology assessment process must be applied where the principal authority to act is located.

The Panel therefore recommended that:

> The National Science Foundation should undertake a series of projects to develop better information about how successful technology assessment has been accomplished in States and to stimulate interest among key State officials in technology assessment.

The Southern Regional Conference on Technology Assessment is one product of the National Science Foundation's effort to carry forward that recommendation. As Co-Chairmen of the Conference, we wish to express our appreciation for the full cooperation and great effort of the sponsoring organizations; of Mr. Edward T. Kelly, the National Science Foundation Program Manager; of the host institution; and of the many Speakers and participants in the Conference. We hope that this may be the first of a number of similar conferences in other regions of the United States; we also hope that this Conference has been of value to the dedicated State and local decisionmakers and administrators who daily struggle with the complex problems of our highly technological society.

—Dr. Vary T. Coates and
Dr. John E. Mock, Co-Chairmen

October 15, 1974

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AN EVALUATION OF TECHNOLOGY ASSESSMENT.
Mr. Walter A. Hahn, Senior Specialist in Science and Technology, Science Policy Research Division, Congressional Research Service, Library of Congress

NOTE: Due to travel schedules, the speakers did not appear in exactly the order listed.

TECHNOLOGY ASSESSMENT AT THE STATE AND LOCAL LEVEL: HIGHLIGHTS OF THE CONFERENCE

The Southern Regional Conference on Technology Assessment pulled together and gave visibility to experience which States and communities have recently gained in Technology Assessment. Each assessment is unique, yet the problems encountered, the alternative solutions tried, and the lessons learned can often be helpful to others who must struggle with the complex issues of a highly technologized society. It will therefore be useful to highlight themes which emerged in the discussions and salient insights offered by speakers at the Conference.

1. The Need

There can be little doubt that Technology Assessment—or as many prefer to say, social impact analysis—is not only appropriate but necessary in planning and decisionmaking at all levels of government. This is now widely recognized by State and local officials. How to institute improvements in established procedures, and where to find the resources and capability to do Technology Assessment, are more difficult questions.

It is in communities and small regions—where people live and work—that the real impacts of technological development are felt. However "quality of life" may be defined (and definitions are legion), it is surely manifested in the everyday conditions under which individuals and families live, work, and spend their leisure. Housing, transportation, energy, utilities, social and health services, education, public services—these are the problems with which State and local governments continually grapple, under intense pressures of scarce dollars, unavailable information, conflicting political demands, and uncertain outcomes. Federal programs can help, but may disappear at the end of a fiscal year. Federal policies may change not only with a change of Administrations, but overnight. Research and information coming from the National level may not be applicable to local situations. But State and local problems continue, and decisions made today may lock a community into a unforeseen chain of consequences or limit options for years to come.

Areas smaller than the nation are moreover particularly vulnerable to converging trends: for example, underdevelopment and unemployment, rising demands for resource extraction, and increasing pressure for environmental protection. Many decisions involve irreversible and large scale changes in the physical environment and in land use, or commitment of funds and nonrenewable resources over long periods of time. Caught in a vise of conflicting and converging needs, responsible officials must of necessity make decisions, usually without sufficient information to identify all possible alternatives and fully evaluate necessary trade-offs.

Public policy related to technology, often thought of as a "national" concern, is therefore directly and intimately a part of local and State decisionmaking, and all techniques which hold promise for improving and broadening the process of formulating and implementing wise public policy are increasingly of interest in all levels of government. Technology Assessment, which aims to provide decisionmakers with better information about the possible consequences of their actions and to help them better manage uncertainty, is such a technique.

2. The Experience

Two States have already established an institutional base for Technology Assessment: The Georgia Center for Technology Forecasting and Technology Assessment in 1970 and the Hawaii State Center for Science Policy and Technology Assessment in 1971. Other States are investigating or experimenting with assessment through their Governor's science advisors, through legislative councils, or through other mechanisms. Re-

gional cooperation is another device used, for example in the assessment of Operation Plowshare, reported at the Conference. Most States, however, although paying increased attention to environmental concerns and gradually broadening the scope of planning, have not attempted comprehensive Technology Assessments. As one speaker at the Southern Regional Conference summed up the situation, assessment at the State level has been "problem-oriented rather than technology-focused, reactive rather than anticipatory, and limited to the three E's—energy, economics, and environment." Newly emerging technologies and social technologies, with few exceptions, have been neglected.

Such assessments as have been made have generally been intended to serve the needs of the Executive branch of State governments. Little or no Technology Assessment—in the States or in the Federal Government—has been done for or by regulatory agencies, although regulation and rate-setting are among the most effective methods of directing and controlling technological development. State legislatures, usually poorly supplied with informational and staff services, have not yet followed the lead of the U.S. Congress in establishing an Office of Technology Assessment, although policy making is pre-eminently a legislative function.

3. The Obstacles

Money, time, and trained people are in short supply in State and local governments. Staff people with experience and capability in interdisciplinary, policy-oriented, applied research are particularly scarce. Agency administrators (and State legislators) tend to be suspicious and intolerant of proposals for "more study" rather than immediate action.

Political pressures and interest group demands are immediate and intense. In each of the three Assessments presented at the Conference the study teams had encountered problems related to political sensitivities—interjurisdictional rivalries, the suspicion and fear of a "threatened" industry, the affiliation of legislators with interest groups affected by the technology.

Technology Assessments, by their nature, usually deal with controversial subjects. A Conference participant noted that while assessors at the Federal level may argue about the value of public participation or how to achieve it, "the closer you get to the grass roots, the more public participation you will get"—whether or not you invite it. Potential detrimental impacts may appear more dramatic and galvanize opinion more effectively than social benefits (which may be more important but more generalized). Because of this intense public interest, there is more danger of Technology Assessment becoming "technology arrestment" at the local than the national or societal level.

State agencies are of course subject to the same barriers that Federal agencies find in attempting to broaden planning and evaluation procedures. Bureaucratic inertia, institutional and personal biases, special constituencies, and the necessity for self-preservation do not contribute to an ability to ask hard questions about downstream consequences. Fragmented responsibilities and narrow organizational charters are not conducive to comprehensive analysis of social impacts. For State as well as Federal decisionmakers, the pressures push toward short-term optimization rather than anticipatory, even-handed judgment.

4. The Strengths

As compared to national or societal assessments, subfederal Technology Assessment can deal with smaller geographical areas, less heterogeneous populations, and more easily identifiable parties at interest. Data is likely to be less aggregated. Direct access can be had to potentially affected segments of the population. A "home-grown" Assessment team, attuned to the mores and idiom of the locality, has a subtle advantage

which can best be appreciated by researchers who have had the experience of being regarded suspiciously as "outsiders."

Some areas of technology are at present extremely resistant to assessment because so little data is available. This is particularly true of very innovative physical and social technologies—for example, the guaranteed annual income, or at one time, the contraceptive pill. It may not be possible to predict public acceptability of the technology, or the ways in which people will use, misuse, and abuse it. In such cases, "social experimentation," or a monitored trial in a limited area, can provide a firmer base for Technology Assessment. Local communities provide the ideal site for many such social experiments.

In some cases such social experiments will occur naturally—for example, when one or two communities in a state adopt cable television, a Technology Assessment by the State of the impacts in these communities can assist other local governments to make wise decisions about cable television franchising.

5. Priorities

In a survey conducted for the National Science Foundation, State officials indicated the following as priority areas for Technology Assessment:

—Natural resources and environmental management: coastal zone and wetlands management, solid waste management systems;

—Energy systems: power plants, off-shore oil wells or supertanker facilities, solar and geothermal energy;

—Human resource programs: manpower training and educational equalization programs, educational technology, health care delivery systems;

—Transportation: special bus lanes, parking restrictions, mass transit systems, airports, highways;

—Government functions: integrated information systems, "little city halls," mobile police units;

—Economic development: industrial parks, shopping centers, new factories;

—Communication systems: cable television franchises;

—Community development: golf courses, other recreation facilities, high rise or scattered site public housing, annexation.

Although local governments have been engaged in such services and functions for a very long time, there is still no reliable way of anticipating how much benefit will result for the community from a new project, or of judging the comparative benefits of competing demands for scarce resources.

6. Ways and Means

Comprehensive Technology Assessments are expensive: experience gleaned at the Federal level indicates a minimum of $100,000 to $200,000 for broad-scale assessments. State and local governments, especially the poorer or less populous, do not have such resources to command for applied research. But comprehensive Technology Assessments have been done at the regional level, through:

—industry and government cooperation;

—pooling of regional resources;

—Federal funding.

A study of solid waste management systems for the State of Connecticut (reported at the Conference) was done by a corporation which also made a substantial contribution to meeting the cost of the study. The assessment of Operation Plowshare, also reported at the Conference, was a cooperative effort of four states. The Port of New York Authority, established by interstate compact, funded a comprehensive assessment of proposed extension of Kennedy Airport runways into Jamaica Bay. A Technology Assessment of the integration of pig farming, of interest to several regions of the country, is being sponsored by the National Science Foundation, and it is worth noting that several State universities are now performing Technology Assessments of interest to their areas with NSF funding.

Georgia and Hawaii have had much success in carrying out Technology Assessments using blue-ribbon panels made up of leaders of industry, academic experts, government officials, and civic leaders. These assessments are usually exploratory rather than comprehensive, but tend to carry substantial impact with State Governors and legislators.

"Mini-assessments" (that is, short exercises designed to draw out information and expert opinion, identify areas of consensus (and disagreement), and develop recommendations for policymakers) can be used where there are not funds or time for comprehensive Technology Assessment. The Hawaii State Center for Science Policy and Technology Assessment has successfully adapted the Nominal Group Technique (demonstrated at the Conference by Professor Andre Delbecq) for use in two- or three-day sessions to assess the potential impacts and policy considerations related to mariculture and other technologies. Other techniques for structuring small group interactions can also be used for this purpose.

Every State has un-utilized resources for Technology Assessment. State universities may contain a nucleus of people familiar with Technology Assessment, experienced in interdisciplinary research, and having a commitment toward public service (and in some cases, with available research funds). Depending on the university, interdisciplinary science policy programs, Departments of R&D Management, or broadly-based Engineering Schools are possible routes of ingress to such people. Corporate management, State academies of science, and professional societies are other sources of expertise. The Intergovernmental Personnel Act of 1970 can sometimes be utilized to borrow talent from the National Government agencies. State and local agencies themselves can be tapped for people who are dissatisfied with conventional modes of evaluation and not afraid to ask hard questions.

Public interest and environment groups often include members with training and experience in physical and social sciences who are under-utilized because they are presently homemakers or retired. Many citizen groups are experienced in organizing people with diverse backgrounds into study groups to gather information and explore issues. They are also able to disseminate and build community support for implementing the results of the Assessment. Organizing Assessment efforts, managing interdisciplinary groups, and reducing representational bias, on the other hand, call for a trained and experienced Project Leader.

7. Implementation

Experienced Technology Assessors at the Conference warned that the quality of an assessment is no guarantee that its conclusions or recommendations will be implemented. Many factors and considerations, other than reliable information about long-range consequences, are necessarily involved in making a decision. Even if a Technology Assessment directly leads or contributes to a wise decision, it will seldom be given the credit, since the political leaders will instead point to their own discernment and wisdom.

It is seldom, however, that a Technology Assessment will produce definitive and clear-cut recommendations. More often, if successfully done an assessment will lay out a range of alternative policy strategies, each involving uncomfortable trade-offs which must be made. Technology Assessment is an input to and an

aid to good decisionmaking; it does not seek to usurp the prerogatives of the responsible decisionmaker. The ultimate rationale for Technology Assessment is that, at any level of government, a decision made on the basis of all available information and clearly recognizing the inevitable uncertainties is likely to be better than a decision made in avoidable ignorance.

—Vary T. Coates

SUMMARY OF THE SESSIONS

WHAT IS TECHNOLOGY ASSESSMENT?

Dr. John E. (Ted) Mock, Co-Chairman of the Conference, is the Science Advisor to the Governor of Georgia

Technology assessment, said Ted Mock in opening the Conference, "may be the answer to Murphy's Law." (Murphy's Law, in its classical formulation, states that "whatever can go wrong, will go wrong.") Technology assessment, he explained, is "the systematic study of the effects on society that may occur when a technology is introduced, extended, or modified, with special emphasis on impacts which were unintended or delayed."

During the 1960's, he reminded the audience, many Americans became concerned with the impact of technology on their environment, on their safety, and on the quality of their life style. Long accustomed to think of science and technology as harbingers of progress and a better way of life, Americans—faced with smog, polluted rivers, congested cities, and disastrous side-effects of drugs such as thalidomide—woke up to the idea that the most promising of technologies may also have unanticipated, unwanted consequences. In their alarm and dismay, Mock pointed out, some have veered toward anti-scientism and even anti-intellectualism.

Emilio Daddario was then Chairman of the Subcommittee on Science, Research and Development of the Committee on Science and Astronautics, U.S. House of Representatives

Public Law 92-484 (Oct. 13, 1972). A complete legislative history, and a listing of members of the Technology Assessment Board and Advisory Council, may be found in ANNUAL REPORT TO THE CONGRESS by the Office of Technology Assessment, March 15, 1974

It was in this context that Congressman Emilio Daddario in 1966 first proposed to the U.S. Congress that it establish an Office of Technology Assessment.

Mr. Daddario and his Subcommittee began systematically to explore the feasibility of a better system for anticipating the effects of technological development and for supplying Congress, other decisionmakers, and the American public with the information needed to formulate wise policy. Six years later, the Office of Technology Assessment was established, and former Congressman Daddario, who earlier had resigned from Congress, was appointed as its first Director.

The Deputy Director of OTA, Mr. Daniel V. De Simone, was present to give the keynote address for the Southern Regional Conference.

THE CONGRESSIONAL OFFICE OF TECHNOLOGY ASSESSMENT

KEYNOTE ADDRESS

Mr. Daniel V. De Simone, Deputy Director, OTA

"It is impossible to go back," said Dan De Simone. The sense of progress and optimism once natural to an increasingly affluent society gave way in the 1960's to a questioning of the inevitability of progress. That unguarded optimism, he said, cannot be restored, but neither can the development of technology be reversed, nor would we wish it to be. Instead, society must learn to handle technology more wisely, "but we must assess its real benefits and costs before we can handle it wisely."

The OTA, De Simone stressed, is a new departure for the Legislative Branch, designed to provide expert and unbiased assistance to Congress in its appraisal of complex issues by providing legislators with information about the current status and possible consequences of emerging technologies. Congress, unlike the President, has very few institutional services to assist it: The Library of Congress (1800) and the General Accounting Office (1921). For the first time in history, with OTA, Congress will have an applied research arm.

Most issues coming before Congress have some technological content, De Simone noted. OTA's responsibilities are to identify future problem areas and to inform and assist the Congress in its deliberations. The ultimate power of decisionmaking remains, as always, in Congress as the representative of the people.

In the first few months of its existence, OTA has identified six general areas for its first efforts: food, energy, health, materials resources, oceans, and transportation. The setting of priorities for assessment is difficult, given the many issues on which Congress must act and the limited resources available for Technology Assessment. De Simone listed questions which must guide OTA in establishing priorities:

(1) Does the technology involve or impinge on major national issues?

(2) Can OTA make a major contribution to clarifying the issues, or would Congressional hearings serve as well?

(3) Are there major alternatives or options to the technological development for which it is necessary to compare the potential costs and benefits?

(4) Are the possible impacts likely to be irreversible, or merely limited and ephemeral?

(5) How much will a thorough assessment cost? How large are the potential benefits to be gained?

(6) What should be its scope? How comprehensive must it be? Is the problem boundable?

(7) What is the likelihood of action by Congress to implement the T.A.?

(8) When completed, will the assessment be timely—neither so premature as to be outdated when the time comes for Congress to act, nor too late to assist the decisionmaking?

(9) Have there been earlier assessments which need reinforcing, validating, or updating?

Technology assessment is needed, said De Simone, when Congressional hearings cannot be relied on to provide the knowledge Congress needs—when the data are uncertain or unavailable, or the scope of the

issue at hand is too wide or too complex to be covered in formal hearings, or is beyond the jurisdiction of any one committee.

In general, OTA will not itself perform the assessments but will initiate and monitor research performed by contractor organizations. OTA's budget for its first (partial) year of operation was $2 million; while this is expected to increase in FY 1975, it is not intended that OTA shall ever become a large, bureaucratic organization. Its staff, at the time of the Conference, consisted of 25 people, and was expected to reach approximately 40 by July 1, 1974, when the new fiscal year would begin.

In closing, OTA's Deputy Director pointed out several areas in which the Office has been asked to sponsor assessments in the near future: national growth policy, environmental protection and management, the effects of chemicals and radiation on future generations, and international trade. In these areas, De Simone said, technology creates major impacts, issues are complex, and Congressmen are asking OTA for technology assessments.

"What," De Simone was asked by participants, "can OTA do to help the States develop T.A. capability?" His answer was candid. "Probably nothing at this time. Instead," he said, "the States can help OTA"—by informing it of their problems and needs.

TECHNOLOGY ASSESSMENT IN THE FEDERAL EXECUTIVE AGENCIES

Dr. Vary T. Coates, Co-Chairman of the Conference, is Associate Director of The Program of Policy Studies in Science and Technology of The George Washington University, Washington, D.C.

"When Congress acts, the Executive Agencies react," said Vary Coates. In the 1960's, public indignation erupted over environmental degradation, health and safety hazards, and disruption of neighborhoods by urban development and highway building programs. When the agitation boiled over into street demonstrations and citizens' court suits, Congressmen began to squirm under the heat from their constituents. They became increasingly suspicious of the justification supplied to them by executive agencies in defending projects, programs, and budgets. The establishment of OTA, Coates pointed out, was only one of the ways in which Congress responded. More directly, Congress brought pressure on the agencies through a series of Acts such as the Highway Planning Acts, requiring metropolitan area coordination, long range planning, and community participation, and through the National Environmental Policy Act of 1969 (NEPA). NEPA required that every project or action receiving Federal funds, if it "significantly affected the human environment," be preceded by an Environmental Impact Statement. These Statements, when adequately prepared, are "partial" or narrow technology assessments. As the courts have successively broadened their interpretations of the substantive requirements of NEPA, Coates explained, the agencies perforce have gained experience in multidisciplinary research aimed at anticipating social impacts of technological projects.

Coates found in a survey of Federal agencies that most Federal agencies, since the mid-1960's, not only have reacted to Congressional

TECHNOLOGY AND PUBLIC POLICY, THE PROCESS OF TECHNOLOGY ASSESSMENT IN THE FEDERAL AGENCIES, a Report prepared for the National Science Foundation by Vary T. Coates, The George Washington University, 1972

pressure but to some extent have taken the initiative in broadening and improving their processes for planning, programming, and evaluation of technical projects and programs. Unfortunately this improvement is slow, spotty, and variable—between agencies and over time. Coates listed as the reasons:

—Self-preservation (agencies for obvious reasons do not like to raise questions about the benefits of their own programs)

—Bureaucratic inertia ("This is the way we've always done it.")

—Limitations of funds, time, personnel and know-how

—Institutional and personal bias (agency personnel have a vested professional interest in and commitment to technologies: FAA is full of pilots and AEC of nuclear physicists)

—Narrowly written legislative charters (and American suspicion of unwarranted government intervention)

—Political dangers (no one wants to be the bearer of bad news)

A further obstacle to the development of technology assessment, Coates noted, is the lack of a well-defined, universally accepted methodology for technology assessment. T.A. instead uses techniques drawn from many disciplines, as appropriate or adaptable for the problems at hand, or seeks to invent methods for anticipating a wide range of potential social impacts and dealing with the inevitable uncertainties and unpredictables. The further development of technology assessment, she advised, will be closely linked to development of futures research. To be useful, T.A. must anticipate not only the societal impacts of technological change but the future social, political, and physical environment in which those impacts will be experienced.

Any attempt to mandate legislatively a requirement for T.A. at this time (after the model of Environmental Impact Statements) would be premature, Coates believes; it would truncate the further development of T.A. methodology, it would be wasteful of resources, and it would tend to stifle innovation and experimentation. Instead, public and Congressional pressure should continue to force all levels of government to broaden the range of considerations in planning and evaluating technology-oriented programs. Can any assessments be free of institutional bias, Coates was asked. There are safeguards which can be built in, she replied: an Oversight Committee of disinterested citizens, critical reviews by opposing interest groups, public hearings, etc.—all devices which have been used, for example, by the National Science Foundation. The best safeguard, however, is to have the assessment sponsored by an agency or institution with no operating responsibility for the subject technology, have it performed by an independent research group, and guarantee that it will get wide public dissemination.

"What results can be shown to have resulted from T.A.?" she was then asked. Coates referred to her survey, already cited, which showed

that, after assessment, projects have been terminated, cancelled, modified, or redesigned; agency procedures modified; new laws passed; or research redirected or initiated. At the least, she said, questions may be raised which influence future decisions.

TECHNOLOGY ASSESSMENT AT STATE AND LOCAL LEVELS

OVERVIEW OF STATE AND LOCAL TECHNOLOGY ASSESSMENT

Edward T. Kelly, Program Manager, Office of Intergovernmental Science and Research Utilization, National Science Foundation

Ed Kelly began the second session of the Conference by observing: "Technology Assessment is too important to be left to the Federal Government." The State and local levels are where Federal technology is implemented, the impacts felt, and services delivered. Moreover, State and local governments themselves initiate and implement technological decisions and programs. But at this level the description of T.A. is vague and its organization undefined. T.A., Kelly said, may be defined operationally, at the State levels as "whatever the states say T.A. is," just as planners often have defined urban development as "whatever we are doing now."

Kelly characterized present State and local technology assessments as follows: they tend to be problem-driven rather than technology-driven, reactive rather than anticipatory, and focused largely on the three E's—environment, energy, and economics. Social technology, though of great importance, is all too likely to be ignored currently as as a subject for assessment. The States have one great advantage, that of flexibility; if a technology (or a technology assessment) does not work in one State, it still can be tried in others—States and local communities offer laboratories for societal experiments. Technology assessments at the subnational levels of government can deal with technologies and problems common to many States or specific to their own area. But they must, Kelly warned, be particularly sensitive to the "convergence of events," the coming together of divergent trends, changes, and pressures to pose unexpected problems—and opportunities.

Public participation is a "given" in State and local assessments, Kelly noted: "the closer to the grass roots you are, the more public participation you will get—whether it is wanted or not." By the same token, there is more danger of "technology arrestment" as a result of assessment, because the pressures are more immediate and more effective at the grass roots level.

Technology assessment is needed for both the legislature and the executive in State governments. (And, Kelly said, it is particularly lacking in State regulatory agencies, as it is at the Federal level.) The policy formulation process is basically a legislative function, he reminded his listeners, but State legislatures have very little informational and analytical support and assistance. In general, the lack of in-depth capability for evaluative research in the State governments led Kelly to call for strong links between universities and their State governments. The universities can provide the resources and the opportunity that will allow the States to carry their rightful share of technology assessment.

TECHNOLOGY ASSESSMENTS DESIRED BY THE STATES

Dr. John E. Mock, Science Advisor to the Governor of Georgia

"From urban blight to rural flight," said Ted Mock, "it is the States which must face the most difficult problems requiring technology assessment, yet they lack the tradition of doing such anticipatory evaluation." They also lack the expertise, the money, and the institutional framework for T.A. Yet some States, notably Hawaii, New York, California, and Georgia, have established an institutional base for T.A. and are rapidly acquiring the experience, the capability, and the tradition. The State of Georgia, for example, under the aegis of the Governor's Science Advisory Council, has done assessments of health delivery, cable T.V., natural gas supply, geothermal energy potential, an information service center, development of new cities, remote sensing (ERTS), metrication, and the impact of the energy crisis. These studies were useful and influential, Mock asserted, and they could be done at fairly low cost to the State because of services donated and capability supplied by industry, local communities, and State agencies.

CANDIDATES AND PRIORITIES FOR TECHNOLOGY ASSESSMENT: A SURVEY OF STATE OFFICIALS, by John E. Mock for the Office of Exploratory Research and Problem Assessment, Research Applications Directorate, National Science Foundation, August 1973. This is Volume III of a series entitled CANDIDATES AND PRIORITIES FOR TECHNOLOGY ASSESSMENTS. The other volumes are: Volume I, SUMMARY OF FOUR STUDIES OF CANDIDATES AND PRIORITIES FOR TECHNOLOGY ASSESSMENTS; Volume II, A SURVEY OF FEDERAL EXECUTIVE AGENCY PROFESSIONALS; Volume IV, AN APPROACH TO PRIORITIES; and Volume V, A SURVEY OF CANDIDATE TECHNOLOGIES

Early in 1973 Mock carried out a survey of State officials to identify candidates and priorities for technology assessment. The survey, commissioned by the National Science Foundation, was addressed to Governors' Science Advisors, Directors of State planning agencies, Directors of State departments of natural resources, and Directors of economic development. The respondents (34% of the 200 officials) identified approximately 250 different candidates for T.A. Areas of major concern were natural resources and environmental management (land use, power plant siting, coastal zone management, desalinization, pollution control); energy (coal gasification, geothermal energy, strip mining, nuclear power plants); and human resources (health care delivery systems, educational technology). A number of officials identified as especially important those areas where there is pressure from converging trends; energy shortages and environmental enhancement, increased automation in industry and lengthened life spans. As predicted earlier by Ed Kelly, Mock noted that State officials framed their candidates in terms of problems rather than in terms of a specific technology.

Mock advised the participants that not all of their assessments will show immediate results—if measured by direct implementation of findings or recommendations. Decisionmaking is still the province of the Governor and the Legislature—it is a political process and reflects other considerations and imperatives besides those informational inputs from the assessment. And, he also noted, even when assessments have a direct and positive influence on the decision, it is likely that the influence will not be acknowledged or spotlighted, since political leaders will themselves take the credit for the wisdom of their decisions. Nevertheless, the T.A. will provide a more rational and farsighted base for decisions than States and communities in the past have had available.

HOW TO DO TECHNOLOGY ASSESSMENT

Mr. Joseph F. Coates, then Program Manager for Technology Assessment, Office of Exploratory Research and Problem Assessment, National Science Foundation. Mr. Coates is now in the Office of Technology Assessment, U.S. Congress

Technology Assessment has come about as a consequence of our struggling, as citizens, to regain control over advancing technology, said Joe Coates as he laid the groundwork for the session on how to do technology assessment. Many converging long-range trends make the development of Technology Assessment inevitable. "We now have it within our collective capability to do whatever we want to do," to manipulate our environment in almost any way we choose. But our capability to manage technology has not kept pace, and thus we consistently sub-optimize on new technological developments and major projects.

The bureaucracy, "whether in or out of government," Coates said, concentrates on short-term optimization. In managing technology, it operates on three principles:

—Can we do it? Will it fly? Is it technically feasible?

—Will someone buy it, or pay for it? (Is it economically feasible?)

—Is it safe?

These three principles are obsolescent as the dominant criteria for evaluating technology; they must be augmented by consideration of

—What else happens? (What are the second order, delayed, and interactive consequences?)

—What are the externalities? (The hidden, societal costs and benefits?)

—Is it "safe" in a deeper, broader, more subtle sense?

These new criteria, said Coates, imply "the integration of uncertainty into the analysis." Technology Assessment is a class of policy studies (hence essentially a paper and pencil analytic-synthetic activity) —it must include the analysis of alternatives and must have an orientation toward both policy and the future. Technology Assessment thus tends to broaden rather than narrow the range of options from which decisionmakers must orchestrate policy.

Coates described the components or modules of a generalized technology assessment:

(1) A statement of the problem to be considered—usually a broader restatement or recasting of the problem after analysis is underway;

(2) Definition of the system (technology), and specific alternatives which could accomplish the same objective (micro-alternatives);

(3) Identification of potential impacts—a creative enterprise requiring imagination and speculation;

(4) Evaluation of potential impacts—a mixed effort of firm-handed analysis and informal judgment necessarily conducted on "semi-solid" footing;

(5) Definition of the relevant decisionmaking apparatus—a step which is often neglected;

(6) Laying out options for the decisionmaker—since traditional categories may now be inadequate, new inventions and imaginative development of options are usually appropriate and often needed;

(7) Conclusions—and possibly recommendations.

To these basic elements Coates added three additional modules which are essential to effective analysis:

(8) Identification of parties of interest; potential "winners" and "losers," including both overt and latent interests;

(9) Definition of "macro-alternatives"—not alternative technologies as considered in Module 2, but broader system alternatives such as energy conservation or solar energy generation rather than the Alaskan Pipeline; this step provides a standard to challenge conclusions drawn from Modules 1 through 7;

(10) Identification of exogenous variables—events which may disturb the system (i.e., natural catastrophe, war, embargoes, depressions, changing birthrates, etc.)

A list of Technology Assessments funded by the National Science Foundation appears in Appendix B

A good technology assessment, Coates asserted, must be done three times: once to understand the problem, once to do the assessment, once to revise and polish it. As the audience reacted with alarm and dismay, Coates explained that Technology Assessment is an iterative process in which each step is a logical rather than a temporal progression—that is, every step requires anticipation or revision of later and earlier steps.

Coates concluded: the cumulative impact of a good technology assessment, if the process has been comprehensive and open, and embraces diversity, may have significant effect on national decisions and policies.

HOW TO ORGANIZE A COMPREHENSIVE TECHNOLOGY ASSESSMENT

Dr. Steven Ebbin, Program of Policy Studies in Science and Technology, The George Washington University

"The organization and management of a T.A. project are critical to its success," Steve Ebbin began, in describing a study which he directed, a comprehensive assessment of the proposed extension of Kennedy Airport runways into Jamaica Bay. The assessment was commissioned by the Port of New York Authority and performed under the direction of the Environmental Studies Board of the National Academy of Sciences, at the urging of the U.S. Department of Transportation. A first and critical step, said Ebbin, was negotiation with PONYA to assure that the study team enjoyed complete independence from the sponsor and that the issues treated and the alternatives studied could be defined as broadly as the team felt desirable. To

further insure the independence and credibility of the study, an oversight committee of twelve distinguished citizens was established.

The selection of the study team, about twenty-five experts with a wide range of disciplines and expertise (about half physical and life scientists and engineers, and half behavioral and social scientists and lawyers) was also critical, Ebbin said. They were selected not only for their expertise but for their ability to work in an interdisciplinary mode, to cooperate with the rest of the team under intense pressures of work and time, and to change their minds when necessary. Most of the team developed a point of view early in the study based on their professional and disciplinary experience and personal values — "if you have no bias," Ebbin commented, "then you have never thought about the problem." The successful integration of the interdisciplinary team, he implied, can be measured by the extent to which these differences were resolved on the basis of the facts as the study progressed and the logic of the emerging data laid the basis for a set of conclusions on which consensus could be reached. Biases, he noted, tend to become mutually self-cancelling as factual information is developed and as professional reputations are laid on the line before the judgments of professional peers.

The study group met for a week of intensive hearings during which both the team of experts and affected segments of the community were consulted, the site was visited, and data gathering began. A core group continued to gather data, and compiled an extensive library on the history, flora and fauna, economics, and sociology of the Bay area. After this preparatory period, there were two months of individual study and site visits. The study group then spent one month of intensive effort, living together and working together fifteen hours a day at a location near the site of the proposed project.

During this period the study group worked in five subcommittees (ground and air transportation systems, recreation and conservation, land use and community needs, metropolitan needs and the expanding economy, and water management). The methods, techniques, and modes of operation used varied from subcommittee to subcommittee. A steering committee made up of the subcommittee chairmen served to integrate the efforts and relate the study to national policy objectives.

During the month spent on site, each of the subcommittees prepared a draft report, and these were integrated by the chairmen and study director, after review by the advisory committee. Ultimately they were combined by the steering committee into a final report. Policy differences which remained were moderated with the assistance of the Oversight committee and resolved by negotiation within the steering committee.

The final report which emerged was widely circulated among the public, the press, PONYA, and Federal, State, and local governments.

The impact of its recommendations was decisive: on the day that it was issued officially, the Port of New York Authority announced that, as recommended by the study, it was cancelling its efforts to win approval for any runway extension into Jamaica Bay.

Strong, professional management is essential for successful technology assessment, Steve Ebbin asserted. On the other hand, he does not favor professional performers of T.A.; that is, unlike some of the other speakers, he fears that practice in successive T.A.'s may not improve the performance of individual assessors but may destroy their flexibility, initiative, and innovative thinking. Ad hoc study teams, he felt, are more effective and less subject to developing a professional "set," even though organizing and managing such studies *de novo* is a taxing undertaking.

It must be recognized, said Ebbin, that technology assessment is in one sense a highly political matter; it is dangerous to the sponsor of a project and to the "establishment," because it will often end with a challenge to their plans. Decision mechanisms in the Executive and the Legislative branches of government, and in the corporate sectors, are not easily able to cope with the results when they represent "bad news." We need new institutional forms, Ebbin concluded, both to perform technology assessment and to use it. There is little, if any, indication that such institutions are now being developed.

COUNTER-INTUITIVE THINKING AND ITS PLACE IN TECHNOLOGY ASSESSMENT

Dr. Marvin Cetron, President, Forecasting International Ltd., Arlington, Virginia

The output of a comprehensive technology assessment, said Marvin Cetron, must be credible information in a communicative, useful form—and the results, as far as possible, must be reproducible by subsequent investigators. Credibility, Cetron said, is the keynote; this is often the best reason for choosing an outside source to perform an assessment, rather than having it performed within the sponsoring organization or agency.

A technology assessment should answer the questions of whether a technology is technically feasible, socially and politically acceptable, and cost-effective in both an economic and a social sense. For the answers to these questions to be credible and reproducible, they must present information which is:

—available "in a digestible form" to lay decisionmakers,

—quantified, to the greatest extent possible, *but*

—integrated to show systematic relationships between events, trends, and impacts.

These desirable characteristics are hardest to achieve, Cetron stressed, when the assessors are dealing with social forecasting, especially prediction of value change. Technological forecasting, by contrast, is relatively easy because one can use hard data and such empirically validated techniques as substitution curves. For value change prediction, Cetron advocates that assessors use indicators from certain

"forerunner" countries such as the Scandinavian societies, which appear to be about a generation ahead of the U.S. in trends which often are common to both societies.

"Counter-intuitive thinking," Cetron said, is the pitfall to be avoided. He uses this term to designate conclusions which are based on logical and reasonable inference but prove to be incorrect in the world of experience—often because the assessors have failed to take into account all of the ramifications of a course of action. One impact or group of impacts, in other words, may inhibit, aggravate, or accelerate the effect of other impacts of the same or concurrent events and actions. Because assessors must often work with "soft" or subjective data, and in order to avoid counter-intuitive thinking, they must go about the identification and evaluation of impacts in such a way as to yield "structured judgments."

Cetron therefore advocates the use of cross-impact and cross-support matrices, techniques which he illustrated for the audience from a number of assessment studies conducted by his research firm. In using such matrices, a group of assessors (who may be the research team, decisionmakers, potential users, affected parties, or a combination of all of these) generate a list of potential impacts or goals and objectives and, by "informed judgment," assign to these items numbers representing measurements or weights. ("Measurement," Cetron noted, "means the assignment of relative numbers to objects or events according to a set of rules.") This allows for the systematic comparison and adjustment of the assigned values in order to investigate relationships—either inhibitive or mutually supportive—between the impacts or objectives. There is nothing either magical or scientific about the numbers, Cetron emphasized; they merely facilitate and rationalize the comparison and justification of subjective judgments. The usefulness of the technique, he recognized, is both underlined and limited by the fact that one is relying on and manipulating partial and often inaccurate data. Cetron argued, however, that the use of a cross-impact matrix often allows one to identify and correct "counter-intuitive thinking," and he illustrated this contention from an assessment of "the wired city." The study of the use of comprehensive telecommunication systems had been expected to show dramatic benefits to be gained by its implementation. Cross-impact evaluation instead revealed that large segments of the city's population, and ultimately the economic viability of the city itself, would be severely damaged or hurt—and the population which stood to lose most, in terms of jobs, income, and services, were the already disadvantaged: low income people, minorities, and women.

For further information, see "*Counter-Intuitive* Thinking: A Part of Technology Assessment," M. J. Cetron, Forecasting International, Ltd., Arlington, Virginia 22209

Cetron then described a study he recently made forecasting developments in energy technologies and relating these to "indicators of satisfaction." Using cross-impact matrices and cross-relevance matrices, potential major problems or disasters in the development of energy technologies were assessed in terms of their potential impact on the environment and the quality of life. Cross-support analysis was then

used to study the effect development of one type of energy technology has on the development of alternative energy technologies. This kind of technology forecasting and assessing, Cetron said, can help us "to determine before the fact who may get hurt by certain developments, how much they may get hurt, who will get help, and how much help."

HOW TO DO T.A. FOR LESS THAN $5,000

Dr. Andre Delbecq, Chairman, Department of Management, University of Wisconsin, Madison

The organizers of the workshop recognized that States and localities often will lack the resources to mount a comprehensive Technology Assessment. (The minimum cost of a comprehensive effort when performed by an independent research organization was estimated by Vary Coates at between one and two hundred thousand dollars.) Dr. Andre Delbecq was asked, therefore, to describe a technique which he has developed for assisting a group of people with varied expertise, knowledge, and experience to reach a "shared judgment." The Delbecq technique was recognized by Dr. Eugene Grabbe, Director of the Hawaii State Center for Science Policy and Technology Assessment, as an inexpensive means of gathering a wide range of information and judgment in a short time, and Dr. Grabbe has adapted and used the Delbecq Nominal Group Technique (NGT) for performing mini-assessments to meet the needs of State policy and decisionmakers.

The Nominal Group Technique is a way of drawing out "the wisdom" of a group composed of individuals from different specialties, careers, ages, and orientations, said Professor Delbecq. Members of the group should be selected carefully not only for their expertise or experience, but for intelligence, flexibility, and interest in the problem at hand. The success of the method depends on achievement of equal participation in order to "decode" judgments, clarify issues, and reach insight into complex problems. It uses a collegial style, based on small group theory showing that "the most creative groups for idea generation are those which don't talk to each other, but interacting groups are most capable of evaluation." The Delbecq NGT process therefore makes use of both modes of group behavior: nominal or silent idea generation and structured interaction for idea evaluation.

The problem to be explored, or the technology to be assessed, first is explained thoroughly. Participants are divided into groups of six, and these groups, working independently, are then led through six steps outlined below:

Step 1. Silent generation of ideas, each member working independently, in writing, for 10-25 minutes.

Objectives: to give participants time to think, to force them by tension and social competition to produce, to avoid polarization and premature evaluation and closure, and to avoid pressure for conformity and deference to status.

Step 2. In round-robin fashion, each member reads aloud one idea, which is written on a flip chart; this continues sequentially for approximately 45 minutes.

Objectives: equal sharing of ideas, depersonalization of ideas, production of a written record, focusing of the problem, visual and audial concentration, toleration of conflicting viewpoints.

Step 3. Serial discussion of all items on flip chart, in informal fashion, for about 30 minutes.

Objectives: clarification, reduction of repetition, overlap, and ambiguity.

Step 4. Silent, individual written voting on priorities (by rank ordering or rating).

Objectives: focus on most important issues, rank ordering of items, consideration of alternatives.

Step 5. Discussion of voting results.

Objectives: to compare perceptions of the approaching consensus and to clarify misinformation.

Step 6. Silent, individual, written voting.

Objective: final re-ranking of ideas and closure.

If more than one group of six have been involved, the procedure may be reiterated by multiple groups of six, on reports from individual groups collapsed after Step 4 and the entire assembly voting on a master list which is discussed through the steps.

"Multidisciplinary assessment," said Delbecq, "is the most difficult of efforts, and truly interdisciplinary efforts are a myth." His technique, he emphasized, can be useful at several stages: problem identification and definition, solution development, assessment of social impacts, or proposal review. NGT can facilitate adoption of results by enlarging the base of participation. If administrators or decisionmakers are simply presented with assessment results, Delbecq noted, proponents of the technology tend to become defensive, and critics focus on only the weaknesses of the proposal. If both have been involved in this kind of intensive effort, however, they are likely to emerge with significantly changed perceptions because, without being forced on the defensive, they have participated in the evolution of a consensus.

HOW TO WRITE ENVIRONMENTAL IMPACT STATEMENTS

Professor Gene E. Willeke, Environmental Research Center, Georgia Institute of Technology, Atlanta

Environmental Impact Statements, Vary Coates had pointed out, are in effect at least partial technology assessments—more or less comprehensive as the language of the National Environmental Policy Act of 1969 is interpreted more or less rigorously: "any actions" which significantly affect the *human* environment. Gene Willeke gave the Conference participants a systematic and thorough lesson in how to prepare environmental impact statements, in 18 simple steps or rules.

Begin, said Willeke, by studying the law: first NEPA, which reminds you that you must be concerned with all environmental impacts, both

the good and the bad. Then consider the legislative history of the Act, to clarify its intent and purpose. Court interpretations of the requirements of the Act have tended to give it additional breadth and substance, and subsequent State enactment of similar laws should also be considered.

Next, Willeke advised, learn the rules, by a thorough review of guidelines furnished by the Council on Environmental Quality, agency guidelines, the review process, and the content of recent statements.

It is important to begin early, he stressed. Planning for the environmental impact statement should be a part of the process of planning the project itself, in order to leave plenty of time for data gathering. Put into the budget money for preparing the statement and be sure to put in enough.

An adequate environmental impact statement cannot be done by one person. Not only should there be a multidisciplinary staff, Willeke insisted, but the public must be involved, and the viewpoint of the agencies who will review the statement should be brought into the process of preparing it. Furthermore, Willeke said, one must get out from behind the desk and visit the area, talk to the people in the community, and take along the staff so that their perceptions are broadened also.

The subtle points are the ones for which one must search: the long-range and diffuse impacts, those which are indirect and for which one must be prepared to expect qualitative or inexact data. But this, said Willeke, must not lead one to overlook the large, obvious, and immediate impacts, especially those which are irreversible.

Advised Willeke: assume the position of people who will be affected by the action or project—do some role-playing. Keep your files and drafts open from beginning to end of the process and have a good record-keeping system so not a bit of information is lost. Checklists can be valuable aids—whether prepared by agencies or borrowed from other researchers or earlier impact statements. A framework to guide the analysis is also needed: it may be in the form of a matrix, a network, a hierarchical structure of impacts, or a framework you yourself devise.

One essential element of the statement, he reminded the audience, is the examination of alternatives, including the alternative of doing nothing. According to Willeke, an important aspect that is often neglected is analysis of the socio-economic characteristics of potential impacts: who gets hurt and who reaps the benefits?

Finally, he warned, one must be on guard lest bias creep in as the statement is drafted; it is necessary to distill the information, yet leave out nothing—especially that which is "bad news." The statement should be made available to the public, in a meaningful rather than a

pro forma fashion; and, above all, Willeke concluded, one must be prepared to revise and modify, as only through a reiterative process can an environmental impact statement, or a technology assessment, be performed adequately.

THREE TECHNOLOGY ASSESSMENTS

Three recent ongoing technology assessments of interest to State officials were described at the Conference: an assessment of Operation Plowshare (the use of nuclear explosives to produce oil and gas in Western States), an assessment of solid waste management technology for the State of Connecticut, and a technology assessment of integration of hog farming, sponsored by the National Science Foundation. Although only one of these appeared to the Conference participants to fit the definition of comprehensive technology assessment, all of the presentations provided valuable insights into the organization and management of complex, multidisciplinary, policy-oriented applied research—a problem with which all State officials find themselves increasingly forced to grapple.

OPERATION PLOWSHARE

Mr. Wyatt Rogers, Associate Director, Western Interstate Nuclear Board

The assessment of Operation Plowshare, for example, as reported by Wyatt Rogers, demonstrated that it is feasible for States to cooperate in assessing developments of mutual concern and that through this technique States can have an impact on Federal programs. The assessment, funded jointly by the National Science Foundation and a compact of twelve States, grew out of a serious concern by western States about a proposed, large-scale commercial program which would utilize nuclear explosives for oil and gas stimulation. The proposed development was viewed by many as an unacceptable assault on the environment, safety, and resources of one region in order to produce presumed benefits for the nation as a whole. The Western Interstate Nuclear Board and researchers from five Universities in the Rocky Mountain region conducted fourteen separate studies over a fourteen-month period (with an additional six months of integrating and "recycling" the results of these studies). Major emphasis was on four areas of concern: impacts on the environment, impacts on utilization of the region's other natural resources, jurisdictional and legal implications for State and commercial Plowshare technology, and methods of encouraging public participation in related decisionmaking. The final results of the study were published by WINB in early 1974. Following the study, representatives of the affected States met to discuss possible joint policy actions to regulate Plowshare projects.

PLOWSHARE TECHNOLOGY ASSESSMENT: IMPLICATIONS TO STATE GOVERNMENTS. Glenn A. Whan, Project Director

A TECHNOLOGY ASSESSMENT OF SOLID WASTE MANAGEMENT

Dr. Jules Mirabal, General Electric Research and Development Center

The technology assessment of solid waste management technology, reported by Jules Mirabal, was thought by most Conference participants to represent more nearly a technical feasibility study than a technology assessment. But as a highly sophisticated example of multidisciplinary applied research in a complex and politically sensitive area, it was nonetheless of great interest to the audience, particularly since it demonstrated a successful cooperation between industry and State government. (The industry—General Electric Research and Development Center—specifically removed itself from subsequent competition to develop the solid waste management centers which were recommended by the study.) The assessment grew out of legisla-

tion calling for a State-wide masterplan to solve solid waste problems in 169 cities and towns in Connecticut. The master plan was required by the legislation to identify and implement solid waste technology which was "environmentally sound, economically feasible, and socially acceptable." On the basis of competition, G.E. was awarded a one-year contract for $450,000, with G.E. contributions bringing the total cost of the study up to $1.15 million. The study was organized around five major tasks: market analysis, transportation aspects, public information, business impacts, and capital acquisition. Mirabal mentioned in passing that because of "political realities" in the State of Connecticut, the area of solid waste collection was omitted from the study; the audience was quick to note the inference and comment on the political pitfalls that await technology assessors in dealing with public service functions in the State and local arena.

TECHNOLOGY ASSESSMENT OF INTEGRATION OF HOG FARMING

Dr. Ivan Smith, Midwest Research Institute

Ivan Smith reported on a comprehensive technology assessment of the integration of hog farming underway at the Midwest Research Institute and funded by the National Science Foundation. The assessment team was instructed to look at the broad societal and regional implications of the possible movement to vertical integration of the pork industry (from production of piglets through feeding to butchering) following the model offered by the beef and chicken industries. The study is to include impacts on the family farmer, the consumer (e.g., food prices and quality of product), labor and management needs, financial institutions, energy utilization, world food needs, and a variety of other affected parties and institutions. Ultimately, and unexpectedly, Smith said, the team find themselves forced to address such broad moral issues as whether the U.S. is justified in making red meat the staple of our diet, given the fact that it takes ten pounds of grain to produce one pound of beef.

The scope of the assessment, Smith pointed out, is reflected in the composition of the research team, with its consultants, which include agricultural experts, management experts, swine nutritionists and veterinarians, engineers, geologists, economists, political scientists, technology forecasters, transportation specialists, regional developers, land use lawyers, social psychologists, and marketing experts. An Oversight Committee further adds to the viewpoints and disciplines represented.

Describing the ongoing T.A. in detail, Smith drew some lessons which the team is learning and some goals which they are pursuing, which he feels should be a part of every assessment. A basic need, he said, is to analyze the driving forces which are bringing about a new technology (or a significant change in the way we perceive or use a technology). This includes a thorough understanding of the boundaries and the current state-of-the-art of the technology under study. Secondly, Smith went on, methodologies must be found and improved which are fitted to the special problems being investigated. Here Smith advised the group, "Watch out for the development of still more jargon—it is important to use the user's language," that is, to be

able to communicate directly with those who will need the information which the assessment will produce. Finally, the assessment report, Smith believes, should be organized by impact areas, and elements of the report directed at and written especially for the various segments of the population who will need to use it. He described for the group how the outline of the hog farming T.A. was developed early in the study to be used as a framework for the analysis as it developed. Separate sections of the report, aimed at categories of users, will be separable from the entire report for fuller and more targeted distribution.

COMMON THEMES

Several insights emerged from the presentations of ongoing assessments and the vigorous discussions which followed. In each of these studies, non-scientific political and bureaucratic individuals and scientists had managed to cooperate productively in spite of pronounced difficulties in communication and differences of viewpoint, values, and objectives. In each of the studies there were, or there may be in the future, political sensitivities and cross-currents which may limit or pose serious problems for the assessment as well as for its implementation: jurisdictional ambiguities in Operation Plowshare, control of solid waste collection by a powerful organization with alleged underworld ties, conflicts of interest between small farmers and agribusiness in the hog farming area. There is also the problem of scarce resources and limited capability when States must grapple with big science and high technology and the complex issues they pose—a theme constantly replayed during the Conference. This problem is most acute for the smaller or poorer States. Three possible means of dealing with the problem were illustrated by the three studies presented: regional pooling of resources by a number of States, cooperation between State governments and industry, and the seeking of funding from a Federal agency, in this case the National Science Foundation through its Research Applied to National Needs Program.

TECHNOLOGY ASSESSMENT IN A BROADER CONTEXT: DISTINGUISHED LUNCHEON SPEAKERS

Professor Dean Rusk, Professor of Law, University of Georgia

The Honorable Dean Rusk helped participants at the Conference look at technology, and where it is taking us, from a global perspective. He spoke of "the breathtaking, accelerating pace of change," and the ever-widening role of science and technology as they condition our daily lives. The issues raised by science range, he said, from methadone to abortion to SALT; in the next three decades, questions different in kind from any mankind has faced before must be resolved if we are to survive. They will have ramifications for the States, for local communities, and for individuals, as well as for mighty nations. If we are indeed committed to democratic government, Rusk reminded us, the public must be supplied with knowledge to face such issues intelligently.

Nuclear weapons, the law of the sea, and the protection of the environment exemplify the complex issues we face. Technology, Rusk said, has produced answers to the old problem of access to information in order to assure compliance with international nuclear agreements—only in time to face a new generation of weapons, MIRVs, which pose problems of verification for which technology does not yet supply an answer.

The Law of the Sea Conference, which opens in June, 1974, will very likely bring about revision of the international law. The public does not yet understand the implications of this revision, nor is it being given the information needed for an understanding. Redefinition of the boundaries of coastal waters will affect fishing rights and access to straits. New rules governing scientific research and development on the oceans will have impacts on military security, business rights, and national concessions. Mining of the ocean beds raises the question of whether the byproducts, dumped back into the ocean, are pollutants or nutrients.

How, asked Rusk, can a political decisionmaker know whether his scientific advisors are speaking as advocates of a point of view, or providing neutral objective information? Political decisionmakers, Rusk reminded the listeners, are nearly always scientific laymen—with no way of knowing whether a "scientific" explanation is well-established empirically, or highly controversial. When information is not available, or when there is a legitimate difference of opinion, Rusk said, the scientific advisors should tell us frankly, "Damned if we know," but too often they will instead pontificate. Further, he said, scientists must help to orient decisionmakers toward the future, by forcing them to face the long-range implications of their knowledge.

"Are we coming to the point that some scientific areas should be off-limits for exploration?" Rusk asked. Test-tube babies, climate modification, biological weapons—these, he implied, may be areas so close to the nature and the very existence of humanity that we are not prepared to handle the knowledge scientists may give us.

Turning for a moment from this highly provocative question, Rusk asserted that "there is a missing piece of machinery" in our governing system. In similar times of crisis, Presidents have created new bodies of advisors: the National Academy of Sciences, established by Lincoln, and the National Research Council established during World War I, for example. The time is overdue, said Rusk, for a National Academy of Public Affairs, like the English Privy Council; but, he told his listeners, this idea has been turned down by several Presidents on the ground that it might limit their decisionmaking power.

Might such a body decide, the audience wondered, when scientific investigators were out of bounds? Who should decide to limit science? Who should be empowered to say what are the boundaries of human knowledge? Rusk admitted, sadly, "I do not know the answer."

Professor Melvin Kranzberg, Georgia Institute of Technology

In a wise and witty address Melvin Kranzberg traced the development of technology from antiquity to the present, and the impact it has had on human life, institutions, and customs. The most important fact about modern, advanced technology, he said, is that

> Our social institutions have become so inextricably interwoven and so interdependent as a result of advanced technology that perturbations in one element of the system can bring about almost disastrous consequences in another element of the system.

Thus a technology which originates as a "technological fix" for one problem may initiate a series of unforeseen problems; for example, as DDT almost wiped out malaria but contaminated the atmosphere and the food chain for years to come.

Nineteenth century social theorists such as Karl Marx and Herbert Spencer, Kranzberg reminded the audience, were among the first to call attention to the unintended, unplanned consequences of technological development. But the social legislation which was passed to control the adverse effects tended to be "fragmented in nature, narrow in scope, and tardy in application." Technology assessment, Kranzberg said, provides a rational means for democratic control of technology. However, he noted, decisions will be made by the political process and that, in a democratic system, is where the decisions belong. "Democracy allows us the privilege of making mistakes." So even if we have highly skilled technology assessment, we are still likely to make mistakes in our use of technology, Kranzberg predicted. But, he added, "at least we will make our mistakes through choice and not through ignorance of the consequences."

AN EVALUATION OF TECHNOLOGY ASSESSMENT

Mr. Walter A. Hahn, Senior Specialist in Science and Technology, Science Policy Research Division, Congressional Research Service, Library of Congress, and President, International Society for Technology Assessment

Walter Hahn, the final speaker of the Conference, performed the invaluable service of summarizing the Conference, pulling together the loose ends, filling areas not touched on by previous speakers, and providing a critical summary of the state of the art in Technology Assessment. T.A., he said, is "the new kid on the block," and we must decide whether we have to lick him or invite him to join us. Clearly in favor of the latter, Hahn pointed out that T.A. has two aspects: some things which have been done all along, although differently or not so thoroughly (systems analysis, product testing, marketing research, and cost/benefit analysis), and some things which are clearly new:

—orienting applied research toward the needs of policy formulation

—providing a data base for decisionmaking in the public arena

—comprehensively anticipating second and higher order impacts

—organizing the unknowns and the uncertainties

—anticipating rather than reacting

—being iterative and open-ended.

Hahn also emphasized that T.A. can and should deal not only with "hard" technologies but with social and institutional technology. T.A.'s are often categorized as either "problem-oriented" or "technology-driven," and Hahn noted that some of the participants had appeared disturbed at the variations in the definitions of T.A. offered by different speakers. But he added three additional, non-exclusive categories: the "policy-driven" T.A., which OTA needs to do to meet immediate legislative needs; the "knowledge-driven" T.A., which universities may engage in ("art for art's sake"), and the "people's T.A.," (undertaken to produce better technological information for the public). All kinds of T.A., Hahn submitted, are part of a thrust or initiative to improve decisionmaking in a technological society.

Hahn told the group that T.A. is truly an international movement, with activity or deep interest in many countries, among them Germany, Japan, Sweden, the United Kingdom, the Netherlands, and Canada. International organizations such as UNESCO, the Common Market, and OECD are becoming involved actively in technology assessment. There are many "actors" in T.A., with many disciplines and positions, Hahn said: in academia, in the local, national, and international power structures, in industry, and in citizens groups. He advised the listeners not to forget one important actor or interest group—mute and often unrepresented but a powerfully affected party: the future generations.

What are the outcomes of technology assessment? Hahn asked. He suggested four explicit outcomes: better identification of first order

effects, identification of the range and intensity of secondary and interactive consequences, identification of the unknowns and uncertainties, and identification of the affected parties. Beyond this, Hahn added, are additional spin-off benefits: identification of weaknesses in our goals, policies, institutions, and customs; determination of areas of needed research; awareness of deficiencies in public participation mechanisms and in public information channels.

Another question which Hahn addressed was, "What does T.A. mean for us?" T.A. is, he said, something we can use in our industry, government job, or university settings:

—to do whatever we do a little better

—to fulfill our responsibilities as part of the community

—to do strategic planning for our institution

—to improve our human relationships by understanding the viewpoints and language of other professions

—to protect and promote our personal rights and interests

—and, for some, to have a "product to sell."

There are critical problems with which the T.A. movement has not yet come to terms, Hahn warned: one is the problem of "Who should be the assessors?" Should they be trained specialists, a team of scientific experts, generalists, representatives of affected interests, or a combination of all of these? Should they be, so far as possible, neutral objective evaluators, or should there be a balancing of value orientations? Another unresolved question is that of appropriate performance standards or criteria. And, finally, there is the important problem of the proper balance between technical evaluation and social evaluation: how broadly should the questions be phrased in order to give useful answers?

Walter Hahn gave a fitting summary to the Conference, as well as to his talk, as he said, "There are many issues to be resolved and things to learn in this new and developing art or science of technology assessment. But we know a lot more than we used to know and we have a wide range of useful techniques that can be combined to assess the social, environmental, and economic impacts of present and proposed technology."

APPENDIX A

PARTICIPANTS IN THE CONFERENCE

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*Speaker

APPENDIX B

A PARTIAL LIST OF ONGOING ASSESSMENTS

Date	*Organization* *Principal Investigator*	*Award No. and Title*	*Duration* *Amount*
6/08/73	U. of California Los Angeles, California David Okrent	GI-39416; "A General Approach to Risk-Benefit Evaluation for Large Technological Systems"	18 Months $343,600
6/27/73	The Futures Group Glastonbury, Connecticut T. J. Gordon	C836000; "Technology Assessment of Geothermal Energy Resource Development"	12 Months $191,882
7/19/73	Stanford Research Inst. Menlo Park, California Edward M. Dickson	GI-39694; "A Technology Assessment of a Hydrogen Energy Economy"	12 Months $122,200
9/07/73	Arthur D. Little, Inc. Cambridge, Massachusetts Joan Berkowitz	C835000; "Technology Assessment of Terrestrial Solar Energy Resource Development"	12 Months $246,664
10/23/73	Haldi Associates, Inc. New York, New York John D. Owen	GI-40456; "Technology Assessment of Alternative Work Schedules"	18 Months $207,400
10/30/73	U. of Minnesota Minneapolis, Minnesota John E. Wertz	GI-40445; "Technology Assessment of Conversion from the English to Metric System in the United States"	18 Months $179,100
12/13/73	Arthur D. Little, Inc. Cambridge, Massachusetts Martin L. Ernst	C844000; "The Cashless-Checkless Society — An In-Depth Technology Assessment"	18 Months $220,776
12/17/73	Braddock, Dunn and McDonald, Inc. Vienna, Virginia Hans B. Schechter	C845000; "Technology Assessment of Alternative Strategies and Methods for Conserving Energy"	18 Months $238,638
1/01/74	George Washington University Washington, D.C. Vary T. Coates	GT-41308; "Southern Regional Workshop in Technology Assessment"	7 Months $20,000

Date	*Organization and Principal Investigator*	*Award No. and Title*	*Duration Amount*
1/02/74	Midwest Research Inst. Kansas City, Missouri Edward W. Lawless	C849000; "A Technology Assessment of Biological Substitutes for Chemical Pesticides"	12 Months $114,345
1/02/74	Midwest Research Inst. Kansas City, Missouri Ivan C. Smith	C850000; "An In-Depth Technology Assessment of Integrated Hog Farming"	18 Months $215,000
3/01/74	SUNY College of Environmental Science and Forestry Albany, New York David G. Palmer	GI-42435; "Public Participation in Environmental Assessment"	6 Months $2600
5/01/74	University of Oklahoma Norman, Oklahoma Irvin L. White	GI-44065; "Planning a Fossil Fuel Technology Assessment"	6 Months $35,000
6/01/74	New England Bureau, Inc. Boston, Massachusetts Martin V. Jones	GI-43739; "A Mini-Technology Assessment of Earthquake Prediction Techniques and Their Applications"	6 Months $22,250
6/01/74	Stanford Research Institute Menlo Park, California Leo W. Weisbecker	GI-43870; "A Technology Assessment of Earthquake Prediction"	12 Months $283,500
7/01/74	University of Washington Seattle, Washington Edward Wenk, Jr.	ERP-74-20740; "Technology Policy Assessment: Refinement and Evaluation of Methods"	12 Months $51,500
7/01/74	Cornell University Ithaca, New York Raymond Bowers	ERP-74-20555; "A Technology Assessment in the Area of Mobile Communications"	12 Months $140,000

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15. Supplementary Notes

16. Abstracts

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Decisionmaking

17c. COSATI Field/Group

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