OFFICE OF TECHNOLOGY ASSESSMENT FOR THE CONGRESS

HEARING

BEFORE THE

SUBCOMMITTEE ON COMPUTER SERVICES

OF THE

COMMITTEE ON RULES AND ADMINISTRATION UNITED STATES SENATE

NINETY-SECOND CONGRESS

SECOND SESSION

ON

S. 2302 and H.R. 10243

TO ESTABLISH AN OFFICE OF TECHNOLOGY ASSESSMENT FOR THE CONGRESS AS AN AID IN THE IDENTIFICATION AND CONSIDERATION OF EXISTING AND PROBABLE IMPACTS OF TECHNOLOGICAL APPLICATION; TO AMEND THE NATIONAL SCIENCE FOUNDATION ACT OF 1950; AND FOR OTHER PURPOSES

MARCH 2, 1972

Printed for the use of the Committee on Rules and Administration

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OFFICE OF TECHNOLOGY ASSESSMENT FOR THE CONGRESS

THURSDAY, MARCH 2, 1972

U.S. SENATE,
SUBCOMMITTEE ON COMPUTER SERVICES,
COMMITTEE ON RULES AND ADMINISTRATION,
Washington, D.C.

The subcommittee met at 10:05 a.m. in room 301, Old Senate Office Building, the Honorable B. Everett Jordan, chairman of the full committee and of the subcommittee, presiding.

Present: Senators Jordan and Griffin.

Subcommittee staff present: Charles E. Graham, associate director of computer services; and Linda Primm, staff assistant.

Full committee staff present: Gordon F. Harrison, staff director; Hugh Q. Alexander, chief counsel; Burkett Van Kirk, minority counsel; John P. Coder, professional staff member; Thomas P. McGurn, director, information and computer services; Hildreth T. Sharp, assistant chief clerk; Peggy Parrish, staff assistant; Kay Ballard Chain, secretarial assistant; and Jack Sapp, editorial assistant.

OPENING STATEMENT OF HON. B. EVERETT JORDAN, CHAIRMAN OF THE COMMITTEE ON RULES AND ADMINISTRATION AND OF THE SUBCOMMITTEE ON COMPUTER SERVICES

The CHAIRMAN. Good morning, ladies and gentlemen. I am glad to welcome each one of you to this hearing this morning. This is the Committee on Rules and Administration Room of the Senate.

This morning this Subcommittee on Computer Services of the Committee on Rules and Administration, of which I am the chairman, will hold hearings on the establishment of an Office of Technology Assessment. I consider this to be a most important hearing.

We are delighted to have so many distinguished visitors who are interested in this piece of legislation appear before us this morning. I am going to read an opening statement which will give some of the reasons why we are holding the hearing.

The purpose of the hearing today is to receive testimony on S. 2302 and H.R. 10243 which propose the establishment of an Office of Technology Assessment to assist Congress in evaluating the scientific, technical and social impacts of legislation.

In brief, the Office would consist of a Technology Assessment Board to formulate policy and an operational unit headed by a director to administer its activities.

The operational unit would be composed of a small, but highly qualified group of experts in the areas of the physical, biological and social sciences.

The basic responsibility of the Office would be to provide an appraisal and "early warning system" of the probable positive and negative impacts of the applications of technology, and to develop coordinative and analytical information which would assist the Congress in determining the relative priorities of programs before it.

Assessments could be initiated by the chairman of any committee of the Congress, for himself or on request of the ranking minority member or a majority of committee members; or by the Technology Assessment Board.

All results of assessments would be freely available to the public except in cases involving national security, or where public information statutes would prohibit it from being published.

It should be noted that the Office itself would be prohibited from operating any laboratories, plants, or test facilities.

In other words, we will not go into the automobile manufacturing business, or operate laboratories to test them.

The Congress has not provided itself with an adequate capability for the independent collection, correlation and analysis of information on the many complex issues which confront all of us every day. The establishment of an Office of Technology Assessment would provide this critically needed service to the Congress.

The need for such an Office is underscored by the rapid pace of scientific and technological developments and the increasingly critical environmental, social, and economic problems confronting our Nation.

In this regard, one of the most pressing needs for Congress under today's conditions is to be better informed concerning the vital issues for which we must create legislation and upon which we must make decisions.

The time is long past when we can afford to forego the benefits of modern techniques in the areas of information and policy analysis. If we are to be the handful of men to make vital decisions, we must have the advantage of the best data available. And I consider the establishment of the Office of Technology Assessment to be a significant step toward providing Congress with the best information that is available.

It is worth noting that the Office of Technology Assessment would be the first office the Congress has established for itself since the establishment of the GAO in 1921, and the first entirely new informational organization since the establishment of the Legislative Reference Service of the Library of Congress in 1914.

Without objection, I ask that copies of S. 2302 and H.R. 10243 be inserted into the record at this point.

(The bills referred to follow:)

92D CONGRESS
1ST SESSION

S. 2302

IN THE SENATE OF THE UNITED STATES

JULY 19, 1971

Mr. JORDAN of North Carolina (for himself, Mr. ALLOTT, Mr. KENNEDY, Mr. PASTORE, and Mr. PROUTY) introduced the following bill; which was read twice and referred to the Committee on Rules and Administration

A BILL

To establish an Office of Technology Assessment for the Congress as an aid in the identification and consideration of existing and probable impacts of technological application; to amend the National Science Foundation Act of 1950; and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Technology Assessment Act of 1971".

DECLARATION OF PURPOSE

SEC. 2. The Congress hereby finds and declares that:

(a) Emergent national problems, physical, biological,

and social, are of such a nature and are developing at such an unprecedented rate as to constitute a major threat to the security and general welfare of the United States.

(b) Such problems are largely the result of and are allied to—

(1) the increasing pressures of population;

(2) the rapid consumption of natural resources; and

(3) the deterioration of the human environment, natural and social,

though not necessarily limited to or by these factors.

(c) The growth in scale and extent of technological application is a crucial element in such problems and either is or can be a pivotal influence with respect both to their cause and to their solution.

(d) The present mechanisms of the Congress do not provide the legislative branch with adequate independent and timely information concerning the potential application or impact of such technology, particularly in those instances where the Federal Government may be called upon to consider support, management, or regulation of technological applications.

(e) It is therefore, imperative that the Congress equip itself with new and effective means for securing competent, unbiased information concerning the effects, physical, eco-

nomic, social, and political, of the applications of technology, and that such information be utilized whenever appropriate as one element in the legislative assessment of matters pending before the Congress.

ESTABLISHMENT OF THE OFFICE OF TECHNOLOGY ASSESSMENT

SEC. 3. (a) In accordance with the rationale enunciated in section 2, there is hereby created the Office of Technology Assessment (hereinafter referred to as the "Office") which shall be within and responsible to the legislative branch of the Government.

(b) The Office shall consist of a Technology Assessment Board (hereinafter referred to as the "Board") which shall formulate and promulgate the policies of the Office, and a Director who shall carry out such policies and administer the operations of the Office.

(c) The basic responsibilities and duties of the Office shall be to provide an early warning of the probable impacts, positive and negative, of the applications of technology and to develop other coordinate information which may assist the Congress in determining the relative priorities of programs before it. In carrying out such function, the Office shall—

(1) identify existing or probable impacts of technology or technological programs;

(2) where possible establish cause-and-effect relationships;

(3) determine alternative technological methods of implementing specific programs;

(4) determine alternative programs for achieving requisite goals;

(5) make estimates and comparisons of the impacts of alternative methods and programs;

(6) present findings of completed analyses to the appropriate legislative authorities;

(7) identify areas where additional research or data collection is required to provide adequate support for the assessments and estimates described in paragraphs (1) through (5); and

(8) undertake such additional associated tasks as the appropriate authorities specified under subsection (d) may direct.

(d) Activities undertaken by the Office may be initiated by—

(1) the chairman of any standing, special, select, or joint committee of the Congress;

(2) the Board; or

(3) the Director.

(e) Information, surveys, studies, reports, and findings produced by the Office shall be made freely available to the

public except where (1) to do so would violate security statutes, or (2) the information or other matter involved could be withheld from the public, notwithstanding subsection (a) of section 552 of title 5, United States Code, under one or more of the numbered paragraphs in subsection (b) of such section.

(f) In undertaking the duties set out in subsection (c), full use shall be made of competent personnel and organizations outside the Office, public or private; and special ad hoc task forces or other arrangements may be formed by the Director when appropriate.

TECHNOLOGY ASSESSMENT BOARD

SEC. 4. (a) **The Board shall consist of** eleven members as follows:

(1) two Members of the Senate who shall not be members of the same political party, to be appointed by the President pro tempore of the Senate;

(2) two Members of the House of Representatives who shall not be members of the same political party, to be appointed by the Speaker of the House of Representatives;

(3) the Comptroller General of the United States;

(4) the Director of the Congressional Research Service of the Library of Congress;

(5) four members from the public, appointed by

the President, by and with the advice and consent of the Senate, who shall be persons eminent in one or more fields of science or engineering or experienced in the administration of technological activities, or who may be judged qualified on the basis of contributions made to educational or public activities; and

(6) the Director (except that he shall not be considered a voting member for purposes of appointment or removal under the first sentence of section 5(a)).

(b) The Board, by majority vote, shall elect from among its members appointed under subsection (a) (5) a Chairman and a Vice Chairman, who shall serve for such time and under such conditions as the Board may prescribe, but for a period of not to exceed four years. In the absence of the Chairman, or in the event of his incapacity, the Vice Chairman shall fulfill the duties and functions of the Chairman.

(c) The Board shall meet upon the call of the Chairman or upon the petition of five or more of its members, but it shall meet not less than twice each year.

(d) Six members of the Board shall constitute a quorum.

(e) Any vacancy in the Board shall not affect its powers, but shall be filled in the manner in which the vacant position was originally filled.

(f) The term of office of each member of the Board appointed under subsection (a) (5) shall be four years, except that (1) any such member appointed to fill a vacancy occurring prior to the expiration of the term for which his predecessor was appointed shall be appointed for the remainder of such term; and (2) the terms of office of such members first taking office after the enactment of this Act shall expire, as designated by the President at the time of appointment, two at the end of two years and two at the end of four years, after the date of the enactment of this Act. No person shall be appointed a member of the Board under subsection (a) (5) more than twice.

(g) (1) The members of the Board other than those appointed under subsection (a) (5) shall receive no compensation for their services as members of the Board, but shall be allowed necessary travel expenses (or, in the alternative, mileage for use of privately owned vehicles and a per diem in lieu of subsistence not to exceed the rates prescribed in sections 5702 and 5704 of title 5, United States Code), and other necessary expenses incurred by them in the performance of duties vested in the Board, without regard to the provisions of subchapter I of chapter 57 of title 5, United States Code, the Standardized Government Travel Regulations, or section 5731 of title 5, United States Code.

(2) The members of the Board appointed under sub-

section (a) (5) shall each receive compensation at the rate of $100 for each day engaged in the actual performance of duties vested in the Board, and in addition shall be reimbursed for travel, subsistence, and other necessary expenses in the manner provided in paragraph (1) of this subsection.

DIRECTOR AND DEPUTY DIRECTOR

SEC. 5. (a) The Director of the Office of Technology Assessment shall be appointed by the Board and shall serve for a term of six years unless sooner removed by the Board. He shall receive basic pay at the rate provided for level II of the Executive Schedule under section 5313 of title 5, United States Code.

(b) In addition to the powers and duties vested in him by this Act, the Director shall exercise such powers and duties as may be delegated to him by the Board.

(c) The Director may appoint, with the approval of the Board, a Deputy Director who shall perform such functions as the Director may prescribe and who shall be Acting Director during the absence or incapacity of the Director or in the event of a vacancy in the office of Director. The Deputy Director shall receive basic pay at the rate provided for level III of the Executive Schedule under section 5314 of title 5, United States Code.

(d) Neither the Director nor the Deputy Director shall engage in any other business, vocation, or employment than

that of serving as such Director or Deputy Director, as the case may be; nor shall the Director or Deputy Director, except with the approval of the Board, hold any office in, or act in any capacity for, any organization, agency, or institution with which the Office makes any contract or other arrangement under this Act.

AUTHORITY OF THE OFFICE

SEC. 6. (a) The Office shall have the authority, within the limits of available appropriations, to do all things necessary to carry out the provisions of this Act, including, but without being limited to, the authority to—

(1) prescribe such rules and regulations as it deems necessary governing the manner of its operation and its organization and personnel;

(2) make such expenditures as may be necessary for administering the provisions of this Act;

(3) enter into contracts or other arrangements as may be necessary for the conduct of its work with any agency or instrumentality of the United States, with any foreign country or international agency, with any State, territory, or possession or any political subdivision thereof, or with any person, firm, association, corporation, or educational institution, with or without reimbursement, without performance or other bonds, and

without regard to section 3709 of the Revised Statutes (41 U.S.C. 5);

(4) make advance, progress, and other payments which relate to technology assessment without regard to the provisions of section 3648 of the Revised Statutes (31 U.S.C. 529);

(5) acquire by purchase, lease, loan, or gift, and holds and dispose of by sale, lease, or loan, real and personal property of all kinds necessary for, or resulting from, the exercise of authority granted by this Act; and

(6) accept and utilize the services of voluntary and uncompensated personnel and provide transportation and subsistence as authorized by section 5703 of title 5, United States Code, for persons serving without compensation.

(b) The Director shall, in accordance with such policies as the Board shall prescribe, appoint and fix the compensations of such personnel as may be necessary to carry out the provisions of this Act. Such appointments shall be made and such compensation shall be fixed in accordance with the provisions of title 5, United States Code, governing appointments in the competitive service, and the provisions of chapter 51 and subchapter III of chapter 53 of such title relating to classification and General Schedule pay rates; except that the Director may, in accordance with such policies as the

Board shall prescribe, employ such technical and professional personnel and fix their compensation without regard to such provisions as he may deem necessary for the discharge of the responsibilities of the Office under this Act.

(c) The Office shall not, itself, operate any laboratories, pilot plants, or test facilities in the pursuit of its mission.

(d) (1) The Office or (on the authorization of the Office) any of its duly constituted officers may, for the purpose of carrying out the provisions of this Act, hold such hearings, take such testimony, and sit and act at such times and places as the Office deems advisable. For this purpose the Office is authorized to require the attendance of such persons and the production of such books, records, documents, or data, by subpena or otherwise, and to take such testimony and records, as it deems necessary. Subpenas may be issued by the Director or by any person designated by him. If compliance with such a subpena by the person to whom it is issued or upon whom it is served would (in such person's judgment) require the disclosure of trade secrets or other commercial, financial, or proprietary information which is privileged or confidential, or constitute a clearly unwarranted invasion of privacy, such person may petition the United States district court for the district in which he resides or has his principal place of business, or in which the books, records, documents, or data involved are situated, and such court (after inspect-

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ing such books, records, documents, or data in camera) may excise and release from the subpena any portion thereof which it determines would require such disclosure or constitute such invasion. Where the subpena or such portion thereof would require such disclosure or constitute such invasion but the books, records, documents, or data involved are shown to be germane to the matters under consideration and necessary for the effective conduct by the Office of its proceedings or deliberations with respect thereto, the court may require that such books, records, documents, or data be produced or made available to the Office in accordance with the subpena but subject to such conditions and limitations of access as will prevent their public disclosure and protect their confidentiality.

(2) In case of contumacy or disobedience to a subpena issued under paragraph (1) the Attorney General, at the request of the Office, shall invoke the aid of the United States district court for the district in which the person to whom the subpena was issued or upon whom it was served resides or has his principal place of business, or in which the books, records, documents, or data involved are situated, or the aid of any other United States district court within the jurisdiction of which the Office's proceedings are being carried on, in requiring the production of such books, records, documents, or data or the attendance and testimony of such person in

accordance with the subpena (subject to any conditions or limitations of access which may have been imposed by such court or any other court under the last sentence of paragraph (1)). Such court may issue an order requiring the person to whom the subpena was issued or upon whom it was served to produce the books, records, documents, or data involved, or to appear and testify, or both, in accordance with the subpena (subject to any such conditions or limitations of access); and any failure to obey such order of the court may be punished by the court as a contempt thereof.

(e) Each department, agency, or instrumentality of the executive branch of the Government, including independent agencies, is authorized and directed to furnish to the Office, upon request by the Director, such information as the Office deems necessary to carry out its functions under this Act.

(f) Contractors and other parties entering into contracts and other arrangements under this section which involve cost to the Government shall maintain such books and related records as will facilitate an effective audit in such detail and in such manner as shall be prescribed by the Director, and such books and records (and related documents and papers) shall be available to the Director and the Comptroller General or any of their duly authorized representatives for the purpose of audit and examination.

UTILIZATION OF THE LIBRARY OF CONGRESS

SEC. 7. (a) Pursuant to the objectives of this Act, the Librarian of Congress is authorized to make available to the Office such services and assistance by the Congressional Research Service as may be appropriate and feasible.

(b) The foregoing services and assistance to the Office shall include all of the services and assistance which the Congressional Research Service is presently authorized to provide to the Congress, and shall particularly include, without being limited to, the following:

(1) maintaining a monitoring indicator system with respect to the natural and social environments which might reveal early impacts of technological change, but any such system shall be coordinated with other assessment activities which may exist in the departments and agencies of the executive branch of the Government;

(2) making surveys of ongoing and proposed programs of government with a high or novel technology content, together with timetables of applied science showing promising developments;

(3) publishing, from time to time, anticipatory reports and forecasts;

(4) recording the activities and responsibilities of Federal agencies in affecting or being affected by technological change;

(5) when warranted, recommending full-scale assessments;

(6) preparing background reports to aid in receiving and using the assessments;

(7) providing staff assistance in preparing for or holding committee hearings to consider the findings of the assessments;

(8) reviewing the findings of any assessment made by or for the Office; and

(9) assisting the Office in the maintenance of liaison with executive agencies involved in technology assessments.

(c) Nothing in this section shall alter or modify any services or responsibilities other than those performed for the Office, which the Congressional Research Service under law performs for or on behalf of the Congress. The Librarian is, however, authorized to establish within the Congressional Research Service such additional divisions, groups, or other organizational entities as may be necessary to carry out the objectives of this Act, including the functions enumerated in this section.

(d) Services and assistance made available to the Office by the Congressional Research Service in accordance with this section may be provided with or without reimbursement from funds of the Office, as agreed upon by the Chairman of the Board and the Librarian of Congress.

COORDINATION WITH THE NATIONAL SCIENCE FOUNDATION

SEC. 8. (a) The Office shall maintain a continuing liaison with the National Science Foundation with respect to—

(1) grants and contracts formulated or activated by the Foundation which are for purposes of technology assessment, and

(2) the promotion of coordination in areas of technology assessment, and the avoidance of unnecessary duplication or overlapping of research activities in the development of technology assessment techniques and programs.

(b) Section 3 (b) of the National Science Foundation Act of 1950, as amended, is hereby amended to read as follows:

"(b) The Foundation is authorized to initiate and support specific scientific activities in connection with matters relating to international cooperation, national security, and the effects of scientific applications upon society by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such activities.

When initiated or supported pursuant to requests made by any other Federal department or agency, including the Office of Technology Assessment, such activities shall be financed whenever feasible from funds transferred to the Foundation by the requesting official as provided in section 14 (g), and any such activities shall be unclassified and shall be identified by the Foundation as being undertaken at the request of the appropriate official."

ANNUAL REPORT

SEC. 9. The Office shall submit to the Congress and to the President an annual report which shall, among other things, evaluate the existing state of the art with regard to technology assessment techniques and forecast, insofar as may be feasible, technological areas requiring future attention. The report shall be submitted not later than March 15 each year.

FINANCIAL AND ADMINISTRATIVE SERVICES

SEC. 10. Financial and administrative services (including those related to budgeting, accounting, financial reporting, personnel, and procurement) shall be provided the Office by the General Accounting Office, with or without reimbursement from funds of the Office, as may be agreed upon by the Chairman of the Board and the Comptroller General of the United States. The regulations of the General Accounting Office for the collection of indebtedness of person-

nel resulting from erroneous payments (under section 5514 (b) of title 5, United States Code) shall apply to the collection of erroneous payments made to or on behalf of an Office employee, and the regulations of the Comptroller General for the administrative control of funds (under section 3679 (g) of the Revised Statutes (31 U.S.C. 665 (g)) shall apply to appropriations of the Office; and the Office shall not be required to prescribe such regulations.

APPROPRIATIONS

SEC. 11. (a) To enable the Office to carry out its powers and duties, there is hereby authorized to be appropriated to the Office, out of any money in the Treasury not otherwise appropriated, not to exceed $5,000,000 for the fiscal year ending June 30, 1972, and thereafter such sums as may be necessary.

(b) Appropriations made pursuant to the authority provided in subsection (a) shall remain available for obligation, for expenditure, or for obligation and expenditure for such period or periods as may be specified in the Act making such appropriations.

92D CONGRESS
2D SESSION

H. R. 10243

IN THE SENATE OF THE UNITED STATES

FEBRUARY 9, 1972
Read twice and referred to the Committee on Rules and Administration

AN ACT

To establish an Office of Technology Assessment for the Congress as an aid in the identification and consideration of existing and probable impacts of technological application; to amend the National Science Foundation Act of 1950; and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Technology Assessment Act of 1972".

DECLARATION OF PURPOSE

SEC. 2. The Congress hereby finds and declares that:

(a) Emergent national problems, physical, biological, and social, are of such a nature and are developing at such

an unprecedented rate as to constitute a major threat to the security and general welfare of the United States.

(b) Such problems are largely the result of and are allied to—

(1) the increasing pressures of population;

(2) the rapid consumption of natural resources; and

(3) the deterioration of the human environment, natural and social,

though not necessarily limited to or by these factors.

(c) The growth in scale and extent of technological application is a crucial element in such problems and either is or can be a pivotal influence with respect both to their cause and to their solution.

(d) The present mechanisms of the Congress do not provide the legislative branch with adequate independent and timely information concerning the potential application or impact of such technology, particularly in those instances where the Federal Government may be called upon to consider support, management, or regulation of technological applications.

(e) It is therefore imperative that the Congress equip itself with new and effective means for securing competent, unbiased information concerning the effects, physical, economic, social, and political, of the applications of technology,

and that such information be utilized whenever appropriate as one element in the legislative assessment of matters pending before the Congress.

ESTABLISHMENT OF THE OFFICE OF TECHNOLOGY ASSESSMENT

SEC. 3. (a) In accordance with the rationale enunciated in section 2, there is hereby created the Office of Technology Assessment (hereinafter referred to as the "Office") which shall be within and responsible to the legislative branch of the Government.

(b) The Office shall consist of a Technology Assessment Board (hereinafter referred to as the "Board") which shall formulate and promulgate the policies of the Office, and a Director who shall carry out such policies and administer the operations of the Office.

(c) The basic responsibilities and duties of the Office shall be to provide an early warning of the probable impacts, positive and negative, of the applications of technology and to develop other coordinate information which may assist the Congress in determining the relative priorities of programs before it. In carrying out such function, the Office shall—

(1) identify existing or probable impacts of technology or technological programs;

(2) where possible establish cause-and-effect relationships;

(3) determine alternative technological methods of implementing specific programs;

(4) determine alternative programs for achieving requisite goals;

(5) make estimates and comparisons of the impacts of alternative methods and programs;

(6) present findings of completed analyses to the appropriate legislative authorities;

(7) identify areas where additional research or data collection is required to provide adequate support for the assessments and estimates described in paragraphs (1) through (5); and

(8) undertake such additional associated tasks as the appropriate authorities specified under subsection (d) may direct.

(d) Activities undertaken by the Office may be initiated by—

(1) the chairman of any standing, special, select, or joint committee of the Congress, acting for himself or at the request of the ranking minority member or a majority of the committee members; or

(2) the Board.

(e) Information, surveys, studies, reports, and findings

produced by the Office shall be made freely available to the public except where (1) to do so would violate security statutes, or (2) the information or other matter involved could be withheld from the public, notwithstanding subsection (a) of section 552 of title 5, United States Code, under one or more of the numbered paragraphs in subsection (b) of such section.

(f) In undertaking the duties set out in subsection (c), full use shall be made of competent personnel and organizations outside the Office, public or private; and special ad hoc task forces or other arrangements may be formed by the Director when appropriate.

TECHNOLOGY ASSESSMENT BOARD

SEC. 4. (a) The Board shall consist of ten members as follows:

(1) five Members of the Senate, appointed by the President pro tempore of the Senate, three from the majority party and two from the minority party; and

(2) five Members of the House of Representatives appointed by the Speaker of the House of Representatives, three from the majority party and two from the minority party.

(c) Vacancies in the membership of the Board shall not affect the power of the remaining members to execute the

functions of the Board and shall be filled in the same manner as in the case of the original appointment.

(d) The Board shall select a chairman and a vice chairman from among its members at the beginning of each Congress. The vice chairman shall act in the place and stead of the chairman in the absence of the chairman. The chairmanship and the vice chairmanship shall alternate between the Senate and the House of Representatives with each Congress. The chairman during each even-numbered Congress shall be selected by the Members of the House of Representatives on the Board from among their number. The vice chairman during each Congress shall be chosen in the same manner from that House of Congress other than the House of Congress of which the chairman is a Member.

DIRECTOR AND DEPUTY DIRECTOR

SEC. 5. (a) The Director of the Office of Technology Assessment shall be appointed by the Board and shall serve for a term of six years unless sooner removed by the Board. He shall receive basic pay at the rate provided for level II of the Executive Schedule under section 5313 of title 5, United States Code.

(b) In addition to the powers and duties vested in him by this Act, the Director shall exercise such powers and duties as may be delegated to him by the Board.

(c) The Director may appoint, with the approval of the

Board, a Deputy Director who shall perform such functions as the Director may prescribe and who shall be Acting Director during the absence or incapacity of the Director or in the event of a vacancy in the office of Director. The Deputy Director shall receive basic pay at the rate provided for level III of the Executive Schedule under section 5314 of title 5, United States Code.

(d) Neither the Director nor the Deputy Director shall engage in any other business, vocation, or employment than that of serving as such Director or Deputy Director, as the case may be; nor shall the Director or Deputy Director, except with the approval of the Board, hold any office in, or act in any capacity for, any organization, agency, or institution with which the Office makes any contract or other arrangement under this Act.

AUTHORITY OF THE OFFICE

SEC. 6. (a) The Office shall have the authority, within the limits of available appropriations, to do all things necessary to carry out the provisions of this Act, including, but without being limited to, the authority to—

(1) prescribe such rules and regulations as it deems necessary governing the manner of its operation and its organization and personnel;

(2) make such expenditures as may be necessary for administering the provisions of this Act;

(3) enter into contracts or other arrangements as may be necessary for the conduct of its work with any agency or instrumentality of the United States, with any foreign country or international agency, with any State, territory, or possession or any political subdivision thereof, or with any person, firm, association, corporation, or educational institution, with or without reimbursement, without performance or other bonds, and without regard to section 3709 of the Revised Statutes (41 U.S.C. 5);

(4) make advance, progress, and other payments which relate to technology assessment without regard to the provisions of section 3648 of the Revised Statutes (31 U.S.C. 529);

(5) acquire by purchase, lease, loan, or gift, and hold and dispose of by sale, lease, or loan, real and personal property of all kinds necessary for or resulting from, the exercise of authority granted by this Act; and

(6) accept and utilize the services of voluntary and uncompensated personnel and provide transportation and subsistence as authorized by section 5703 of title 5, United States Code, for persons serving without compensation.

(b) The Director shall, in accordance with such policies as the Board shall prescribe, appoint and fix the compensa-

tion of such personnel as may be necessary to carry out the provisions of this Act. Such appointments shall be made and such compensation shall be fixed in accordance with the provisions of title 5, United States Code, governing appointments in the competitive service, and the provisions of chapter 51 and subchapter III of chapter 53 of such title relating to classification and General Schedule pay rates.

(c) The Office shall not, itself, operate any laboratories, pilot plants, or test facilities in the pursuit of its mission.

(e) Each department, agency, or instrumentality of the executive branch of the Government, including independent agencies, is authorized and directed to furnish to the Office, upon request by the Director, such information as the Office deems necessary to carry out its functions under this Act.

(f) Contractors and other parties entering into contracts and other arrangements under this section which involve costs to the Government shall maintain such books and related records as will facilitate an effective audit in such detail and in such manner shall be prescribed by the Director, and such books and records (and related documents and papers) shall be available to the Director and the Comptroller General or any of their duly authorized representatives for the purpose of audit and examination.

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UTILIZATION OF THE LIBRARY OF CONGRESS

SEC. 7. (a) Pursuant to the objectives of this Act, the Librarian of Congress is authorized to make available to the Office such services and assistance by the Congressional Research Service as may be appropriate and feasible.

(b) The foregoing services and assistance to the Office shall include all of the services and assistance which the Congressional Research Service is presently authorized to provide to the Congress, and shall particularly include, without being limited to, the following:

(1) maintaining a monitoring indicator system with respect to the natural and social environments which might reveal early impacts of technological change, but any such system shall be coordinated with other assessment activities which may exist in the departments and agencies of the executive branch of the Government;

(2) making surveys of ongoing and proposed programs of government with a high or novel technology content, together with timetables of applied science showing promising developments;

(3) publishing, from time to time, anticipatory reports and forecasts;

(4) recording the activities and responsibilities of Federal agencies in affecting or being affected by technological change;

(5) when warranted, recommending full-scale assessments;

(6) preparing background reports to aid in receiving and using the assessments;

(7) providing staff assistance in preparing for or holding committee hearings to consider the findings of the assessments;

(8) reviewing the findings of any assessment made by or for the Office; and

(9) assisting the Office in the maintenance of liaison with executive agencies involved in technology assessments.

(c) Nothing in this section shall alter or modify any services or responsibilities, other than those performed for the Office, which the Congressional Research Service under law performs for or on behalf of the Congress. The Librarian is, however, authorized to establish within the Congressional Research Service such additional divisions, groups, or other organization entities as may be necessary to carry out the objectives of this Act, including the functions enumerated in this section.

(d) Services and assistance made available to the Office by the Congressional Research Service in accordance with this section may be provided with or without reimbursement

from funds of the Office, as agreed upon by the Chairman of the Board and the Librarian of Congress.

COORDINATION WITH THE NATIONAL SCIENCE FOUNDATION

SEC. 8. (a) The Office shall maintain a continuing liaison with the National Science Foundation with respect to—

(1) grants and contracts formulated or activated by the Foundation which are for purposes of technology assessment, and

(2) the promotion of coordination in areas of technology assessment, and the avoidance of unnecessary duplication or overlapping of research activities in the development of technology assessment techniques and programs.

(b) Section 3 (b) of the National Science Foundation Act of 1950, as amended, is hereby amended to read as follows:

"(b) The Foundation is authorized to initiate and support specific scientific activities in connection with matters relating to international cooperation, national security, and the effects of scientific applications upon society by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such activities. When initiated or supported pursuant to requests made by any other Federal department or agency, including the

Office of Technology Assessment, such activities shall be financed whenever feasible from funds transferred to the Foundation by the requesting official as provided in section 14(g), and any such activities shall be unclassified and shall be identified by the Foundation as being undertaken at the request of the appropriate official."

ANNUAL REPORT

SEC. 9. The Office shall submit to the Congress and to the President an annual report which shall, among other things, evaluate the existing state of the art with regard to technology assessment techniques and forecast, insofar as may be feasible, technological areas requiring future attention. The report shall be submitted not later than March 15 each year.

UTILIZATION OF THE GENERAL ACCOUNTING OFFICE

SEC. 10. Financial and administrative services (including those related to budgeting, accounting, financial reporting, personnel, and procurement) and such other services as may be appropriate shall be provided the Office by the General Accounting Office, with or without reimbursement from funds of the Office, as may be agreed upon by the Chairman of the Board and the Comptroller General of the United States. The regulations of the General Accounting Office for the collection of indebtedness of personnel resulting from erroneous payments (under section 5514(b) of title 5,

United States Code) shall apply to the collection of erroneous payments made to or on behalf of an Office employee, and the regulations of the Comptroller General for the administrative control of funds (under section 3679(g)) of the Revised Statutes (31 U.S.C. 665(g)) shall apply to appropriations of the Office; and the Office shall not be required to prescribe such regulations.

APPROPRIATIONS

SEC. 11. (a) To enable the Office to carry out its powers and duties, there is hereby authorized to be appropriated to the Office, out of any money in the Treasury not otherwise appropriated, not to exceed $5,000,000 in the aggregate for the two fiscal years ending June 30, 1973, and June 30, 1974.

(b) Appropriations made pursuant to the authority provided in subsection (a) shall remain available for obligation, for expenditure, or for obligation and expenditure for such period or periods as may be specified in the Act making such appropriations.

Passed the House of Representatives February 8, 1972.

Attest: W. PAT JENNINGS,

Clerk.

The CHAIRMAN. We have tried to take the witnesses in the order in which they applied. I believe Senator Allott applied first.

Is he here?

(No response.)

Senator Allott is not here.

Senator Kennedy is here.

Senator Kennedy is one of the cosponsors of this legislation. Senator Kennedy, we are delighted to have you.

STATEMENT OF HON. EDWARD M. KENNEDY, A U.S. SENATOR FROM THE STATE OF MASSACHUSETTS

Senator KENNEDY. Thank you very much, Mr. Chairman.

If I may, I would like to have my complete statement appear in the record.

The CHAIRMAN. Without objection, it will be included in its entirety.

Senator KENNEDY. Thank you very much.

I am pleased to appear before the Rules Committee this morning to offer testimony supporting the establishment of a Congressional Office of Technology Assessment. I would like to commend the distinguished chairman for his leadership in introducing S. 2302, which I cosponsored, and for promptly calling this hearing after passage of the companion bill in the House.

As chairman of the Senate Subcommittee on the National Science Foundation, I have had a long-standing interest in technology assessment and its implications for public policy.

Ever since former Congressman Daddario originated the technology assessment concept in the mid-1960's, the National Science Foundation has been the principal agency engaged in advancing the state-of-the-art in this important area.

NSF's key role in this field is recognized by the bills before this committee, which would amend NSF's basic statute to enable the Foundation to work closely with the proposed Congressional Office of Technology Assessment. Thus, my support for this office is based on my experience with NSF's technology assessment programs and my continuing responsibility in the development of national science policy.

The term "technology assessment" might sound esoteric and far removed from the concerns of Congress, but this would be a misleading impression. Technology assessment refers to matters of the utmost importance and urgency to those of us in the Congress and to each of our citizens. Like it or not, science and technology have become central to our civilization, to our economic strength, to the preservation of our environment, and to the quality of our lives.

What citizen does not have vital data on himself stored in some computer memory cell? Who is not at the mercy of far-reaching power blackouts and brownouts? How many citizens are impervious to the transportation snarls that strangle our cities? What family will not some day be dependent on the outmoded medical technology which prevails in far too many of our hospitals?

Which one of us doesn't daily take some chemical additives with his food? Or hasn't used some medication which FDA hasn't yet certi-

fied as effective? Who doesn't breathe the pollution in our air? Or regret the filth in our rivers and streams?

We live in a world increasingly shaped by man, and technology is the principal tool he uses to shape it.

But technology is a two-edged sword: with every capability it provides, come new problems; and with every problem it poses, come new opportunities.

Technology assessment is the early anticipation and evaluation of those problems and opportunities.

Next week, as chairman of the Senate Subcommittee on Health, I will hold hearings on an amendment to the Lead-Based Paint Poisoning Prevention Act. About 400,000 children suffer from lead poisoning, and each year about 200 children die from it. Much of the problem comes from homes that were painted over 30 years ago with lead-based paints.

If Congress had had an Office of Technology Assessment 30 years ago, it is conceivable we could have anticipated this problem and enacted legislation which would have spared thousands of children from the grievous effects on this poison.

The office's role is merely to estimate the social, economic and technical consequences of various alternatives. It is up to Congress to evaluate these consequences and make policy choices involving the various alternatives.

Thus, the OTA would not have presumed to advise Congress on the desirability of the SST. But the OTA would have assisted Congress in assessing the impact of supersonic noise, the effect of SST's on the ozone layer in the upper atmosphere, the probable utilization of SST's, and their economic consequences, both on the domestic economy and on America's international economic position. Armed with this knowledge, the relevant committees and individual Members of Congress could make much better informed choices on major programs like the SST.

The ABM debate is another one which would have profited considerably from an Office of Technology Assessment. At the start of the debate, there was a paucity of information available to the Congress and the public, which expressed other than the administration view on the issue. Accordingly, I requested a group of scientists and scholars to come together and produce a book on the ABM which would inform the public on the issue and provide Congress with another source of expertise, with which to evaluate the administration's proposals.

This effort, in effect, constituted a major technology assessment, and it convinced me of the tremendous importance and difficulty of carrying out such analysis effectively. We cannot continue to depend on ad hoc assessments of this sort in the future. Congress needs a strong capability for performing these assessments on a continuing, timely basis.

This is particularly true when one considers the vast resources of technical expertise available to the executive branch. For example, when NASA and the Department of Transportation recently conducted a comprehensive technology assessment of Civil Aviation Research and Development—the CARD study—they had a million dollar budget, over 50 professional staff members, and the use of outside contractors. If Congress is called upon to pass legislation arising from

that study's recommendations, how much staff support will Congress have available to evaluate those recommendations?

In recent years, we have witnessed a steady erosion in the congressional role in foreign policy. A similar erosion has been taking place with respect to national technology programs. Congress cannot reach sound judgments on such programs without a solid basis of facts. The Congressional Research Service and the General Accounting Office do not have the staff resources or special skills to perform this function for technology programs. The extensive hearings in the House demonstrated the need for a new Office of Technology Assessment to do the job.

Unless Congress creates such an office, its national science policy role will become more and more perfunctory and more and more dependent on administration facts and figures, with little opportunity for independent congressional evaluation.

I agree with the intent of the House amendment which limits the Board to congressional Members and assures congressional control of the Office. But once the Board is made entirely congressional, I think it then becomes important to have a statutory advisory panel to the Board. I would envision such a panel as having about 12 public members drawn from a variety of fields, with the Comptroller General, the Director of the Congressional Research Service, and the Director of the Office of Technology Assessment as ex officio members.

Finally, I think it is desirable that the bill be further amended to permit appropriate public participation in the assessment process. Environment and conservation groups, public service law firms, nonprofit research organizations and other citizens' groups should be allowed and encouraged to submit information and ideas to the Office before it completes its assessments. Thus, major assessments could be publicly announced, perhaps in the Federal Register, so that such groups and individual citizens would have an opportunity to submit their views for the record.

Mr. Chairman, I just have a few final comments to make.

The February issue of Scientific American has a timely article which highlights the need for this Office. Entitled "Technology Assessment and Microwave Diodes," it summarizes a preliminary technology assessment of an important new development—the advent of cheap solid-state devices for the generation of microwaves. The article predicts:

> * * * that microwave devices will soon be on the market at prices that individuals can afford, with the likely result that microwave systems for use in homes, automobiles, and boats will proliferate.

This will lead to car telephones becoming as common as car radios are today, to automotive radar systems which avert collisions or automatically inflate air bags when they are about to occur, and to a host of other applications.

The net result of these developments over the coming decade will be to vastly increase the amount of microwave radiation to which people are exposed. The article states:

> There is no doubt that microwave radiation can be harmful to living organisms, but there is considerable controversy over the levels of irradiation required to produce significant effects.

The time to find answers to these questions is now, not after individual microwave devices pervade our economy. The purpose is not to prevent new developments of this sort from occurring, but to assure that they are channeled so as to achieve the maximum benefit for society.

This is the kind of question on which the OTA could provide considerable assistance.

To do so, Congress needs the proposed Technology Assessment Office, and I urge the committee to give favorable consideration to this proposal.

The CHAIRMAN. Thank you very much, Senator Kennedy. We will certainly insert your entire statement in the hearing record, and take into consideration your recommendations on what you think ought to be in this bill.

Senator KENNEDY. Thank you, and I commend you, Mr. Chairman, for providing leadership in this area.

(The formal statement of Senator Kennedy, enclosing articles entitled "Technology Assessment and Microwave Diodes"; "Science and Space—Technology's Sneers"; and "Office of Technology Assessment: Congress Smiles, Scientists Wince", follows:)

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About 400,000 children suffer from lead poisoning, and each year about 200 children die from it. Much of the problem comes from homes that were painted over thirty years ago with lead based paints.

If Congress had had an Office of Technology Assessment thirty years ago, it's conceivable we could have anticipated this problem and enacted legislation which would have spared thousands of children from the grievous effects of this poison.

The March 6th issue of *Newsweek* points out that the automobile was once viewed as an answer to urban pollution due to horses, "but no one foresaw that the auto would someday create pollution problems much more severe than did the horse it replaced."

It's doubtful that an Office of Technology Assessment at the turn of the century could have foreseen the extent of automobile pollution in the 1970's. But such an Office hopefully would have alerted the Congress to the problem much earlier than was the case. If the problem had been clearly presented to Congress in the late 1940's, for example, it's possible that national transportation policy may have been significantly different over the intervening decades. The public roads program may have been handled differently, and much more intensive research would have been directed toward alternative transportation systems, such as urban mass transit or electric cars.

This illustration makes an important point. The Office of Technology Assessment is not intended to make or to recommend policy to the Congress. The Office's role is merely to estimate the social, economic and technical consequences of various alternatives. It's up to Congress to evaluate these consequences and make policy choices involving the various alternatives.

Thus, the OTA would not have presumed to advise Congress on the desirability of the SST. But the OTA would have assisted Congress in assessing the impact of supersonic noise, the effect of SST's on the ozone layer in the upper atmosphere, the probable utilization of SST's, and their economic consequences, both on the domestic economy and on America's international economic position. Armed with this knowledge, the relevant committees and individual Members of Congress could make much better informed choices on major programs like the SST.

The ABM debate is another one which would have profited considerably from an Office of Technology Assessment. At the start of the debate, there was a paucity of information available to the Congress and the public, other than the Administration view on the issue. Accordingly, I stimulated a group of scientists and scholars to come together and produce a book on the ABM which would inform the public on the issue and provide Congress with another source of expertise, with which to evaluate the Administration's proposals.

This effort, in effect, constituted a major technology assessment, and it convinced me of the tremendous importance and difficulty of carrying out such analysis effectively. We cannot continue to depend on ad hoc assessments of this sort in the future. Congress needs a strong capability for performing these assessments on a continuing, timely basis.

This is particularly true when one considers the vast resources of technical expertise available to the Executive Branch. For example, when NASA and the Department of Transportation recently conducted a comprehensive technology assessment of Civil Aviation Research and Development (the CARD study), they had a million dollar budget, over fifty professional staff members, and the use of outside contractors. If Congress is called upon to pass legislation arising from that study's recommendations, how much staff support will Congress have available to evaluate those recommendations?

The total Technology Assessment Office envisioned under the bill is not much larger than the team the Administration assembled to assess this one area. And this covers only civil aviation. It doesn't encompass railroads, automobiles, or urban mass transit. And it certainly doesn't purport to treat other areas of technology outside of transportation.

In recent years we have witnessed a steady erosion in the Congressional role in foreign policy. A similar erosion has been taking place with respect to national technology programs. Congress cannot reach sound judgements on such programs without a solid basis of facts. The Congressional Research Service and the General Accounting Office do not have the staff resources or special skills to perform this function for technology programs. The extensive hearings in the House demonstrated the need for a new Office of Technology Assessment to do the job.

Unless Congress creates such an Office, its national science policy role will become more and more perfunctory, and more and more dependent on Administration facts and figures, with little opportunity for independent Congressional evaluation.

Accordingly, I strongly support the establishment of a Congressional Office of Technology Assessment. In light of the House debate on the bill and the amendments which were voted, I would like to address some comments to the specific provisions of the bill.

The principal purpose of the House amendments to the bill was to assure Congressional control of the Office. The original bill has the Office under the policy control of a Board which consists of Congressional and public members, with the public members appointed by the President, and with the Chairman of the Board drawn from the public members.

I agree with the intent of the House amendment which limits the Board to Congressional members and assures Congressional control over the Office. I think, however, that the Board should include more than five Senators and five Congressmen—perhaps about ten from each House—in order to allow for greater diversity of committee representation among the members.

But once the Board is made entirely Congressional, I think it then becomes important to have a statutory Advisory Panel to the Board. I would envision such a panel as having about twelve public members drawn from a variety of fields, with the Comptroller General, the Director of the Congressional Research Service, and the Director of the Office of Technology Assessment as ex officio members.

I am opposed to the amendment which downgrades the status of the Director of the Office. This function will require the highest level of professional background and leadership. In order to attract and retain the kind of talent which is needed, the Director should have the option to initiate some assessments at his own discretion, in addition to doing so at the request of Congressional committees.

Finally, I think it is desirable that the bill be further amended to permit appropriate public participation in the assessment process. Environment and conservation groups, public service law firms, non-profit research organizations, and other citizens' groups should be allowed and encouraged to submit information and ideas to the Office before it completes its assessments. Thus major assessments could be publicly announced, perhaps in the *Federal Register*, so that such groups and individual citizens would have an opportunity to submit their views for the record.

I consider this last provision extremely important to the success of the Technology Assessment Office. For as an arm of Congress, it must be responsive to the Nation's social needs. To assure that technology is truly directed toward those needs, individual citizens must have the right to participate in the assessment process.

Mr. Chairman, with respect to this or any of the other amendments to the bill, I would be happy to assist the committee and make the staff of the National Science Foundation Subcommittee available to provide any support which the committee might find helpful.

Mr. Chairman, I just have a few final comments to make. The February issue of *Scientific American* has a timely article which highlights the need for this Office. Entitled "Technology Assessment and Microwave Diodes," it summarizes a preliminary technology assessment of an important new development—the advent of cheap solid-state devices for the generation of microwaves. The article predicts "that microwave devices will soon be on the market at prices that individuals can afford, with the likely result that microwave systems for use in homes, automobiles, and boats will proliferate." This will lead to car telephones becoming as common as car radios are today, to automotive radar systems which avert collisions or automatically inflate air bags when they are about to occur, and to a host of other applications. The net result of these developments over the coming decade will be to vastly increase the amount of microwave radiation to which people are exposed. The article states "there is no doubt that microwave radiation can be harmful to living organisms, but there is considerable controversy over the levels of irradiation required to produce significant effects."

The time to find answers to these questions is now, not after individual microwave devices pervade our economy. The purpose is not to prevent new developments of this sort from occurring, but to assure that they are channeled so as

to achieve the maximum benefit for society. This is the kind of question on which the OTA could provide considerable assistance.

As a final point, I would like to call the committee's attention to an article on OTA in this week's issue of *Science*. The article makes several caveats with respect to technology assessment. First, that no assessment can be entirely objective or impartial; there are always bound to be some hidden assumptions which bias the result somewhat. Second, that it is extremely difficult to delimit the scope of an assessment without omitting some important considerations. And finally, that technology assessment is an imperfect tool, which cannot provide panaceas.

But despite these caveats, we have to go ahead and make the best assessments possible. To do so, Congress needs the proposed Technology Assessment Office.

I urge the Committee to give favorable consideration to this proposal.

[From the Scientific American, February 1972]

TECHNOLOGY ASSESSMENT AND MICROWAVE DIODES

The advent of cheap solid-state devices for the generating of microwaves provides a rare opportunity for attempting to predict the impact of a technological development on society

(By Raymond Bowers and Jeffrey Frey)

The notion of technology assessment—the attempt to anticipate the effects, good or bad or both, of the introduction of new technology—has been widely discussed in recent years [See "The Assessment of Technology," by Harvey Brooks and Raymond Bowers; SCIENTIFIC AMERICAN, February, 1970]. Not much has been done, however, in the way of actually assessing a technology. In this article we attempt such an assessment, taking as a case in point the rapidly evolving technology of solid-state microwave devices. Our attempt cannot be comprehensive; it is beyond our competence, for example, to estimate the social consequences of microwave technology, just as it would have been difficult for anyone in 1950 to foresee the full social impact of television. We shall focus mainly on the problem of regulating microwave devices in order to ensure the efficient use of the electromagnetic spectrum. In addition we shall touch briefly on the potential hazards to health from the devices and on whether or not microwave technology might result in invasion of privacy. We hope these first steps will lead to an analysis of broader social implications.

The term microwave refers to wavelength. Although the microwave region of the electromagnetic spectrum is not precisely defined, we use the term to describe radiation of wavelengths ranging from 30 centimeters to three millimeters. In terms of frequency the range is from one gigahertz (billion cycles per second) to 100 gigahertz.

Devices that generate and receive microwaves have been developed for more than 30 years. They are now used widely for communications and navigation and in industrial electronics. Typical applications include television and telephone transmission, radar and machine control. In general, however, the microwave sources now in service are expensive. Such electron-tube sources as the klystron and the magnetron cost many hundreds or even thousands of dollars. As a result most microwave systems are operated by military and industrial organizations.

This situation is likely to change radically within the next decade. Reliable and cheap microwave sources, which in mass production can be expected to cost only a few dollars, are now being developed. They are solid-state devices that have resulted from the pioneering work of such investigators as W. Thornton Read, Jr., of the Bell Telephone Laboratories and J. B. Gunn of the International Business Machines Corporation, who showed that crystals such as gallium arsenide, silicon and germanium can, under certain conditions, generate or amplify electrical signals at microwave frequencies [see "A Solid-State Source of Microwaves," by Raymond Bowers; SCIENTIFIC AMERICAN, August, 1966].

Four devices in particular have been reasonably well developed and will be of major importance in the future. They are the Gunn oscillator; the L.S.A. (for limited space-charge accumulation) diode, which was invented by John Cope-

land of Bell Laboratories, the Read and IMPATT (for impact ionization avalanche transit time) diodes, which are basically similar to each other, and the TRAPATT (for trapped plasma avalanche triggered transit) diode. When these devices are used in the proper circuits, they act as negative conductances: a microwave voltage applied to their terminals causes a current to flow that is 180 degrees out of phase with the voltage. Unlike positive conductances, in which voltage and current flow are in phase so that the conductances absorb energy, negative conductances can transform direct-current energy supplied by a battery or some other source of power into microwave energy.

From the trend of development one can foresee that microwave devices will soon be on the market at prices that individuals can afford, with the likely result that microwave systems for use in homes, automobiles and boats will proliferate. (Microwave cooking ovens are already on the market, but our concern in this article is with microwave sources of considerably lower power.) One can also expect commercial organizations to use microwave sources on a large scale for transmitting information and controlling industrial processes. Indeed, microwave devices may proliferate as much as television sets have proliferated.

The microwave part of the radio spectrum, particularly the range from one to 10 gigahertz, has been exploited for some time. One of the principal nonmilitary uses is for communication. Present long-distance communication links mostly occupy the bands from 3.7 to 4.2 gigahertz and 5.925 to 6.425 gigahertz. As these bands become saturated new links will be authorized in the band from 11.7 to 12.2 gigahertz.

Microwaves do not bend with the curvature of the earth, so that for long links it is necessary to use repeaters that receive, amplify and retransmit the signal. The spacing between repeaters in the lower two microwave bands is determined by the curvature of the earth, features of the terrain and acceptable antenna heights. A spacing of about 30 miles between repeaters is normal. The cost of the electronics (exclusive of antennas) in a typical repeater can be less than 10 percent of the total cost. In addition, expensive equipment must be installed at each terminal to switch incoming and outgoing calls to the proper circuits. When the cost of this equipment is included for a link operating below 10 gigahertz, the fraction of the total cost of the system that is attributable to microwave components is small. Therefore no major cost benefit is obtained by using solid-state devices below 10 gigahertz.

Above 10 gigahertz attenuation of the signal by the atmosphere becomes a major factor. Repeaters have to be more closely spaced; at 12 gigahertz the maximum practical spacing is about four miles, at 18 gigahertz it is 2.3 miles and at 30 gigahertz it is 1.3 miles. Microwave-equipment costs can become a significant part of total costs. The relatively inexpensive solid-state microwave devices therefore open the spectrum above 10 gigahertz to long-distance communication links and could have a considerable effect on activity across the spectrum.

Another field of application for solid-state microwave devices will certainly be indirect satellite-to-earth communication. The microwave devices will be important components in the home television sets that are equipped to receive directly from satellites. In reflecting on the potential social impact one might consider a satellite that the National Aeronautics and Space Administration plans to launch in 1973. The satellite could ultimately carry direct transmission to 600,000 village receivers in India. A recent World Administrative Radio Conference in Geneva set aside three new microwave bands (22.5 to 23, 41 to 43 and 84 to 86 gigahertz) for satellite-to-earth communication. It may well be that microwave systems will also be used for television broadcasting in local areas, providing another large area of application for solid-state microwave devices as oscillators in television receivers.

The new developments in solid-state microwave sources also have the potential for a major improvement of land-based, mobile communication systems. Automobile telephones, for example, could become common. Such telephones cannot be widely installed now because only a narrow band of the spectrum is assigned to this purpose, but if microwave or millimeter-wave bands were made available, the service could expand. Short-wave systems of this kind are directional and of short range, so that it would be necessary to have a large number of local terminals to receive and retransmit the signal from an automobile as the automobile moved along. A system for finding the automobile for incoming messages would also be required; it too probably would involve microwaves.

In the field of guidance and control, which includes radar, radio location and other operations, the availability of solid-state microwave devices is similarly ex-

pected to result more in the expansion of existing applications than in new applications. It will soon be possible for light aircraft to carry both altimeter radar and collision-avoidance radar at costs comparable to the cost of other electronic equipment for general aviation. Weather radar is also a possibility, but it will require higher peak power than is likely to be available within the next decade. Radar for small boats may well become practical.

A new and large radar market could arise with the installation of radar in automobiles for such purposes as indicating clear lanes, warning of obstacles in backing up, providing automatic headway control and triggering passive-restraint devices such as the air bag. (The accelerometer devices that currently trigger air bags at the instant of impact must inflate the bag in such a short time that the accompanying noise is almost explosive. A simple radar trigger could yield the extra fraction of a second required to reduce this problem.)

Microwave systems are already in service as burglar alarms and have the potential for development as fire alarms. An electric company in Illinois is about to test an automatic meter-reading system in which a truck with a microwave transceiver will interrogate a small transponder on each house and obtain the meter reading, which will then be recorded on magnetic tape. Microwave systems could also be used to keep track of buses, service trucks, police cars and other vehicles whose location needs to be known. One can also foresee applications of microwaves in process control (counting, monitoring thickness and so on) and in medicine and biology for such purposes as detecting changes in the circulatory and respiratory systems.

The benefits that could result from expanding microwave applications and developing new ones are considerable. The entire communication system could be improved by opening the frequency range above 10 gigahertz, thereby relieving the congestion at lower frequencies. The new sources also provide a potentially economical means of communication for places where wired systems are unavailable or impractical. As we have already implied, microwave systems have the potential to improve transportation, reduce damage by fire, aid crime detection and advance health care.

These benefits will be accompanied by a number of problems, which need attention soon if the benefits of microwave technology are to be maximized. Most of the problems are related to the fact that a large proliferation of microwave devices would make heavy demands on part of the electromagnetic spectrum and could result in a good deal of mutual interference not only among these devices but also with other electronic systems. Moreover, the possibility of a health hazard from widespread exposure to microwave radiation needs to be examined closely.

A fund of experience and a system of institutional arrangements are now in hand for controlling microwave systems (mostly military and industrial) that consist of no more than a few tens of thousands of units and that range in cost from $100,000 to $10 million per system. If unit prices fall to about $1,000 and microwave systems are installed extensively in light aircraft, large private boats and large trucks, the number of systems might rise to perhaps a million. Even with such numbers the problems would be manageable compared with what will happen if the unit price of microwave systems falls below $100 and the systems are widely installed in automobiles and trucks. Society is simply unprepared to deal with the number of systems (perhaps 100 million) that could result.

Let us examine the problems more closey, beginning with the problem of managing the electromagnetic spectrum. As recently as 1965 it was possible for the Joint Technical Advisory Committee of the Institute of Electrical and Electronics Engineers and the Electronic Industries Association to note that the spectrum space above 10 gigahertz "is unique at this point in history, in that there are relatively few services implanted in the band." Today, however, new common-carrier land transmitters are being assigned to the band from 10.7 to 11.7 gigahertz, cable-television relays are at 12.7 to 12.95 gigahertz and most satellite-to-earth links may well be above 12 gigahertz. These activities, which have a potential for substantial growth, are being forced above 10 gigahertz because of pressure on the spectrum from below rather than because of any technological advantage in having them there.

In the U.S. the spectrum is allotted in blocks for specific uses up to 90 gigahertz. Recent proposals would extend block allocations to 300 gigahertz. Nonetheless, most of the spectrum above 10 gigahertz is currently unexploited. One of the difficulties in considering how the spectrum might be utilized is inadequate information on the number of present users. From the data that are avail-

able, however, one can conclude that the spectrum below 10 gigahertz is filling rapidly to the point where growth of microwave systems might be affected. Virtually all these systems employ the older, electron-tube sources of microwaves.

Congestion of the spectrum varies from place to place. In places as different as New York City and Venice, La., certain bands are saturated. The nature of the locality determines the type of congestion. New York, a center of commerce, communication and entertainment, is afflicted with saturation in the common-carrier band from 3.7 to 4.2 gigahertz and with severe congestion in the other two common-carrier bands below 12 gigahertz, and the petroleum area around Venice has safety and special-service bands that are nearly full. The block-allocation system followed by the Federal Communications Commission does not allow the transfer of the common-carrier spectrum to safety and special services or vice versa. As a result of this policy and the growth of commercial microwave systems the problem of the saturation of specific microwave bands in certain locations is growing.

One must therefore assume that there will be extensive exploitation of the spectrum above 10 gigahertz once economic and reliable systems are available. Indeed, if the large numbers of systems that are implicit in the potential application of microwave techniques are to be accommodated, the only place for them is above 10 gigahertz. Since solid-state microwave devices already span a range of frequencies up to 100 gigahertz, it is tempting to assume that a prospective increase by a factor of 10 in the microwave frequency range available should accommodate all expected applications. We think such an assumption may prove to be optimistic.

A number of steps could be taken that might facilitate preparation for the proliferation of microwave systems. First, calculations should be made of the likely uses of the microwave spectrum. The calculations would take into account communities of varying population density having all the foreseeable microwave systems; fixed and mobile communication systems, automobile radar and so on. The aim would be to predict what degree of congestion might arise.

Second, an adequate base of data for making the calculations and for correlating them with the real situation should be established. One of the requirements for minimizing the congestion of the spectrum is complete information on how the spectrum is being used: a computerized data base containing information on the location, frequency, radiated power and power contour for every operating and proposed transmitter. Until recently the only organization that compiled much of this information, at least for the common-carrier bands, was the American Telephone and Telegraph Company. We think a more comprehensive system should be developed and maintained by an appropriate Government agency. Without an adequate data base it will be necessary to have excessively large margins on each side of every allocation of the spectrum in order to prevent overlap.

A third suggestion is that the principle of block allocation of frequencies in the microwave spectrum needs to be reconsidered. Simple block allocation is excessively rigid, as the cases of New York City and Venice show. Flexibility should be expressly built into the system. If account is taken of the directionality and polarization of each beam, multiple uses of the same frequency are possible, even in the same area. In addition, performance requirements should be established, differing for different services in different parts of the spectrum and applicable to both transmitters and receivers.

We should like to take note of a further problem that may arise if cheap sources of microwave power become available. The fact that the microwave sources in service up to the present time have been expensive has led naturally to the development of expensive and high-quality components of microwave systems in order to obtain maximum benefit from the sources. The new sources, however, make "cheap and dirty" systems possible. It is conceivable that some manufacturers will sacrifice narrowness of beam and precision of frequency control in order to achieve lower costs. This development is particularly likely for devices with power below the level where licensing and strict regulation are normally required.

In this area a large responsibility rests on the engineering profession to insure that these low-power devices are non-polluting from the electromagnetic point of view. The question is whether the profession can establish standards that keep bandwidth, beam width and power at the minimum level to accomplish the objective of a given system. Standards of this kind involve a principle of conservation of a natural resource—the electromagnetic spectrum—that should

be applied whether or not a problem of congestion is foreseen. If this much responsibility is not exercised by the profession, Government regulation and control will surely be necessary.

One area where engineering and manufacturing attention is needed in order to facilitate conservation of the spectrum is the area of antenna design. Techniques for the design of inexpensive, narrow-beam antennas (perhaps fiber-glass paraboloids or dielectric molded structures) do not seem to have kept pace with the improvements in microwave sources. One possibility is the development of active antennas, which provide a degree of amplication at the receiving end; they would allow the use of transmitters of lower power than would otherwise be required. In addition, frequencies for specific applications should be chosen (whenever it is possible) to take advantage of the natural attenuation of the signal in the atmosphere, so that a signal would not penetrate beyond the area that needs to receive it. If the engineering is done properly, many of the low-power microwave devices need be no more troublesome than a flashlight.

It seems to us that concern should be given to the prospect that microwave devices might be incorporated in toys (for both children and adults) and in systems where wired transmission could do the job equally well. Some people contend that since the broadcast spectrum is an exhaustible resource it should not be used for trivial purposes or in situations where the task can be accomplished by other means. We think it would be impracticable to prevent the development of such applications; indeed, to do so would involve a restraint on use of the spectrum that impinged on the rights of some developers. It seems much more realistic to assume that such systems will be developed and to assign them to frequency ranges that are well separated from systems serving more vital functions. The time may come when the spectrum is so congested that an embargo will have to be placed on all new broadcast microwave systems performing a function that could just as well be done with cables.

Another type of interference, not connected with spectral overlap, has recently attracted attention. Microwave radiation can interfer with the operation of some nonmicrowave electronic systems even at low radiation levels, sometimes with unfortunate effects. For example, stray radiation from microwave ovens has been responsible for the malfunction of some heart pacemakers. The level of radiation needed to produce interference, according to the U.S. Public Health Service, is of the order of five microwatts per square centimeter. This level of power might well be present at reasonable distances from the kinds of system we have been discussing.

We turn now to microwaves as a possible health hazard. Since it is reasonable to expect that large numbers of microwave systems will be in the hands of private individuals and therefore will be relatively unsupervised, the need for exploring the biological effects of microwave radiation is urgent. Standards that were established at a time when microwave systems were fairly uncommon and when the average person was unlikely to be irradiated by a microwave beam may be inadequate when microwave beams are emitted from many automobiles, traffic signals and utility poles.

A measure of the magnitude of the problem can be obtained by considering automobiles with radar. A collision-avoidance radar on an automobile might have an average power output of 50 milliwatts; if the power were transmitted within a beam angle of two degrees, the power density at a distance of five meters from the vehicle would be more than 100 microwatts per square centimeter. It is unlikely that anyone would be irradiated by a single beam for any length of time, but he would be exposed to the beams from many vehicles. The prospective levels of power from automobile radar units are inconsequential under safety standards current in the U.S., but they could be of consequence according to standards adopted in eastern Europe. We shall return to this point.

There is no doubt that microwave radiation can be harmful to living organisms, but there is considerable controversy over the levels of irradiation required to produce significant effects, over the permanence of the effects and over the physiological events that cause them. Cases are on record of cataracts and testicular damage in man and of death in animals exposed to microwave radiation experimentally. These effects were probably caused by heating due to absorption of microwave energy at power levels much higher than the ones we have been discussing. Subtler effects have been reported at low levels of power, however. They are called "athermal" effects because they do not seem to be directly attributable to heating. They include mutations in garlic root tips grown

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in a high-frequency field and a tendency for certain animals to respond to such fields in various ways.

The amount of microwave energy absorbed by an object depends on the electric properties of the object and the frequency (and hence the wavelength) of the radiation with respect to the size of the object. The human body begins to absorb radiation significantly when the frequency exceeds about 15 megahertz. The absorptivity of microwaves varies over parts of the body and also varies with time. Microwaves penetrate fat about 10 times more deeply than muscle, and the difference is presumably reflected in the absorption. Certain organs, notably the eye and the testes, are particularly sensitive to heating effects.

Athermal effects were not included when the current recommended U.S. radiation safety limit was set by the Department of Health, Education, and Welfare at an average of 10 milliwatts per square centimeter for long exposures. Athermal effects apparently were considered, however, when the U.S.S.R. established a maximum standard of 10 microwatts per square centimeter per working day—a factor 1,000 times smaller than the U.S. figure. A number of informed American workers are skeptical about many of the Russian results and consequently regard the Russian standards as being unnecessarily stringent, but skepticism is not a sufficient basis for setting standards.

The U.S. standard was set as a result of a program on the biomedical aspects of microwave radiation that was administered by the three military services from 1957 to 1961. Some workers see this research as being largely irrelevant to the subject of low-power microwave radiation because of the neglect of athermal effects and an apparent tendency of the investigators to reject data from eastern Europe on athermal effects. These data have included evidence of hypertension, disturbed heart rhythm and decreases in the sensitivity of various sense organs. The average power levels at which the effects were noted ranged upward from 30 microwatts per square centimeter, and frequencies were usually in the range from ultrahigh to low-microwave—a range where absorption by the skin and bone of the skull is small. Recent experiments in the U.S. are said to have demonstrated that the metabolic activity of the embryonic chick heart is disturbed by 24-gigahertz radiation and that the development of insect pupae can be adversely affected by irradiation with 10 gigahertz. Both of these experiments involved power levels too low to cause significant heating.

Another factor not included when the current U.S. standard was set is the duty cycle of the applied radiation, that is, the percentage of time during which the radiation is being emitted. In an experiment involving two groups of rabbits no members of a group that received 80 milliwatts per square centimeter of continuous-wave radiation for one hour developed cataracts, whereas cataracts did develop in all members of the second group, which received pulsed radiation of 400 milliwatts per square centimeter with a duty cycle of 20 percent (and hence the same average power as the first group received). Thus a radiation standard based solely on average power may not be adequate.

What emerges from this discussion is that the effects of microwave radiation on biological systems are poorly understood. Plainly it is necessary to do much more research in this area, emphasizing low-power effects, and to reexamine safety standards before microwave devices proliferate. The work should be concerned not only with human beings but also with other biological systems. If this research is not done, public controversy will surely develop once the devices proliferate, just as controversy has arisen over low-level radiation emitted from nuclear reactors. In the case of microwaves it is still possible to investigate the low-level effects before massive deployment of microwave devices. The Electromagnetic Radiation Advisory Council of the U.S. Office of Telecommunications Policy is said to be developing a national research program along these lines.

Our final point has to do with the concern that a number of people have expressed over the possibility that new developments in electronics may be used as a means of invading privacy. A related issue is that as more information is transmitted by way of microwave beams, banks, industrial organizations and other users of these links may become concerned over the possibility that transmissions will be intercepted.

We have examined the privacy question in a preliminary way and have come to the tentative conclusion that the new sources do not represent a special problem in the sense of adding a new dimension to the privacy issue. Indeed, in certain respects the new microwave systems seem to have certain advantages over telephone lines in maintaining privacy. To tap a microwave beam one must find it, and its position may not be physically apparent. Moreover, it appears likely

that double-frequency transmission will be easier in the microwave range than it is over telephone lines. In such a system one frequency carries a coded message and the second one transmits the code. Anyone trying to intercept the information will have to find both frequencies; he will also be up against the fact that the signal transmitting the code can occupy an exceedingly narrow band.

If someone is really determined to intercept information, it is almost impossible to thwart him indefinitely. Our concern has been with making interception difficult enough to discourage it on a frequent or casual basis. It would seem prudent, when large amounts of information are to be transmitted by microwave systems, to encode it in at least a simple way.

We should like to emphasize that none of our conclusions about microwave technology is firm and that we have not dealt with certain important questions in our assessment of the technology. Our purpose has been mainly to initiate debate on these issues and to indicate areas where more detailed analysis is necessary. We hope particularly that the technical community, at its meetings and in its publications, will devote attention to these problems, inviting contributions from social scientists (who can add valuable perceptions to the assessment of broad social implications of microwave devices) as well as from physical scientists and experts in technology. To give attention to these problems is part of the public responsibility of the research and development community.

[From Newsweek, Mar. 6, 1972]

SCIENCE AND SPACE—TECHNOLOGY'S SEERS

Bizarre as the idea might seem these days, there once was a time when the automobile was seen as the perfect answer to urban pollution. That was back at the turn of the century, when horses provided virtually all of the motive power for society—and daily deposited some 2½ million pounds of manure and 60,000 gallons of urine on the streets of New York City alone. Small wonder that turn-of-the-century scientists hailed the development of the auto as a clean, quiet and efficient means of transportation. Some even thought that travel by motor car would be much safer than it was by horse or horse-drawn vehicles—and on this count, surprisingly enough, they were absolutely right.* But no one foresaw that the auto would someday create pollution problems much more severe than did the horse it replaced.

Now, however, the U.S. Congress is trying to create a kind of early-warning system to evaluate every aspect of the various new technologies it is regularly asked to fund, with special emphasis on their social, economic and environmental impact. This is to be done by an Office of Technology Assessment, a new organization that the U.S. House of Representatives recently voted to create. If the Senate concurs—and it is expected to—the Congress will have acquired its first new permanent organization set up specifically to assist its deliberations since the General Accounting Office was ordained in 1921.

The need for such an organization springs actually from Congressional apprehensions about skyrocketing Federal expenditures for research and development (from $3 billion in 1954 to about $18 billion this year) and Congressional doubts about how well and how wisely those funds are being spent. One case in point was last year's battle over the supersonic transport (SST), during which the protagonists and the critics generated such an impenetrable fog of claim and counterclaim that many congressmen felt they were flying blind most of the time. Another was the plan to build a jet airport in the Florida Everglades—a project that cost $10 million before it was canceled because of the damage it would have done to the environment.

"Congress has always reacted to the technical initiatives of the executive branch," says former Rep. Emilio Q. Daddario, the Connecticut Democrat who is generally conceded to be the father of the technology assessment bill. "And we just haven't had the capability to evaluate them. A lot of times, we had no choice but to swallow a new project whole or spit it up whole."

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*According to estimates by the National Safety Council, the fatality rate in travel by horses or horse-drawn vehicles was more than 10 times greater than it is by motor car today. The NSC estimates that travel by horse produced 25.5 fatalities per 100 million miles traveled, but that travel by auto produces only 2.1 fatalities per 100 million miles.

FACT

The OTA will be a fact-finding organization that reports only to the Congress. It will be directed by a ten-man board of representatives and senators and managed by a permanent staff of no more than 50 to 100. Individual technological assessments will be contracted out to ad hoc groups drawn from universities or nonprofit organizations and these would be specifically enjoined from making policy or suggesting legislation.

Not even the most enthusiastic advocates claim that technology assessment will accurately predict the future course of events. But Dr. Harvey Brooks, Harvard University's dean of engineering and applied physics, insists that predictions about the future ramifications of technology should be hazarded, even if some prove ultimately to be wrong. "It's much easier to correct a guess about the future," he says, "than to wait for the future to arrive."

As an example of how a specific new technology might be assessed, Professors Raymond Bowers and Jeffrey Frey of Cornell University have examined the impact cheap microwave diodes might have on society. Diodes are small, solid-state devices that generate and receive frequencies; microwaves are those frequencies between 1 billion cycles per second (a gigahertz) and 100 billion.

COST

The expense of these devices has limited their application to military and industrial organizations for communications and navigation purposes, but now several firms are developing low-cost ones. If these are successfully mass-produced, the effect would be to throw open an Oklahoma Territory of frequencies—and people and systems that have been operating in heavily crowded lower frequencies are certain to rush into the microwave bands.

Among the many new uses that the two Cornell scientists see for the inexpensive, mass-produced microwave systems are: television sets that could receive programs directly from orbiting communications satellites; telephones as commonplace in automobiles as radios are today; vastly improved burglar and fire alarms, and a host of automobile equipment including collision-avoidance radar, clear-lane indicators, backup indicators and triggers for safety airbags.

But Bowers and Frey, writing in the current Scientific American, foresee almost as many problems as advantages: the allocation of specific microwave channels for these purposes; the possible interference among various microwave transmitters, especially in such congested areas as New York City, and, perhaps most important of all, the health hazards posed by this type of potentially dangerous electromagnetic radiation.

If a microwave anti-collision radar should someday become standard equipment on every automobile (basically, such a unit would set off an alarm whenever it sensed that the car was closing rapidly on an object ahead), then consideration must be given now to people who will be crossing in front of those vehicles and who might thus be irradiated. The power levels of an automobile radar should be low, the Cornell scientists say, but its possible health hazards cannot be lightly dismissed.

If the advocates of technology assessment are correct and if the proposed new Congressional organization fulfills the expectations set for it, the OTA could become a major force in American society in the future. "It's very important," said Brooks, "that people get a sense that technology is really subject to the will of the people, that it's not an autonomous force that goes its own way."

[From Science, Mar. 3, 1972]

OFFICE OF TECHNOLOGY ASSESSMENT: CONGRESS SMILES, SCIENTISTS WINCE

(By Deborah Shapley)

In what can only be regarded as a minor miracle of legislative revival from the dead, the House of Representatives on 8 February approved former Congressman Emilio Q. Daddario's 1967 plan for an Office of Technology Assessment (OTA) for Congress.

The sudden introduction of the measure, the swift, hour-long debate, and the substantial (256 to 118) vote in favor of the bill was a revelation that technology

assessment has been in recent years not dead but only sleeping. The legislative Lazarus is scheduled for immediate (2 March) hearings in the Senate, and floor debate and vote is likely to occur soon thereafter. But many high priests of science, with a bow to their old pal Daddario, are highly skeptical of the measure.

In the current bill the OTA would produce "technology assessment" studies of such live-wire issues as the SST and the antiballistic missile, petroleum reserves, or electric cars. The OTA would consist of a small core staff who some estimate will number 20 and others say could be 100. There would be a Director (allegedly some people are already politicking for the post), and a Board of Directors who now would be Congressmen, but who were originally to include four Presidential appointees. Budget for the first 2 years would be $5 million; other Congressmen say it would rise soon thereafter to $10 million per year. Studies would be made only at Congressmen's requests and would be performed outside—but it is unclear which groups would get the contracts to make the objective and impartial studies that the Congressmen are dewily anticipating.

But the primary doubt about the measure comes from scientists and some congressional staffers who are veterans of technical and political scuffle and know, firsthand, the scope of the problems involved. Some simply don't believe that "technology assessment," as such, is a meaningful term. If the term is interpreted too narrowly, an Office of Technology Assessment could warp the free, creative development of American science and technology. "I hope you give technology assessment a black eye," reacted one scientist in industry when asked for his opinion of the concept.

The technology assessment idea is largely the brainchild of Daddario (who stages a comeback this week as a star witness before the Senate subcommittee). Daddario, during his tenure as chairman of the House Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, began discussion of technology assessment in 1965. A bill was introduced in 1967, but according to staffers, it was intended only for "discussion purposes." The committee asked subsequently for four separate studies on technology assessment to back it up (see *Science*, 14 November 1969). A seminar was held in 1967, for "a lot of blue sky types."

However, blue sky types are not the sort of people who get legislation through Congress. In fact, the legislative progress of technology assessment under Daddario proceeded at a speed only comparable to that of the advance of the Ice Age. Not until 4 years after the idea was introduced, in 1969, did the Daddario effort produce a serious bill proposing technology assessment machinery for government. The following year, 1970, Daddario resigned his congressional seat to run for governor of Connecticut (he did not win the election).

Daddario's successor to the subcommittee chair is John W. Davis (D–Ga.), a veteran Southern Democrat. Daddario is the intellectual father of the Office of Technology Assessment, but Davis appears to be the man who will probably get credit for OTA's actual creation. Finally, late last year, the measure was presented to the House Rules Committee (which was tied up with other pressing congressional proposals), but it declined to clear the bill for floor debate and a vote. However, in late January, the Rules Committee took up the bill and quickly approved it. The floor debate and passage of the bill followed a little more than a week later.

Why the sudden breakthrough, 7 years after the idea first came up? None of those connected with the bill claim to know the answer, but two possible causes are often cited. The first is that the new subcommittee chairman, Davis, is politically close to his fellow Southern Democrat William M. Colmer (D–Miss.), who is one of the kingpins of the House and chairman of the key House Rules Committee.

A second explanation is that congressional frustrations in obtaining technical information have mounted rapidly since the Nixon Administration took office and became embroiled in bitter dogfights wtih Congress over the ABM and the SST. Historically, Congress has had virtually no technical expertise among its members or staff. It has had only the General Accounting Office (GAO) and the Library of Congress's Congressional Research Service (CRS) for conducting its own studies. In the past, Capitol Hill has had to rely on the executive agencies for technical information. Furthermore, under the Nixon Administration, the executive agencies are less cooperative in handing out data in answer to congressional requests. This trend is creating pressure within the Congress to set up a technical information service of its own. Hence the sudden popularity of technology assessment.

Whatever their motives, the Members of the House who debated the technology assessment bill were generally rapturous. Richard H. Hanna (D-Calif.) said that the current congressional work load is "so great it would give the Jolly Green Giant a double hernia" and inquired, "Who is in charge?" As politicians will, he answered his own question, saying that the "avalanche" of "so-called progress" created by technology is, "whether we like it or not, who is in charge." John F. Seiberling (D-Ohio) said that without an OTA to aid it, Congress would be threatened by an erosion of its Constitutional authority. Alphonzo Bell (R-Calif.) said that the OTA would have had "an invaluable role" in the ABM and SST debates, and called OTA's assignment a "comprehensive intelligence gathering and early warning system for the Congress." But, reassured Jack Brooks (D-Tex.), Congress is not setting up a batch of scientists to run its business for it. "I am convinced . . . the experts should be on tap, not on top," he said. Finally, mixing his sciences and his metaphors, John B. Anderson (R-Ill.) declared that the future OTA will "crystalize a concept that has long been percolating in this body."

Enthusiasm notwithstanding, the technology assessment bill seems to present problems. First, the well-meaning lawmakers hold widely varying views of what OTA will do. The language of the bill suggests a sort of scientific DEW line, but many Representatives simply see it as another research office.

One camp views OTA's functions as being very grand. OTA will be a "technology-predictive tool," said Thomas M. Pelly (R-Wash.). It will examine, he said, "the effects of the choice of a particular technology at a time when the application of that technology lies in the future, or is still hypothetical." [In fact, the merits of the technology assessment office and its governing board began sounding so fantastic that H. R. Gross (R-Iowa) got fed up and snapped, "Perhaps this Board could give us some advice before we get into another war. . . ."]

At the opposite end of the spectrum John J. Rhodes (R-Ariz.) termed OTA simply "a clearinghouse" and "a purveyor of knowledge which has been gathered by other governmental or non-governmental bodies." Many of the Representatives compared OTA with GAO, but Representative Gross declared. "there is no similarity whatever with the General Accounting Office. . . . "

Technology assessment, like motherhood, is hard to oppose. But there seems to be a plethora of views on what, exactly, it is. Many of the ingenuous lawmakers said that they were looking forward to the "objective" and "impartial" studies that OTA would produce on such complex matters as the SST. But the Davis committee's most recent report, which even attempts some sample technology assessment studies, says impartiality is impossible.

Conducted by the CRS, which has a reputation for milk-toast responses to the issues of the day, the report concludes: "A technology assessment institution . . . cannot exclude all bias. . . . Bias lurks in the basic assumptions, explicit or implicit, in every study. It is found in the omissions and neglected challenges. Selection of factual evidence to present, since no study can accept all evidence, is subject to bias. Sometimes even the order in which the elements of the analysis are presented reveals bias. The author of a technology assessment must not claim, therefore, that his is the last word on the subject. . . ."

There are vast differences, too, on what a technology assessment study should include. The language of the bill calls on OTA to list the "physical, economic, social, and political" effects of a technology. Yet in this February's *Scientific American*, two Cornell scientists, Raymond Bowers and Jeffrey Frey, have published a technology assessment of future microwave devices, in which they specifically disclaim any ability to predict the social impact of widespread use of them.

Many scientists simply believe that these impacts cannot be foreseen, hence to predict such effects is at best a relativistic exercise. Harvey Brooks, Dean of Engineering Sciences and Applied Physics at Harvard, says. "The assessments will be probabilistic. Assessments will identify the issues to be resolved, the pros and cons and alternatives. But if the Congress expects the office to come up with a go or no-go answer, it is totally naive. If they tried to do that, they'd get clobbered. . . . But I think such an office could do a great deal to illuminate the issues." Brooks says he believes an OTA could have helped Congress on the SST dispute.

But a prominent government scientist, who asked not to be identified, takes a more negative view. He does not think that an OTA would have altered the ABM debate very much. "In private industry, the president of a company can make his own evaluation of which product the company should build. . . . But

in government, issues become focused only after millions of dollars have been spent.

"The Congress doesn't have the option of buying various products off the shelf. On issues like the SST—we literally made a decision to go or not to go. There is no room for comparison and alternatives.

"An Office of Technology Assessment will come up with a long list of things we don't know. For politicians opposed to a given project, it will supply grounds for not going ahead. One effect of such an office will be to take more time on big projects."

An even more drastic fear in the scientific community is that technology assessment—in the most rigid sense, that of predicting and then directing technology—could warp the creativity of American R. & D. William O. Baker, who is vice president, research and patents, of Bell Laboratories said in an interview that he feared crude arbitration of technical development by Congress. "Technology assessment can subvert the principles at the very heart of free choice in democracy," he said. "There is no basis or natural concordance between the capability to do science and technology and the public purpose. The efforts of making technology assessments may well destroy the long-range values of the technology itself. When you attempt to prejudge certain alternatives, you thereby bias possible later and realistic choices of action.

"Technological development fluorishes only with a more delicate balance."

The sudden emergence of a real, live technology assessment bill has sparked many emotions—from the fatigue of legislators tired of wheedling facts from executive agencies to the fears of some scientists that Congress may now embark on a clumsy, destructive attempt to manage national R. & D.

The fact is that no one—neither scientists nor lawmakers—has a clear idea of what sort of creature the OTA will be or what it will and will not do. But Congress seems prepared to rush ahead anyway.

Lawmakers Lack a Crystal Ball

Many scientists have doubts as to what, exactly, technology assessment is. But Congress, in recent weeks, has become suddenly enamoured of the idea of setting up an Office for Technology Assessment, to research all kinds of technology-related problems. The preamble to the bill, (H.R. 10243) passed by the House of Representatives on 8 February and now before the Senate, explains why.

"Emergent national problems, physical, biological, and social, are of such a nature and are developing at such an unprecedented rate as to constitute a major threat to the security and general welfare of the United States . . .

"The growth in scale and extent of technological application is a crucial element in such problems and either is or can be a pivotal influence with respect both to their cause and to their solution.

"The present mechanisms of the Congress do not provide the legislative branch with adequate independent and timely information concerning the potential application or impact of such technology, particularly in those instances where the Federal Government may be called on to consider support, management, or regulation of technological applications.

"It is therefore imperative that the Congress equip itself with new and effective means for securing competent, unbiased information concerning the effects, physical, economic, social and political, of the applications of technology, and that such information be utilized whenever appropriate as one element in the legislative assessment of matters pending before the Congress."—D.S.

The Chairman. Senator Allott, we are delighted to have you this morning. You are cosponsor of this bill, and we are glad to hear you in any way you wish to proceed.

STATEMENT OF HON. GORDON ALLOTT, A U.S. SENATOR FROM THE STATE OF COLORADO

Senator Allott. Thank you, Mr. Chairman.

I think I will save time if I read my statement. It is not too long. I think we can thereby avoid repetition.

I am very pleased to have this opportunity to submit to this subcommittee my statement regarding the creation of an Office of Technology Assessment. Since the early days of the 90th Congress, I have been working to bring to the Congress a capacity for making intelligent decisions relating to priorities of scientific endeavor. I believe this measure will help accomplish this goal.

I might add that the creation of this Office within the Congress will also help dispel the suspicion—within and without the Congress—that the Government is operating blindly in an area demanding specialized knowledge.

My original efforts to bring to the Congress this technology assessment capability were directed to the establishment of a Joint Committee on Science and Technology.

I should note at this point that I personally would prefer the creation of such a joint congressional committee over the creation of a separate office.

However, I realize the creation of an independent Office of Technology Assessment will not be subject to the objections prevalent when an effort is made to form a joint congressional committee.

In 1970, when I introduced this bill in the Senate, I had reached the conclusion that the best way to bring this analysis capacity to the Congress was by the creation of an Office of Technology Assessment.

In short, this approach is the most feasible way to fill a void that has for some time existed. You can imagine my gratification when the Senator from North Carolina, in introducing this bill under his auspices, joined in my prior efforts in this area.

This bill will establish an Office of Technology Assessment which is to be within and responsible to the Congress. In this respect, it is similar in structure to the General Accounting Office and the Library of Congress.

The Office will be governed by a Technology Assessment Board; I will touch upon the issue of the makeup of the Board later in my testimony.

The basic responsibilities and duties of this Office, as I envision them, are to provide objective, independent research and analysis to the Congress at the request of congressional committees. A committee request can be generated by the chairman, ranking member, or by majority vote of the committee members. This service will supplement and provide information in the area of research and development so that the Congress can be better informed in its decisionmaking process.

As our scientific capabilities expand, it is becoming increasingly important for us to refine our methods of reviewing our national science effort, and the processes whereby this effort is translated into technological advances.

Technology assessment, the expressed mission of this Office, is an important part of our current science effort, because increasingly, we are experiencing that there is a long leadtime for the conversion of knowledge into technology.

Accordingly, it is increasingly important for the Congress to equip itself for a new and continuing capability for evaluating technology and its uses.

I wish to highlight two areas of authority granted to the Office which I believe are of high import.

First, to avoid the creation of a new and sprawling bureaucracy, I think it is important to stay with the intent of the House-passed bill in requiring that the research projects be contracted out to independent groups.

Second, I believe that the authority to hold hearings and subpena requisite information is of utmost importance to the successful implementation of the mission of the Office.

Now, I would like to touch upon the makeup of the Board of the Office.

After reviewing the floor debate in the House of Representatives which occurred when the other body considered H.R. 10243, the companion bill to S. 2302, I am persuaded that the amendment of Congressman Jack Brooks is a sound one. I would urge that this committee adopt that approach.

As you know, the provision for makeup of the Board, as reported by the House committee provided for 11 members, as follows:

> Two members of the Senate who shall not be members of the same political party, to be appointed by the President pro tempore of the Senate;
>
> Two Members of the House of Representatives who shall not be members of the same political party, to be appointed by the Speaker of the House of Representatives;
>
> The Comptroller General of the United States;
>
> The Director of the Congressional Research Service of the Library of Congress;
>
> Four members from the public appointed by the President, by and with the advice and consent of the Senate, who shall be persons eminent in one or more fields of science or engineering or experienced in the administration of technological activities, or who may be judged qualified on the basis of contributions made to educational or public activities; and
>
> The Director of the Office.

Congressman Brooks' amendment provides for the Board to be made up of five Members of the Senate, appointed by the President pro tempore of the Senate, three from the majority party and two from the minority party and five Members of the House of Representatives appointed by the Speaker of the House of Representatives, three from the majority party and two from the minority party.

Mr. Brooks' amendment which was adopted by the House also weakens the powers of the Director of the Office. In quoting from Mr. Brooks' remarks which appear in the February 8, 1972, Congressional Record on page H 855, he states as follows:

> The amendment will do two other things. It will take away from the director of the office the power to initiate assessments and run the whole business the way he pleases. This director now has subpoena power and the right to call people and set hearings and initiate hearings and report findings.
>
> Instead my amendment provides that the initiation of work will be by the Congressional Committees and the OTA Board.
>
> My theory is simply that experts are to be employed by a committee to give their advice and to listen to it and appreciate it and make the decision yourself.

I think it is justified to assure that an autocratic director cannot thwart the intent of the Congress or become too much of a power in himself.

Because it is essential that this Office be responsive to the needs of the Congress and because a major purpose behind the creation of this Office is to help Congress counterbalance the obvious advantage that the executive branch possesses insofar as expertise available in this area, I believe that Mr. Brooks' amendment in its entirety is a good one.

At this point, I would add, however, that the committee might want to consider establishing some sort of a science advisory board to the Technology Assessment Board. Such an advisory board could be appointed by the President of the United States and provide the congressional Board members with ongoing scientific input. These individuals could possess the same qualities as those stated for the public members of the Board in S. 2302.

The House-passed bill creates this office as one whose primary responsibility is informational. I believe this is a wise charge to the office. However, as the office carries out its evaluation and analysis responsibilities in responding to the requests of the various congressional committees as set forth in the bill, I can envision that information developed by the office could dictate a certain course of action.

So the Board would not be prohibited from making a given recommendation to the Congress, I would hope that this committee would consider a provision which would allow the Office of Technology Assessment to make a specific recommendation to the Congress. I would hope that this committee would consider a provision which would allow the Office of Technology Assessment to make a specific recommendation to the Congress upon a two-thirds vote of the Board.

In other words, if such an overwhelming majority of the Technology Assessment Board were convinced that a certain course of action would be wise and in the best interests of the Nation, the Board should be allowed to make such a recommendation.

Mr. Chairman, I could sit here for hours and relate experiences which I have encountered during my tenure in the Senate which would point to the overwhelming need for the creation of an Office of Technology Assessment—the creation of a capability within the Congress to help us better manage and better use technology.

Rather, let me use a current example: President Nixon has requested an increase of over $1 billion in research spending for fiscal year 1973. If an Office of Technology Assessment had been in existence during the last few years, the Congress would have available to it right now, the kind of analysis with which to adequately review such a request.

In my judgment, the Office of Technology Assessment will not only enable us to spend wisely on behalf of science but convince the public, whose money we are spending, that our spending is done intelligently and conscientiously. The money it will cost to establish and operate an Office of Technology Assessment should be recouped many times over in expenditure savings.

Technology is simply the ability to apply knowledge. Its worth depends on how men handle it. When we learn to understand technology and how to implement it, we will be better equipped to deal with the complex problems of modern society.

I sincerely hope that this committee will act favorably on this bill to assist us—the Congress—in exercising our constitutional responsibility—to rationally set this Nation's priorities in science.

The CHAIRMAN. Thank you very much.

Would you care to make further comments concerning your feelings of the makeup of the Board?

Senator ALLOTT. I have given much thought to this, Mr. Chairman. I suppose the representation I have made in following the Brooks amendment arises out of this thought, that I would like to see the Director of this body not have the power the Comptroller General has. and in the scientific field this board should exist as a body which is responsible in total to Congress and not to the executive.

I am afraid that with the other makeup, it might tend to proliferate itself, expand, become the victim of Parkinson's law.

With the makeup I have proposed here, it seems to me that what we would end up with is a board of ten, which would definitely represent the Congress.

It is true the powers of the Director would be somewhat curtailed, but I am fearful unless Congress exercises this control constantly by its own membership that we will lose the Technology Assessment Board as an instrument of Congress and that it may just become another public entity, going out in all directions on different horses.

This way we initially have complete control of the Director, have a better chance to keep control of the Director, and we have a better chance to keep control of the work of the Board by siphoning it through committees.

The CHAIRMAN. I know you are fully aware that the executive branch now has a great deal of information in many areas which we do not have. We have little or no access to it, and most often we get from them only what they want to give us.

I concur that this should be an agency controlled by the Congress, because it is for our own use. We would set it up. We should control it.

If it is not controlled here, we are liable to find the control somewhere else, and that we do not need. We need to have an organization that works for us on a full-time basis, and supplies the information we need to handle legislation, which is constantly coming before the legislative branch.

Senator ALLOTT. The Senator is entirely correct. I have reviewed the membership of the Senate in my own mind, and I do not believe that there is one of us who could qualify in a scientific field or could claim to be an expert in a single scientific field, at least none come to my mind.

During the course of these years, when I have served now going on 14 years on what used to be the Independent Offices Subcommittee of Appropriations, as the ranking member of that committee, and for 9 years on the Defense committee, in all of these areas, under these two committees, we have had hundreds of scientific witnesses. To use the vernacular, there have been many times when I have not at all been sure whether we were being given a snow job or not.

I think it is important that we have this kind of a board, tied up with responsibility directly to Congress, keeping tight control of it within Congress, and responsible only to Congress, so that when we get in these situations of where expertise, scientific expertise, is needed in one or more of the disclipines, that we have a way of finding out what the facts are so that we are not confused by a lot of high-sounding scientific terms.

The CHAIRMAN. Thank you very much. We appreciate your fine testimony. You have done a lot of work on this, and we are grateful for it.

Next, we have Chairman George Miller, chairman of the House Committee on Science and Astronautics. We would be glad to have a statement from you, sir.

STATEMENT OF HON. GEORGE P. MILLER, A U.S. REPRESENTATIVE FROM THE STATE OF CALIFORNIA, AND CHAIRMAN OF THE HOUSE COMMITTEE ON SCIENCE AND ASTRONAUTICS

Mr. MILLER. Thank you very much, Senator.

I do not have a prepared statement, because the chairman of the Subcommittee on Science, Research and Development, who is sitting right behind me, Judge Davis, will testify.

I merely wanted to come over to indicate our deep concern with this bill and with the matter of setting up the board. We have no place in government in particular available to us in Congress, no one central place, where we can go get the necessary information that will guide us in future technology.

There is meeting today here in Washington an international group that is concerned with many of the vaxatious problems that will confront the country within the next decade or two, population growth, food, energy, et cetera.

We have a Subcommittee on Science, Research, and Development right now looking into the energy problem. I do not know of any other place in the government where this is being done.

Yet, we are confronted with a problem which is of utmost importance to this country. Do we know that by the end of the century there will be sufficient fossil fuels and sufficient sources of electricity to keep the lights burning in this room? That affects us directly.

So I want to thank you, Senator, for holding these hearings. I am very happy to see here former Congressman Daddario, who originally spearheaded this work. He is the former chairman of the Subcommittee on Science, Research, and Development, and we owe him a great debt of gratitude.

I may say, following what Senator Allott had said, this Board will have available to it great sources of information that, for the most part, the Government does not use now.

Seated right behind me is the former president of the Academy of Sciences. Have we used the Academy of Sciences to the best advantage in things that have been developed?

Now, you have a very fine Academy of Engineering, and an Academy of Management; and these are the agencies that can give us information. We use them in our committee by contracting with them. That is one of the reasons that we have had some success in the work that we undertake.

Again, I want to thank you, sir, for the privilege of being here.

I have got to run over to the other side because I have a hearing going on right now.

I commend you and recommend this bill to you.

The CHAIRMAN. Thank you very much. I appreciate your taking time to come over.

Congressman John W. Davis of Georgia.

Mr. Davis, we are glad to have you. Sit down and proceed as you wish, sir.

STATEMENT OF HON. JOHN W. DAVIS, A U.S. REPRESENTATIVE FROM THE STATE OF GEORGIA

Mr. DAVIS. I want to thank you for having us over, and I want to urge your favorable consideration of H.R. 10243.

I think that by this time the concept of technology assessment has been sufficiently explored and developed. It is, I believe, a potential activity which most of us agree is highly necessary. In view of these facts, I will not endeavor to discuss further all of the basic tenets, the background and the work which have gone into the making of this bill.

With your permission, however, Mr. Chairman, I should like to incorporate into the record at this time—by reference—the official activities on the House side relative to the proposed Office of Technology Assessment. I have a file of the documents here, which I would like to leave with you for whatever use you care to make of it.

The CHAIRMAN. They will be included. Thank you very much for bringing them.

(The documents referred to are as follows, and may be found in the files of the subcommittee:)

1. Inquiries, Legislation, Policy Studies re Science and Technology; 2nd Progress Report of the Subcommittee on Science, Research, and Development, 1966.
2. Technology Assessment, A Statement of Emilio Q. Daddario, Chairman, Subcommittee on Science, Research, and Development, July 1967.
3. Technology Assessment Seminar, Proceedings before the Subcommittee on Science, Research, and Development, September 1967.
4. Technical Information for Congress, report to the Subcommittee on Science, Research, and Development from the Science Policy Research Division, Congressional Research Service, April 1969, revised April 1971.
5. Technology: Processes of Assessment and Choice, report of the National Academy of Sciences to the Committee on Science and Astronautics, July 1969.
6. A Study of Technology Assessment, report of the Committee on Public Engineering Policy, National Academy of Enginering, to the Committee on Science and Astronautics, July 1969.
7. Hearings before the Subcommittee on Science, Research, and Development on Technology Assessment, November, December 1969.
8. Hearings before the Subcommittee on Science, Research, and Development re H.R. 17046, March and May 1970. (Field hearings)
9. Hearings before the Subcommittee on Science, Research, and Development re H.R. 17046, May and June 1970.
10. A Technology Assessment System for the Executive Branch, report of the National Academy of Public Administration to the Committee on Science and Astronautics, July 1970.
11. Technology Assessment, Annotated Bibliography, report prepared for the Subcommittee on Science, Research, and Development, July 1970.
12. House Report 91-1437 to accompany H.R. 18469, Establishing the Office of Technology Assessment, September 9, 1970.
13. House Report 92-469 to accompany H.R. 10243, Establishing the Office of Technology Assessment, August 16, 1971.

Mr. DAVIS. Mr. Chairman, I would like to now spend a moment commenting on the bill as it passed the House and is now before you.

As I have indicated, and as you are well aware, our committee spent more than 5 years in developing the technology assessment concept

for Congress and in drafting, considering, reporting and passing this bill through the House.

As you are also aware, the House made several amendments on the floor. In brief, the amendments made the following changes:

(1) The form of the Technology Assessment Board, which was designated to develop and promulgate the policies of the proposed office, was completely altered. Our committee version had included on the Board four Members of the Congress, two each from the House and Senate, four members from the public who are especially qualified to serve, the Comptroller General of the United States, the Director of the Congressional Research Service, and the Director of the Office of Technology Assessment itself.

The amendment offered on the floor of the House did away with this form of the Board and substituted 10 Members of Congress, five from each body, in what is in effect a joint committee, since the majority party would always control and would have the chairmanship and vice chairmanship of the Board.

(2) The authority of the director of the office to initiate assessments was eliminated so that assessments could be undertaken only at the instigation of the committees of Congress or of the Board itself.

(3) The subpena power of the office, which was designed to make sure that all necessary information would be available to the office on those rare occasions when it was not freely offered, was eliminated.

(4) The authority of the office to hire personnel in "excepted positions" which had been placed in the act to assure that the office would have the ability to get the kind of people it needs, also was eliminated.

Turning first to the makeup of the Board, please note that the Board has no powers of any kind which would affect congressional processes. It does not even have powers of recommendation. Its purpose is to provide the Congress with a kind of comprehensive, evaluated information which it presently does not have.

Since this is the case, those arguments which are made for majority rule in the makeup of the Board, based on an assumption of majority responsibility, are not convincing to us. In the view of the Committee on Science and Astronautics, it is more desirable that there be parity of congressional membership.

Obviously, we believe that the composition of the Board as it was designed and reported by the committee is desirable and workable. If, however, this committee concludes that the Board should consist solely of Members of Congress, then we urge that there be an equal number of Members from both Houses and from both parties.

In the latter event, we would suggest eight members—four from the Senate to be appointed by the President pro tempore, and four from the House to be appointed by the Speaker.

If it is concluded that the Board should be composed exclusively of Members of Congress, then I would also strongly recommend that the Director of the Office be returned to the Board, at least as a nonvoting member.

My thinking on that, Mr. Chairman, is that it is highly important in the affairs of protocol affecting other agencies and branches of government that the Director of the Board be given as much prestige as possible; that he have as much standing as possible; and I think if he

were made a nonvoting member of the Board, it would add greatly to the weight to be given to the work of such a Board.

This would appear clearly necessary; otherwise, the liaison between the policymaking Board and its operational arm under the director, could be severely weakened.

Insofar as choosing a chairman and vice chairman may be concerned, we believe that there would be little more difficulty under the arrangement I have suggested than there would be under the usual joint committee system. I feel certain that adequate agreement among the Board members could be reached on these selections with some reasonable mode of rotation included if the Board so desires.

With regard to input from the public, our studies convince us that there must be close participation by appropriate segments of the public in the operations of the Board. Not only is this essential from the standpoint of creating an attitude of public trust where the Office is concerned, but it is also important in view of the fact that few Members of Congress have the variety of background and expertise which will be needed for the formulation of effective policies.

We would therefore recommend, in the event that no public members are included on the Board itself, that an advisory council containing public members be set up to assist the Board.

There are many ways in which such a group might be organized and function. I believe that a workable arrangement would go something like this—that the advisory council consist of 10 members, eight of whom could be drawn from the public, the other two being the Comptroller General and the Director of the Congressional Research Service, ex officio.

Four of the public members might be appointed by the President pro tempore of the Senate and four by the Speaker of the House, possibly on the basis of recommendations submitted to them by the Board.

We would suggest that the Board establish some form of rotation in office for the public members and that the Board also have the authority and latitude to fix the duties of the council as it sees fit.

We would suggest that no ex officio member of the council become its chairman, since the chief reason for the council is to secure adequate liaison with nongovernmental sources of talent. On the other hand, we believe the ex officio members are necessary inasmuch as the bill provides that both the GAO and the Library supply supporting services to the Office of Technology Assessment.

Finally, let me conclude with an observation on what we believe to be a most important matter. This is, in fact, a plea that the authority and powers of the Director of the Office not be watered down.

The Director is the chief executive official of the Office, and whether or not the proposed OTA operates usefully depends on him to a very great extent. And, at this point, let me add parenthetically that regardless of the Director's statutory authority, it is exceedingly important that the Board take great care in making his selection.

There are two immediate reasons why the Director must retain the authority he now has in the bill and why he should, we think, be returned as an ex officio member of the Board as well as have his powers of inaugurating assessments restored.

The first reason is that if the Board is composed exclusively of Members of Congress, the individuals comprising it will probably not have the necessary time to give to act as an effective unit. We all know how difficult it is to assemble the membership of a joint committee. It is almost impossible to get them all together, and rarely is it possible to secure anything close to a majority.

Hence, if the basic powers now vested in the Director are removed from him and placed in the Board, the consequences are readily discernible—the whole operation would probably devolve upon an already over-committed chairman or else demand an unrealistic number of Board meetings. In my opinion, such a situation is highly undesirable.

My personal feeling is that I would like to see a board created which is a working board. The bill provides that the Board prepare an annual report on its activities. I think the effect of that annual report is one of the most important things about this piece of legislation, inasmuch as the report could be widely disseminated, and its results become of benefit to a constituency far wider than this Congress.

The second reason is that if the Office of Technology Assessment is to be truly a new arm for the Congress, then its chief executive must have the power to conduct his business—always, of course, within the limitations of the policies and decisions imposed by the Board. But such an executive official should not be merely in the role of staff director to a joint committee.

He should have the stature and freedom to administer his organization in the same way that the Comptroller General and the Librarian of Congress are now authorized to operate.

In view of the fact that the OTA would be a service adjunct to the Congress and to the Congress only, we can visualize no acceptable alternative to this mode of operation.

In any event, the Director is subject to the will of the Board, which can remove him at any time that it considers he is not doing the job it wants.

Thank you very much, Mr. Chairman.

The CHAIRMAN. Thank you very much.

As you well know, the Comptroller General and the Librarian of Congress are included in this bill to assist the Office with its duties. This is very, very wise. The Library of Congress, in particular, has been about the only source we have had to go to for answers to a great many questions that we have had in the past, and they have done a magnificent job with it.

Mr. DAVIS. They certainly have.

The CHAIRMAN. So we are pleased to include them in the bill, as well as the Comptroller General's Office. They, of course, do come directly under the Congress, so we are not losing control by bringing them in.

Mr. DAVIS. That is right.

The CHAIRMAN. We are glad to hear your recommendations, and appreciate your being with us.

Mr. DAVIS. Thank you very much.

The CHAIRMAN. Thank you very much.

Senator Griffin was here, but he had to leave.

Congressman Brooks, we are glad to have you.

STATEMENT OF HON. JACK BROOKS, A U.S. REPRESENTATIVE FROM THE STATE OF TEXAS, AND CHAIRMAN OF THE JOINT COMMITTEE ON CONGRESSIONAL OPERATIONS

Mr. BROOKS. Thank you. You are very gracious.

May I say, Mr. Chairman, whatever success we had in the House in amending the legislation to provide for the Congress of the United States to make up the Board and control and operate this potential facility for Congress is due largely to your own fine comments in the Senate, which I quoted from extensively in the House when you pointed out that the Congress needs to have an independent assessment of scientific effects.

We do not need to have some organization tell us what the industry wants us to know or what the Defense Department wants us to know. We need to have an independent agency that is responsible to Congress, not to some other organization.

I thought your comments were very well stated in the Senate, and put more graciously, perhaps, than that; I quoted them directly in the House, and that is probably why they were more effective, Senator.

The CHAIRMAN. Thank you very much.

Mr. BROOKS. Basically, I would like, if I might, to revise and extend my remarks, and submit a statement. The first couple of pages are background on information requirements for Congress, and then concisely go to the particular facility, which is the creation of an Office of Technology Assessment.

I just want to say that technology assessment is a developing art, not a science, and it relies on a number of scientific disciplines and specialties which are themselves in varying stages of development.

If this technique is going to prove its worth to the Congress, the Office of Technology Assessment must be given close and continued supervision.

Its functions must be clearly and carefully defined. Its limitations must be widely understood.

Technology assessment can narrow the range of uncertainties in determining programs with high technological content. But even fully developed it will permit only statements of likely consequences, not certainties.

Technology assessment, through rigorous and systematic analysis, can aid us in evaluating alternative courses of action advocated by competing interests. It cannot replace—or appear to replace—the legislative process in deciding between such interests.

Establishment of an Office of Technology Assessment, its administration, its choice of policy problems or programs for assessment, its method of organizing the necessary research and presenting findings—all must be under the direction of Members of Congress and subject to orderly congressional procedures. Specifically, I do not believe that Members of Congress are incompetent to administer functions and programs. I do not think we are all scientists and we should go out and do the technical work ourselves. But I do think that Members of Congress, House and Senate, are fully competent to employ people and direct what they should and ought to do for the Congress of the United States.

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I do not think we ought to employ people to tell us what we must do and determine what our policies ought to be. They were not elected for that purpose.

I think we make a serious error when we turn over unlimited authority to any director of an agency like this, a director who might recommend programs and determine and begin programs and assessment, not just recommend them to the Board or to the members of the committee, but authorize and begin them on his own. I do not know who would employ the 50 to 100 people. I assume he would.

I think we can get into trouble, delegating this kind of authority.

I think Congress must have complete control, through an all-congressional board or committee, over the activities and reports from the Office of Technology Assessment.

I was delighted to learn, as I came in, that Senators Allott and Kennedy had both seemed to indicate some support for congressional control of this type of an organization.

The CHAIRMAN. May I interrupt at this point?

Mr. BROOKS. Yes, sir.

The CHAIRMAN. I would like to say that we are in a better position to know what we need than any outside agency. We know what we have to have on a day-to-day basis.

As you well know, there is legislation pending before us now carried over from last year. You have the same thing.

We know there are many things concerning which we need the answers in order that we can develop the proper legislation to fit our needs.

Mr. BROOKS. Senator, that is exactly what I agree with. I think that Congress itself, the Senate and the House, best know what they need to determine, and they can ask people. I am not ashamed to ask my staff to do something and tell them what they ought to be doing. If you have a real difference with your staff, you can eliminate the staff.

If you are not successful in those judgments, you will get beat and I will get defeated.

But as long as we get elected, I think we must exercise that judgment and not have a staff member telling us what we need to do. I did not seek election to work for them. I respect their judgment and their expertise and their help and their loyalty. But they just did not get elected to tell me what to do.

The CHAIRMAN. I agree with you on that.

Mr. BROOKS. I think Congress does know what they need to find out, and we can direct that kind of a staff.

The CHAIRMAN. Fine.

Mr. BROOKS. If I could add one more paragraph.

The CHAIRMAN. Certainly. I did not mean to interrupt you.

Mr. BROOKS. The makeup of the Board or Committee must reflect the majority and minority compositions. Those with the responsibility need to have the authority to act.

I never object, as a Democrat, to being responsible for what goes on if they will give me the the authority to act. When the Republicans control the Congress, then they can have a majority of every committee, and I think it is fitting and proper that when you have a majority, you have the control. Then they can blame the majority if it is not correct, if it is not done accurately and done in accordance with what the public wants.

The OTA director and all other staff members must be under the control of the Board or Committee. Congress can not allow any staff member to initiate activities or to be beyond congressional authority.

The Board or Committee could appoint an advisory group which, upon request, can provide technical assistance as necessary. This group, which could include public members, should report to the Board or Committee. Funds could be provided to allow for per diem payments to advisory-group members within the limits of Federal consulting fee regulations. It could be a high-level appointment. They could be people with great talent, and if they are interested in helping the Government, in contributing in this fashion, they could make such a contribution.

But set up, apart from the congressional process, working in opposition to the committees of Congress, an Office of Technology Assessment could delay or jeopardize the improvement in information resources intended under the 1970 act.

Properly established and directed, an Office of Technology Assessment, both responsible and responsive to the Congress, can contribute substantially to the strength and vitality of our National Legislature.

I want to thank you again, Senator, and your committee for your gracious reception and my opportunity to testify before you.

The CHAIRMAN. I appreciate very much your being here. You have spent an awful lot of time on this piece of legislation, and your remarks are most timely.

Thank you very much for being here.

I do not have any questions at this time.

We will probably call on you for some more answers a little later when we take the bill up in the committee.

Mr. BROOKS. I will be glad to cooperate in any way I can.

(The formal statement of Congressman Brooks follows:)

STATEMENT OF HON. JACK BROOKS, A U.S. REPRESENTATIVE FROM THE STATE OF TEXAS, AND CHAIRMAN OF THE JOINT COMMITTEE ON CONGRESSIONAL OPERATIONS

We are all acutely aware that Congress does not command the information resources—the analytical "power" independent of the Executive Branch—it should have.

This is recognized throughout the 1970 Legislative Reorganization Act, which envisions more intensive program review and more extensive fiscal control, authorizes additional staff, and directs congressional agencies to provide research support consistent with these aims.

But such measures can contribute significantly only if they are effectively employed. We do not need *more* information. As congressmen, we are surrounded by words, by unrelated facts and figures, and—all too often—by diverse opinions on what constitutes "scientific" evidence.

To carry out the intent of the 1970 Act, we must develop techniques and mechanism to sift and refine information so that it fits patterns of congressional use. This will require—

First, identification of new sources of knowledge, research techniques, and information processing methods applicable to congressional needs for policy analysis and program evaluation.

Second, participation in the design of Executive Branch fiscal, budgetary, and program-related information systems—along with ready access to the data they contain—to insure that such systems supplement but do not supplant congressional policy-making.

Third, evaluation of existing congressional practices and institutional arrangements which may not permit maximum possible use of organized intelligence in legislative and budgetary review.

In this context, the objectives of proposals for an Office of Technology Assessment are certainly desirable: To help us identify in advance the *probable* im-

pacts—including side effects—of technology on the natural and social environments.

These objectives will not be achieved easily or quickly.

As presently conceived—in H.R. 10243 as amended—the Office of Technology Assessment represents a significant departure from past practice. It does not simply create another congressional research agency, where the methods of study are well defined. It is not another auditing service, following well-established accounting methods.

Technology assessment is a new research technique—a developing art, not a science. It relies on a number of scientific disciplines and specialities which are themselves in varying stages of development.

If this technique is to prove its worth within the Legislative Branch, the Office of Technology Assessment must be given close and continuing supervision.

Its functions must be clearly and carefully defined.

Its limitations must be widely understood.

Technology assessment can narrow the range of uncertainties in determining programs with high technological content. But even fully developed it will permit only statements of likely consequences, not certainties.

Technology assessment, through rigorous and systematic analysis, can aid us in evaluating alternative courses of action advocated by competing interests. It cannot replace—or appear to replace—the legislative process in deciding between such interests.

Establishment of an Office of Technology Assessment, its administration, its choice of policy problems or programs for assessment, its method of organizing the necessary research and presenting findings—all must be under the direction of Members of Congress and subject to orderly congressional procedures. Specifically—

Congress must have complete control—through an all-congressional Board or Committee—over the activities and reports from the Office of Technology Assessment.

The make-up of the Board or Committee must reflect the majority and minority compositions. Those with the responsibility need to have the authority to act.

The OTA Director and all other staff members must be under the control of the Board or Committee. Congress cannot allow any staff member to initiate activities or to be beyond congressional authority.

The Board or Committee could appoint an Advisory Group which, upon request, can provide technical assistance as necessary. This group, which could include public members, should report to the Board or Committee. Funds could be provided to allow for per diem payments to Advisory Group members within the limits of Federal consulting fee regulations.

Set up apart from the Congressional process—and, possibly, working in opposition to the committees of Congress—an Office of Technology Assessment could delay or jeopardize the improvement in information resources intended under the 1970 Act.

Properly established and directed, an Office of Technology Assessment—both responsible and responsive to the Congress—can contribute substantially to the strength and vitality of our National Legislature.

The CHAIRMAN. Congressman Mosher. You may proceed in any way you wish.

STATEMENT OF HON. CHARLES A. MOSHER, A U.S. REPRESENTATIVE FROM THE STATE OF OHIO

Mr. MOSHER. Mr. Chairman, I am appearing here as the ranking minority member of the House Science and Astronautics Committee.

First, I want to emphasize the very strong bi-partisan support that this legislation has had in the House. It was my privilege back in 1970 to join with former Congressman Daddario in co-sponsoring the original bill in the House, which is essentially the same legislation that we have before us today.

Our bill has had unanimous support, both in the subcommittee and in the full Committee on Science and Astronautics in the House. I want to reinforce the appearance of Senator Allott here earlier to indicate the bi-partisan nature of this support in the House.

The CHAIRMAN. I can assure you the same thing prevails here. For example, when we established the Subcommittee on Computer Services under the Committee on Rules and Administration, we appointed two Democrats and one Republican. We work together with no problem whatsoever.

Mr. MOSHER. Second, Mr. Chairman, I want to very strongly agree with the gentleman from Georgia, Congressman Davis. In his concept of a very competent advisory board, to aid and support the board that will control the Office of Technology Assessment, I hope that the Senate will incorporate in its legislation some sort of advisory board as defined by Congressman Davis.

I fully agree with Congressman Brooks that Congress should and must have complete control of this new arm of the Congress, the new Office of Technology Assessment.

Yet, I am a little bit unhappy about the board as it came out of the House by amendment on the floor. Without the advice of a group of very competent people experienced in science and technology and particularly the management of modern technology, I think the board is inadequate. So I hope that we will add that device in your legislation.

I feel that as the House approved the bill, the board would be hardly more than a joint congressional committee, and I think we need more than that.

Moreover, I would prefer a congressional board where both of the parties were equally represented, as suggested by Mr. Davis. I think both Mr. Davis and I speak for both sides of the House Science and Astronautics Committee in making that point.

Finally, Mr. Chairman, may I express the hope that the tone of the Senate report and debate on this subject will accentuate the positive. I am a little bit concerned about some of the debate in the House and some of the public discussion of this office indicating an assumption that its role will be largely negative, that it will be a bulwark against the development of technology.

I do not conceive of this new office as being anything which would enshrine negative thinking.

In my prepared comments, and I will not read them——

The CHAIRMAN. It will be included in the record in its entirety.

Mr. MOSHER. I use the phrase in my prepared statement of "technology arrestment." I want it to be understood that this is a Technology Assessment Board and not a technology arrestment board.

We all know of course that any new ideas can be analyzed to death, but I do not conceive of this new office as having that role.

I think more of it as being an office that will alert us to new opportunities in technology that will point the way for Congress in making advancement of technology rather than devoting all the time to being a bulwark against progress.

Mr. Chairman, those are the three points that I want to make primarily and I will appreciate your willingness to accept my brief prepared comments.

The CHAIRMAN. We are delighted to have your remarks. They will be most helpful.

I know you have spent a lot of time on this, too. We certainly will be calling on you again, I am sure, before we get a bill that is satisfactory to both sides.

Thank you for being with us today.

(The formal statement of Congressman Mosher follows:)

STATEMENT OF HON. CHARLES MOSHER, A U.S. REPRESENTATIVE FROM THE STATE OF OHIO

Mr. Chairman: I join in strong support of the bill before your Committee to establish an Office of Technology Assessment. It is my privilege to appear with the other members of the House Science and Astronautics Committee here this morning in emphasizing our support for the bill.

I point out that this bill to create an Office of Technology Assessment has received as extensive and thorough a review as virtually any other issue ever to come before our Committee. The original work in fact, dates back to over five years ago when Congressman Emilio Daddario introduced the first bill. As one of the most active members on the Subcommittee which had responsibility for this legislation, I have a great personal interest in the bill and would like to add my wholehearted backing to the Senate companion bill.

I also emphasize, Mr. Chairman, that H.R. 10243 has received strong bipartisan support both in the Science Committee and in the full House. The bill was reported out of the full Science Committee by a unanimous vote on July 22, 1971. Three weeks ago on February 8, 1972, the bill passed the House by a margin of more than two to one.

I hasten to add, however, that our original bill was recast to a certain extent by amendments offered during debate on the House Floor. I would like to discuss briefly two of those changes. One pertains to the makeup of the Technology Assessment Board, the policymaking arm of the Office. As Mr. Davis discussed, the Board was altered by a floor amendment so as to be composed exclusively of Senate and House Members. I feel the concept behind this change was sound as it attempted to insure the responsiveness of the Office to the Congress. But I feel that if the Board is to be made up of Members only there should be parity in the Board membership in order to avoid a Joint Committee type of operation. I also second Mr. Davis' recommendation that the Director of the Office be returned as a member of the Board.

The second change which I will touch on concerns the authority and powers of the Director. Here again I concur with Mr. Davis' testimony as he outlined both the background on the issue and the reasons compelling strengthening the role of the Director. I ask your consideration in reviewing this matter and in returning adequate power and authority to the Director's function.

Finally, Mr. Chairman, I would like to voice my concern with the rather widespread misunderstanding concerning the role of the Office of Technology Assessment. Apparently, many individuals and organizations prominent in the scientific community are skeptical about the direction in which technology assessment is headed. As an example, the National Patent Council went so far as to state that the mandate of the Office of Technology Assessment would be to enshrine negative thinking. The Council further added that most businessmen will automatically find technology assessment limiting to innovative actions.

I am distressed to learn that this erroneous impression appears to be quite widespread. What this negativism means to me is that there has not been satisfactory explanation given to the role and duties of the new Office. Needless to say, I feel it is incumbent upon the Congress to dispel this kind of misleading and inappropriate commentary. If you would permit me, Mr. Chairman, I would like to recommend that both the spirit and substance of the Senate report on this bill, as well as the Senate debate on the Floor emphasize the positive aspects of the Office of Technology Assessment.

Clearly, one of the more important functions of this new Office will be to identify problems amenable to a technological solution. I anticipate these will be problems in the fields of housing, environment, transportation, and agriculture—problems of immediate concern to society as a whole. This Office in effect will be charged with insuring that this country obtains the full benefits of its

investment in research and development and that the complete inventory of our technology be turned to the total use of the public sector. We are not talking about technology arrestment; indeed, we are talking about an even fuller application of existing and emerging technologies so as to provide the maximum benefit to society.

Mr. Chairman, I feel that I can speak for the other members of the Science and Astronautics Committee when I say that we are highly optimistic about the role of this new arm of the Congress. We therefore look forward to prompt action on the part of your committee in order to permit final realization of this goal.

I thank you for this opportunity to appear before you.

The CHAIRMAN. Congressman Symington, you may proceed as you wish.

STATEMENT OF HON. JAMES W. SYMINGTON, A U.S. REPRESENTATIVE FROM THE STATE OF MISSOURI

Mr. SYMINGTON. Mr. Chairman, I want to thank you very much for this opportunity to appear before you and lend my support to the bill you are considering.

I cannot refrain at the outset from expressing the honor I feel and pleasure in the company of my old subcommittee chairman, Mr. Daddario of Connecticut, who did so much to bring this worthwhile legislation into focus and to your attention. He was the one I think who established the fact that the Congress still operates in the quill pen and roll-top desk era, while the rest of the Government is moving ahead with the kind of resources this bill would give us.

As you know, this bill is the result of considerable work on the part of the Committee on Science and Astronautics of the House—and, more particularly, the Subcommittee on Science, Research, and Development on which I serve.

I will not comment on the changes which were made on the floor of the House, since you are well aware of these, and they have already been discussed in some detail. I would, however, express the hope that your committee will report the bill favorably with a minimum of substantive change.

Mr. Chairman, I would like to direct the committee's attention to two points.

The first of these concerns the qualifications of the Director of the Office of Technology Assessment. It is clear that the proposed Office will need a chief executive of unusual talent and managerial ability. The necessary insights and the capability of handling complex situations—not only in their technological sense, but in their political, economic and administrative contexts—will not be easy to find within the experience of one man. Nevertheless, this is what the job will require and I suspect that the task of the Board in recruiting such a person will be a difficult one.

I would suggest, therefore, that the status of the Director, as spelled out in the bill, should be as high as the congressional process will allow. To me, it would be a very serious mistake to weaken the Director's authority as it now stands. It would, in my opinion, be equally shortsighted to deprive him of the stature inherent in a fixed tenure and a statutory salary level.

Does this make him a czar? If so, he would be a czar on pretty short tether, because he is the creature of the Board and the Congress, whose

Members now would comprise the Board, and should he fail to meet the test, they can remove him at any time.

I think that any diminution of the duties, powers, and administrative authority of the Director will serve to frustrate the effort to find one with the ability to make the technology assessment concept work. For the same reasons, I would also urge that the authority of the Director to originate assessments, along with the Board and the committees of Congress, be restored.

I understand in this connection that Senator Kennedy did not complete his entire statement, but a paragraph in the middle of page 3 reads as follows:

> I am opposed to the amendment which downgrades the status of the director of the office. This function will require the highest level of professional background and leadership. In order to attract and retain the kind of talent which is needed, the director should have the option to initiate some assessments at his own discretion, in addition to doing so at the request of Congressional committees.

I do not share myself the view that Congress is capable of running an office of this kind. It is capable of creating one, just as it has created a number of other independent agencies to serve it, but it looks for good men in whom it can repose its trust.

My second point is a corollary of the first. The other side of the coin of competent directorship is the need to secure first class assistance, liaison, and cooperation with the outside institutions providing the actual assessment work.

Contrary to the impressions of many people, it is not always easy to get the best qualified people, company, or university, to undertake a Federal job. They must first have a high regard for the Government agency which wants to do business with them and considerable trust in the personnel and methods of that agency. The need here is for an administrator of consumate skill in dealing with the whole community of science and technology—one who, because of these skills, is able to secure the services of those who really have the most to offer. The relevance of this observation will be apparent when it comes time to put together truly first-rate, efficient, ad hoc groups for the purpose of doing assessments for the Office. The success of the new Office of Technology Assessment, I submit, will be in direct proportion to the reputation the Office acquires and that, in turn, will to a considerable extent depend on the stature of the Director.

Again I would depart from my prepared statement to express my view that it would be unfortunate for the country, and the scientific community in particular, to think that we had a "democratic" technology assessment director or a "republican" one. Regardless of his past politics, he becomes a nonpartisan director, as I would hope would be the board which appoints him or at least bipartisan.

Finally, Mr. Chairman, may I suggest that the points here raised are particularly meaningful for the early years of the existence of the Office. These are the formative years; they comprise the period during which the administration of the Office will be most difficult and when the limitations of money and facilities are likely to produce the greatest hardships to effective operation. For the foregoing reasons, I hope that this committee will give special attention to its decisions with regard to the directorship of the Office.

Thank you very much, Mr. Chairman.

The CHAIRMAN. Thank you so much. I appreciate all these fine suggestions, and they certainly will be given serious consideration.

We need something very badly that will give us information on problems that we have every day. They are technological in every respect, and we need to know what impact these problems will have on the future. We want to be very careful that we are not out chasing rabbits when we should be bird hunting.

Mr. SYMINGTON. I think the chairman's point is extremely well taken. I believe that the Director of the Technology Assessment Office will find all too soon that he has precious little time to initiate experiments of his own or develop experiments on his own because of the flood of inquiries which he will encounter undoubtedly—and that he will have to deal with as effectively and quickly as possible—from the Congress. I am sure he would realize that his tenure and the effectiveness of his operation will depend on the degree to which he can satisfy the requirements of Congress.

Yet at the same time I think it would be a mistake not to at least give him the option which I am sure he will use with great caution to apply any part of the resources of his office to an effort to seek facts with respect to which the Congress may not yet have expressed its curiosity, but which he as a man, gifted in the field of perspectives in science and technology, may think fit to be explored—in anticipation of likely congressional inquiry.

Again, I do not think he will do this to the jeopardy of his mandate or his job.

The CHAIRMAN. I agree with you on that. With the number of problems that face the Congress now, we must concentrate our efforts on those with the highest priorities. That is the genesis of part of this legislation. We must determine what we need. The committees of the Senate, and I am sure the House, are asking for information from outside sources which could be brought in on contract, and some of that has been done. We feel very great necessity for having this capability available to us without trying to find an agency to do it.

If you keep a tight control, and we would be able to do that, I would have no objection whatsoever to the Director, whoever he might be, coming up with a program that is not directly related to something that we have asked for; however, I think he should come to the committee and say we think this is something that could be used and you should have, and we would like to start to work on it.

As you pointed out, we are going to get enough inquiries from Congressmen themselves to keep them busy for quite a while.

Mr. SYMINGTON. That is true. I do not think the Director should or will be in the business of recommending programs per se, but should be trying to anticipate and report the likely effects of a program contemplated by the Congress, a legislative program of one kind or another. He has the entire, we would trust, academic community of the United States willing and ready to assist him in any inquiry he might put.

The CHAIRMAN. I think you are exactly right. I appreciate very much the fine testimony. Thank you, sir.

Now if I may call my good friend Mr. Daddario.

You did a great job in helping promote this particular piece of legislation. I am happy you are with us today. You may proceed in anyway you wish.

STATEMENT OF EMILIO Q. DADDARIO, SENIOR VICE PRESIDENT, GULF AND WESTERN PRECISION ENGINEERING CO., MANCHESTER, CONN.

Mr. DADDARIO. I am of course pleased to be here and happy for the opportunity to support legislation to establish an Office of Technology Assessment in the Congress.

You are to be highly commended for your leadership and everyone else in the Congress who is supporting this legislation must be grateful to you for moving further ahead toward the development of information capabilities for the Congress which can give it an anticipatory rather than a reactive capability and by so doing fulfilling a requirement which the people of this country desire within the structure of the Congress. The sensitivity to this need as shown by you and others who have sponsored this legislation is of vital importance to the improvement and to the maintenance of the whole democratic process in our society.

The legislation itself can be measured in importance by the impetus it has given, even before its passage, to programs on technology assessment throughout the world in many countries, their universities, and their industries. Many of the universities, both here and abroad use congressional publications, hearings, and reports as the basic textbooks on which those courses are based.

Last fall I gave a course at MIT and one day was called upon by special committee on technology assessment from Japan. That country felt it important enough to send such a group here to interview our people because they recognize the importance of technology assessment in their own society and recognize that the leadership has come from the United States.

The Office of Economic Cooperation and Development, NATO, and many other world wide organizations are seeking to build a technology assessment capability. The important point here is that we should be proud that it is the Congress which has stimulated this activity, and I do think that once the legislation is passed, we will by that mere fact create additional activity which will again inure to the benefit of the Congress and will give it added status because it will have promoted farsighted legislative and governmental activities of such general importance.

Now there has been quite a bit of discussion here this morning about the form in which this legislation should take. When the legislation was proposed in the first instance, it did have bipartisan support both in the House and Senate and it was indicated by all concerned that the legislation was of such a nature that it would be constantly improved throughout the legislative process. The fact that the legislation is still being shaped is of utmost importance for it reflects the thinking of many experienced legislators.

There are only certain elements which in the final analysis must be included. Foremost in importance is that the Congress develop such an information capability to improve its decisionmaking ability. When the Technology Assessment Board is formed it must have a highly competent staff and it must take advantage of assessment capabilities which are being developed and which already exist in some

measure in the Congressional Research Service and in the General Accounting Office.

The executive director must be, as Congressman James Symington pointed out, a man who, as the Technology Assessment Board comes into existence and when there will be just a small amount of money available to him, will be a man of influence in the scientific and technical community. He must be of sufficient stature so that he can call on information which presently exists and provide the Congress in those early years with technological assessments of importance as a base on which future programs may receive support.

I point this out, Mr. Chairman, for however the legislation is finally formed these elements must in some way be included as the legislation reaches its final form.

The last point that I would like to make then is that the Technology Assessment Board is aimed at supplying for the Congress an information producing capability which then must have some public involvement. It must be proven, I believe, to the public at large that it does have an opportunity through this new technology assessment capability to participate early in the development of legislation and in the pursuit of alternative goals of action. By so involving the public at large, we will give them confidence that we are not being controlled by technology, but are the masters of it and of its application. We will give faith to those who expect the Congress to use available technology only after great study and after great attention has been paid to the alternative courses of action. The public is now extremely sensitive to the use of technology and has become somewhat antagonistic to it because it believes we apply our technology haphazardly. Much more will be demanded of government in this area in the future and this legislation will add to the public confidence that we are not only concerned but taking action.

I would hope that as you form the legislation here in the Senate, as you come to grips with the conflicts which we always have with legislation, that it will be kept in the forefront that public participation in some important way, through an advisory mechanism perhaps, is necessary.

I have spoken apart from the text and hope I might have an opportunity to submit it for the record.

The CHAIRMAN. Without objection, it will be included in the record, upon completion, thank you very much.

You spoke of the Japanese. One of the things that we need to do is to try to catch up, in some areas, with the other parts of the world, for example the rapid development in a great many fields by Japanese. Their economy today is largely a product of this technological advance. The same thing is true in Germany. Here we see two defeated nations only 25 years ago, left in shambles, that are now leading contenders for the world marketplace. They have done a great many things with their technologies, and I have a first-hand knowledge of the things that they have done because I have been to both of these countries and done considerable studying of their progress as well as you have.

There is no question in my mind that we are going to have to move our technologies in the same direction more rapidly than we have in the past.

If we are going to keep ahead in the area of technology assessment, and I think it is imperative that we do, the work that you have done and are willing to do is very much appreciated. It is nice to see you again personally.

Mr. DADDARIO. I appreciate that, Senator Jordan. I might add I have no fear about our ability to compete technologically with any other country throughout the world.

We still have the strongest technological and scientific base of any nation on earth. The important point, the imperative question that we should raise for our purposes here is that we develop a capability to use our knowledge in bold and innovative ways and not have it restricted by the pressures of society which because of lack of involvement and understanding prevent us from using what we have available to us in the best possible way. The Technology Assessment Board will help us to do that, and therefore has important implications in advancing our ability to meet international challenges of trade, to raise the level of our economy, and to maintain our standard of living and way of life.

The Technology Board capability moves us down the road to the point where we can overcome some of the handicaps which stand in the path of progress.

The CHAIRMAN. I agree with you thoroughly. I thank you very much for being with us.

Mr. DADDARIO. I appreciate the opportunity, Senator Jordan.

(The formal statement of Mr. Daddario follows:)

STATEMENT OF EMILIO Q. DADDARIO, SENIOR VICE PRESIDENT, GULF AND WESTENR PRECISION ENGINEERING CO., MANCHESTER, CONN.

Mr. Chairman, members of the committee, I am indeed pleased and honored to appear before you today in support of S. 2302, "Technology Assessment Act of 1972." You can judge my gratification from the fact that I proposed in 1967 the orginal bill introducing the concept of Technology Assessment.

It has been said that technology assessment is an idea whose time has come. I believe it is more than that; it is a mechanism for improving decisions that has become essential to efficiency and safety in today's era of technology. It is the institutionalization of a methodology for previewing potential effects of technological developments so that the information generated may increase our ability to forestall the detrimental effects and encourage the beneficial effects of our inventions.

On indication of the need for this ability to assess new developments is the extent to which other nations are moving towards technology assessment.

A number of European countries are considering or instituting mechanisms for evaluating technologies. The United Kingdom has established a program analysis unit in its Ministry of Trade and has also used special commissions to investigate such major developments as a new airport in the London region. West Germany has set up an institute for systems planning and the Bundestag has established a committee to consider impacts of public works developments. Sweden, the Netherlands, Norway, and France also are studying methodologies of technology assessment.

In the Far East, Japan's Ministry of Trade and Information has begun an extensive study of future technological possibilities.

And our neighbor to the north, Canada, is also looking to the future of technological development.

In addition, the multi-national groups NATO and the Organization of Economic Cooperation and Development have been holding meetings on the subject to encourage innovation and exchange of ideas.

At the time I introduced it, the idea of technology assessment was hazy. It was clear that technology was having fundamental impacts on our society, that

technological development was accelerating, and that specific technologies were having unforeseen effects—some beneficial, some detrimental. In many cases these effects could have been anticipated, with great savings in money and grief. Many examples come to mind today: thalidomide, persistent pesticides, cyclomates, the Cross Florida Barge Canal, the SST, to name but a few. In every case better foreknowledge could have prevented unhappiness, wasted money, and disrupted businesses.

The idea behind technology assessment was that some way should be evolved by which new technologies could be evaluated in greater detail before they were developed—some way of going beyond profitability and usefulness to assess long-range implications for public health, the environment, the economy, and other secondary effects. That original bill was introduced to encourage discussion and thinking about this idea and about possible institutional arrangement. The development of the original proposal to the bill before you is worth summarizing, both to indicate its foundations and also because it illustrates the principle of assessment in action.

In 1967 the Subcommittee on Science, Research, and Development—of which I was chairman—of the Committee on Science and Astronautics faced this new idea. What did technology assessment mean? What would the effects be of institutionalizing it? These are the questions which initiate an assessment.

The subcommittee held a seminar, attended mainly by scholars, to discuss the idea. Then the subcommittee commissioned four expert studies: by the Congressional Research Service, the National Academy of Sciences, the National Academy of Engineering, and the National Academy of Public Administration. These analyses were followed by extensive hearings, which resulted in the bills now before you.

This process illustrates the mechanisms for technology assessment provided for in S. 2302. The seminar compares to the Technology Assessment Board, whose job is to identify the problem and decide whether more study is indicated. The four contracted studies compare to the analyses the Office of Technology Assessment will contract. These two steps of identifying and analyzing a problem are the heart of the Technology Assessment Act. They are the preliminaries to the usual Congressional activities of hearings, deliberations, bill writing, debate, and voting. Technology assessment is a process, needed to improve the decision-making capabilities of Congress, by providing it with the best available analyses of the implications of technological-intensive decisions.

The process by which this bill evolved—a process in which I shared for many years, as you know—reveals certain necessary aspects of assessment. The subcommittee, in taking up the idea, found it essential to go outside the governmental community to get ideas, criticisms, and data. This was the seminar. I cannot stress too strongly the need for public representation on the Technology Assessment Board in some way. The public representatives provide new perspectives, and also they return to their everyday jobs aware of these ideas, and they can stimulate more public thinking. When the participants in our technology assessment seminar returned to their jobs and universities, they continued to discuss the ideas they had shared, and they encouraged much work contributing to the development of the present legislation.

At the next step, the committee found the contracted studies invaluable. They provided the best possible expert assessments of the problem and of possible institutional arrangements. It should be clear that this job is an informational one. They did not write the legislation, nor will those task forces contracted by the Office of Technology Assessment. But the studies gave us the data and the concrete proposals which could be used and shaped and discussed as we legislators proceeded to the hearings and to bill writing.

The bill has already been voted on in the House. In the debate there the major arguments were brought out, and the Office of Technology Assessment found widespread favor. I do not want to repeat the many just words spoken in support. But I do want to emphasize three points which my long experience with this issue has led me to believe most important.

First, the Office of Technology Assessment is a tool to improve decisions. It will not make policy; it will be a source of information to the legislators. Foreknowledge is never perfect and cannot prevent all errors, of course. And ultimately many decisions must be made with insufficient data melded with various political considerations. But the cost of the envisaged office—between $5 and $10 million per year, depending on the demands of Congress—is not unreasonable.

This much or more could have been saved if assessments had led Congress to early decisions not to support or to support alternatives of the Cross-Florida Barge Canal (terminated after $50 million was expended); the Everglades Jet Port ($10 million expended); or the SST (nearly $1 billion expended). What grief could have been saved if an assessment had led to improved regulation of drugs in 1960—before thalidomide. I don't want to belabor the point—it is always tempting to indulge in hindsight; but the need is genuine.

Second, I want to make it clear that technology assessment is a positive process. It is not designed to stop technological development. Technology assessment is to preview secondary effects so as to allow us the time and knowledge to anticipate and prevent undesirable effects before they occur. In a few cases this may mean that a technology has to be stopped, but generally it will only mean that certain precautions need be taken. And by preventing undesirable side-effects, we lessen the chances that a backlash against the whole technology will occur, when in fact the technology is beneficial and the undesirable side-effects could be controlled. Furthermore, technology assessment may reveal beneficial uses of technologies which would otherwise have gone unremarked and undeveloped; and in this way it can encourage and stimulate beneficial developments. Thus industry, government, and the public will all benefit from assessment.

Mr. Chairman, I have confidence that this Committee and the Senate will produce a bill which can be made compatible with the House version (H.R. 10243). You have made great progress in bringing the Office of Technology Assessment close to realization and I offer you my heartiest congratulations. There is one major function in the legislation that I consider urgent and critical and which does not appear in the bill as passed by the House. I refer to public participation in the management structure of the OTA.

The root of the need for Technology Assessment is in the public mind—the attitude of skepticism toward applied science—the decline of credibility of all institutions. We are looking to the Congress—the branch of government closest to the people—to restore confidence that society controls technology and not vice versa.

The goal of Technology Assessment is an improved choice for society in the allocation of resources and among alternative paths to national goals. I believe that there must be direct two-way communication between the OTA and leading representatives of the non-government sector in order to (1) make sure that the Board and the OTA Director are cognizant of priorities and opinions in the public mind; and (2) provide outlets for the results of Congressional Technology Assessments into the information channels of the private sector.

I recognize that the Congress is "tuned in" already through its constituencies. In fact this is the strongest point for having an OTA independent of the Executive Branch. You in the Senate and in the House are more responsive to the wants and needs of society than is the Administration. But I insist that the participation of public leaders in the operation of the OTA would do much to strengthen that response, speed the consideration of needed assessments, and improve the implementation of assesment results.

Public education has always been a role for the Congress. A panel of public leaders, advisory in nature to the OTA Board, would assure that the Congress is altered to potential impacting technologies or application projects as early in the game as possible. This is crucial if the assessment process is to match the pace and momentum of decisions as they proceed through the Congress. And of course the public advisory group would carry back a first hand account of what the Congress had done to assure itself that alternatives had been considered and consequences examined.

It is this restoration of confidence in the decision making institutions, including the Congress, that is the most valuable product of Technology Assessment. Therefore I strongly urge you to work out a means of public participation in the OTA format. Recognizing the underlying concept of the debate in the House I believe an advisory panel would fulfill the need I have outlined while still leaving operation control of the office in the hands of an all-Congressional Board.

The CHAIRMAN. Dr. Handler, it is always nice to have an opportunity to visit with you, to discuss some of the things we are both interested in. I do not know anybody more capable and better prepared to discuss this subject than you. We appreciate your being here to present your thoughts on this subject.

STATEMENT OF DR. PHILIP HANDLER, PRESIDENT, NATIONAL ACADEMY OF SCIENCES, WASHINGTON, D.C.

Mr. HANDLER. Thank you, Senator Jordan. I feel very privileged to be here this morning to discuss a bill which, essentially, is concerned with how the Congress shall do its own business.

As a member of the general public, I consider that a high privilege indeed. I would associate myself with the general thrust of the remarks of those who have preceded me this morning and particularly with the elegant statement of Mr. Symington. I agree with his quotation of someone else to the effect that the purpose of this bill is to bring the Congress into the current era, out of the rolltop desk and quill pen days, so that it shall become more fully capable of exercising its responsibilities to the American people.

A very large fraction of all the legislation that comes before the Congress today already relates to management of technology in one way or another. For example, we have a set of regulatory agencies which are asked to safeguard the public against immediately foreseeable, demonstrable, but undesirable consequences of a new technology but these agencies are rarely asked to encourage innovation. The Food and Drug Administration, the EPA, FCC, and FTC are prototypes of such agencies. On the other hand, DOD, AEC, NIH, and NASA are specifically encouraged to foster new technologies as, we hope, will, someday, DOT and HUD.

I would like to associate myself with the remarks of Congressman Mosher, in that I hope that this new Office, when it is brought in to being, will not view itself solely as a policeman, that while it safeguards the interests of the public with respect to technology which might conceivably be harmful, balancing this against those benefits for which it is introduced, the new Office will also indicate where we require new technologies and encourage their development.

Technology assessment is already an ongoing enterprise, although the term is certainly new and the impetus for thinking in this vein we very much owe to Congressman Daddario. Still, technological assessment activities have been going on for quite a long time. In general, these have been conducted either by an agency which was attempting to forward the technology with which it was particularly interested or by some organization in the private sector which, again, had some technology which it chose to forward. On the other hand, other assessments have been made by consumer or environmental groups which were bent on stopping the use of some technology. Unfortunately, rarely do we seem to have an opportunity to get a balanced view of the totality of what a given technology entails for our society.

That is not because of any bias on the part of these various individuals or agencies but rather because it is so very difficult. To think that this new Office would be embarking on a simple enterprise would be terribly misleading. The real problem arises from the fact that technology pervades all of our society and that whereas the immediate consequences may be foreseeable, the second and third order consequences are terribly difficult to foresee when all other aspects of our society are also changing. Who foresaw that the tin can, by liberating women from the thralldom of the kitchen, would so alter our society, or that plant hormones and harvesting machinery while

cheapening the price of cotton, would send large numbers of unprepared blacks into what thus became the ghettos of our large cities? Alternately, who understood that the simple laboratory experiments of some university physicists and chemists would one day permit us to view the President, live, at a dinner in Peking?

At the same time, the pace of human affairs goes on ever more rapidly, or at least it seems to. We have engaged in the process of growth ever since becoming a nation. But we are now on the uprising slope of the exponential curves which describe the use of our natural resources and the natural resources we import from abroad, the amount of food we can produce, but not the amount we do produce, and the extent to which we place into our surroundings pollutants of diverse sorts and seriousness.

The result of that increased pace is that we have less and less time in which to deal with newly recognized problems, before they get out of hand. Therefore, an office devoted to looking well ahead is very badly required by this Nation. The Congress must, every day, deal with the immediacies of life, be they crime, national security, health, unemployment, or whatever. But it is also responsible for our national long-term future. To assure its role in that regard, there is required a reliable source of information, understanding, and advice concerning the impact of current legislative activity on the life of the Nation in years to come.

The Academy—for which I do not speak at the moment, I speak for myself only—has been engaged in doing a limited sort of technological assessment since the time of World War I, when President Wilson issued the Executive order which brought into being the National Research Council which we operate. This activity, however, has largely been at the behest of the executive branch, agency by agency. And again, rarely have these efforts been attempts to see all of the consequences of a given action; even less rarely have we been asked to look at an entire situation and suggest what new technology might be required.

But more recently, the Congress has been turning to us for rather broader questions. We welcome these requests.

For example, the Clean Air Act of 1970 asked that the Secretary of HEW (but now the Environmental Protection Agency) request the Academy to examine whether or not it is technologically feasible for the automobile industry to meet the standards for automobile emissions which that act specified. Dr. Kantrowitz, who is in the room, is a member of that committee.

Congress has included in the Defense Department authorization a request that the Academy examine consequences of the use of defoliating herbicides in Vietnam and report back to the Congress. Even now, in progress through the Congress is a bill which relates to the setting of water quality standards in 1981, which contains a clause that asks us to predict the total national economic, social, and ecological consequences of failure or success in meeting those standards, by the year 1981. Whether our crystal ball will prove up to it is rather another matter. I am not sure anyone has the capability to truly undertake that task.

There is a bill which Senator Kennedy has introduced which asks that we examine all the social, ecological, and economic consequences

of drilling for offshore oil along the eastern seaboard of the United States. And there is a bill which Congressman Brooks has introduced which asks us to maintain continuing surveillance of what may happen to the United States as a result of the continuing introduction of computers into various aspects of our national life.

These are all perfectly legitimate questions, and they require answers; if adequate answers could be made available, the Congress would certainly be in a much better position to perform its legislative work for the Nation.

Accordingly, it is apparent that the Congress itself already senses these requirements for long-term technological assessment without having created an appropriate mechanism for its achievement. In view of these requirements for the Nation at all times, it seems to me not merely a legitimate action, but a highly necessary one that the Office of Technological Assessment be created if the Congress is to function in a matter which is satisfactory to itself. Thus my principal thought this morning is to endorse this bill and its concept, rather than its detail.

I would not presume to speak to the composition of the Board to judge whether that Board is to be a joint committee of the two Houses, or whether it should take the form which was originally proposed. I leave that entirely up to the political wisdom of the Members of the House and Senate.

But if the amendment which Mr. Brooks introduced is accepted, then I think it becomes particularly important that the bill also include, in statutory fashion, a requirement for an advisory council or committee—whatever you may please to call it—advisory to the Board, rather than to the Director, consisting of knowledgeable public figures. Its membership should be based on demonstrated competence, serve for fixed terms and in such fashion as to be relatively independent of the political process.

I would like very strongly to associate myself with the remarks of Congressman Symington with respect to the qualifications and the role of the Director. His statement was so eloquent in that regard, I would not attempt to embellish it further, but simply indicate my own strong feeling that the role of the Director should not be diminished if he is to be able to do for the Office what the Congress would intend in creating that Office. Unfortunately, to remove from that Office all power of initiative would necessarily have such an undesirable effect.

I would think it might be useful to consider also that the Director should serve as a nonvoting member of the Board itself. He should be included in its deliberations, other than when his own position is being discussed, but would not have a vote.

Just a few other small remarks.

I would hope that the language of the bill would be not such as to indicate or suggest that, indefinitely, there would be strong reliance by the Congress on the transfer of funds from some executive agency—the National Science Foundation—as a mechanism for funding the studies which are contemplated in the bill itself. I hope that the Board would be sufficiently well funded that that would not become the only mechanism which is open to it. I remind you of the action which the House Science and Astronautics Committee undertook,

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through its subcommittee which Mr. Daddario chaired, which led to the two reports from our Academy and the NAE on the problems and mechanisms of technological assessment. Those studies were directly funded to the Academy by funds made available by the House committee.

I think we should note, sir, that in the introduction to that report, it is indicated that our committee undertook its tasks reluctantly. When they came to the end of their exercise, they were pleasantly surprised to have completely turned around. Originally highly skeptical of the possibility of technological assessment, they now believe that not only is it feasible, but essential.

I do not think there is any point in my speaking to the matter of the power of subpena, which was removed from the bill, when amended on the floor. I do not know how essential that is to the operation, but feel that that was small loss.

The CHAIRMAN. May I ask you a question at that point? I think you are thoroughly familiar with what would be necessary in this area from your own experience in operating the National Academy of Science. Do you find it necessary to subpena records?

Mr. HANDLER. No, sir.

The CHAIRMAN. You usually get good cooperation from people who have the information?

Mr. HANDLER. We do indeed. Those from whom we require information have complete assurance that any proprietary information will be protected. We have never had a violation of that confidence, so far as I am aware. Our respondents provide the information on request. If you will ask Dr. Kantrowitz (currently on the Committee on Motor Vehicle Emissions which is dealing with the Clean Air Act of 1970 provisions) the same questions, he will, I think, assure you they get most of the information they request from the automobile manufacturers. As far as I can make out, they have been completely forthcoming without any requirement for subpena or use of subpena power.

One could imagine other circumstances perhaps, but by and large I think one can function without it.

The CHAIRMAN. I was glad to have that information, because there has been a little bit of disagreeemnt as to whether we should or should not utilize the subpena powers for the Office of Technology Assessment. We have certain subpena powers anyway, as you know. They have always been adequate so far as I know.

You mentioned the Clean Air Act. I am on the Senate Public Works Committee and helped write that act.

Mr. HANDLER. The intent of the bill is admirable. Whether its achievement was feasible was not known at the time it was drafted.

The CHAIRMAN. The automobile manufacturers have asked for some additional time. Whether it is justified or not, I would not be able to say. The same thing is true with regard to the Clean Water Standards Act of 1971, which I helped write and pass. Some of its provisions are very questionable under specific circumstances and specific areas. That is another good reason why I think this office would be very helpful. It would help guide us before we pass legislation, and set certain constraints and requirements on something which we do sometime with inadequate information.

I have no great fault to find with the legislation which I have participated in.

Mr. HANDLER. I was not taking exception to that legislation.

The CHAIRMAN. I understand that. Additional information could be very helpful to us. I think Congress could require it, and it would remove some of the degree of uncertainty with which we must necessarily function under current circumstances.

When we pass legislation and turn it over to an agency to enforce, we can upset the whole economy of this country. We need to improve on the information we use in our legislative process. To this degree I think the office would be very helpful.

I appreciate your being with us. Come back some time so we can have a further discussion on some more of these things.

Thank you so much for being with us.

Mr. HANDLER. Mr. Chairman, may I, before stepping down, reiterate my appreciation for the opportunity to be here as well as my appreciation to you, Senator Allott, Chairman Miller, and Congressmen Davis, Mosher and all the others who have brought this bill to the Congress. Thank you.

The CHAIRMAN. Dr. Faiman and Mr. Doyle, I believe you are appearing together.

STATEMENT OF ROBERT DOYLE, LEGISLATIVE COUNSEL, NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS; ACCOMPANIED BY DR. ROBERT FAIMAN, VICE PROVOST FOR RESEARCH AND SPECIAL PROGRAMS, UNIVERSITY OF NEW HAMPSHIRE

Mr. DOYLE. I am legislative counsel for the National Society of Professional Engineers, Mr. Chairman. It is a voluntary, nonprofit organization, consisting of nearly 70,000 professional engineers engaged in virtually every aspect of engineering practice.

The spokesman on this legislation for our membership is Dr. Robert Faiman. He is vice provost for research and special programs, University of New Hampshire, a past chairman of our professional engineers in education practice section, and served for a number of years with great distinction on our board of directors. With your leave, he will present our testimony.

The CHAIRMAN. You may proceed as you wish.

Mr. FAIMAN. Thank you, Mr. Chairman. I might indicate that in my former position, dean of engineering, and practicing faculty member in engineering, I had the opportunity to be concerned with and involved in many State, regional and, in fact, national problems involving technological utilization, assessment, and parts of the solution process.

I have been privileged, as Mr. Doyle indicated, to work with the National Society of Professional Engineers in a number of capacities. It is an honor to speak on their behalf today.

I have certain prepared remarks which I will excerpt, if I may, and also depart at a certain point.

The CHAIRMAN. It will be included in the hearing record in its entirety.

Mr. FAIMAN. I will try to keep it brief, since I know your time is passing by.

We feel strongly that the Office of Technology Assessment for the Congress would provide a significant additional resource to aid the Federal legislative process. It could provide more effective utilization by the Congress of the scientific and engineering resources of the United States as a policy research tool for the more intelligent selection of options leading to attainment of national goals and for the protection and promotion of public welfare. But perhaps even more importantly, such an office would represent a philosophical and organizational commitment. Coupled with the resources of the administrative branch, universities, and groups and individuals in the private sector, such commitment may serve to bring to the entire technical-social interreaction problem truly meaningful and acceptable data for the exercise of political and social judgments at the national level.

Since, at least in an idealized context, the profession of engineering is dedicated to serve in the solution of problems, not only in a limited individual technical role, but for the benefit of society in the broadest sense, the concepts embodied in this proposed law are of the deepest importance to us.

The membership of the National Society of Professional Engineers consists of professional engineers engaged in virtually every aspect of engineering practice and administration as well as educational and governmental service. It is organized at the National, State and chapter levels, and represents a concerned and competent group who share a dedication to serve their accepted professional and civic obligations.

Distinguished witnesses who have preceded me this morning have well and clearly established the need for the role of such an office with respect to the Congress. However, in my opening paragraph, I refer to what might be considered a spinoff effect of such an office. This effect, the establishment of meaningful and acceptable data on which the decisionmaking processes of our society could be based, might be its more important long-range contribution. Any one of us in a decisionmaking role, whether administrative or legislative, is regularly—and rightly—constrained and influenced by the opinions, beliefs, and feelings of those with or for whom we work. And it has been both wisely and cynically observed, that the facts of a situation are not what matter: It's what people think they are that is important.

As a society we have not—in the face of the almost seemingly unlimited outpouring of new knowledge and new problems—devised mechanisms for establishing conclusions and facts which a reasonable majority may consider and accept. The identification of potentials for good and bad, weighing the alternative courses of action available following appraisal of scientific, engineering, social, economic, national defense, and moral considerations, is an urgent and critical necessity.

The Office of Technology Assessment, as proposed by the bill under consideration here today, S. 2302, and by H.R. 10243 which passed in the House on February 8, 1972, could well serve as the springboard for the development of this mechanism. It could, as our judicial system does admirably well, entertain competing and oftentimes conflicting points of view, and within the framework of adversary balance, pro-

duce data and information upon which a reasoned and acceptable conclusion may be based. Congressman John W. Davis, in referring to the House approval of H.R. 10243, described the function of the Office of Technology Assessment as "one of setting out channel markers in the legislative waters Congress must sail." I would hope that this Office could achieve such status and repute that its reports and data might well be widely recognized and accepted and form the basis for effective consensus and action in many other public and private sectors.

The Office of Technology Assessment, as an arm of the Congress, which is representative of the totality of public interest, would appear to be the basis for a mechanism which has so far apparently eluded us. I would urge that the potential educational and leadership function of such an office not be underestimated.

Many of the previous remarks have obviously been broader than the specific topic of the proposed legislation. I hope that they have not obscured our full endorsement of the concept that such direct support as the Office of Technology Assessment could provide to the congressional process is, in its own right, of great importance.

I would like to depart from my prepared remarks now, based upon my reaction to earlier testimony, and explain perhaps the basis for some of our earlier concerns. The arguments advanced on the floor of the House by Mr. Brooks and reiterated this morning by that gentleman as well as other witnesses in support of the need for reconstituting the Board are indeed persuasive.

We simply point out our concern for the additional need to insure broad acceptability of the Board's activities, and raise the question, without attempting to provide an answer, whether this corollary benefit could be achieved under the House amendment. It is obvious and appropriate that the Office be truly a creature of, and fully responsive to, the Congress.

The thrust of our concerns as expressed in our earlier testimony is that the broadest credibility of the Office also exist.

I would only urge that a mechanism to assure maximum status and stature be incorporated in the final legislation.

For the same reason, the effective implementation of section 3(F) directing the use of "competent personnel and organizations outside the Office, public or private," we feel, is of paramount importance.

Congressman Symington earlier suggested that validity and integrity of its recommendations will obviously be accepted in direct ratio to the diversity and competence of its inputs.

I express my appreciation, as well as that of the Society, in being able to appear before you this morning.

The CHAIRMAN. I understand you concur in an advisory board outside of the Congress being initiated and brought into being so that we can get wider public acceptance?

Mr. FAIMAN. Public and professional acceptance, I would say.

The CHAIRMAN. I would hope that it would be professional.

Mr. FAIMAN. I did want to make that distinction. We find in attempting to obtain acceptance by the general public of advice and counsel, the degree of scientific integrity of the sources from which that material has arisen becomes a rather critical issue on occasions.

The CHAIRMAN. You are in a position to know, being on research and special programs at New Hampshire University. Much of the in-

formation you develop through your research is not made available readily to agencies of Government and others that should have it.

Mr. FAIMAN. Dr. Handler pointed out that all of us are continually engaged in some variety of technology assessment or utilization. But the spectrum of materials that are available is so broad, so complex, simply the mechanisms that we have at the present time for the advice of the administrative side of this Government or certainly of the Congress is not adequate at the present time.

The CHAIRMAN. Your institution may be engaged in a field of research in an area similar to another institution, but with an entirely different approach. I would think that having access to all of this information, both sides, through this agency, would be most beneficial to the Congress.

Mr. FAIMAN. I would be pleased, and I know my faculty engaged in this kind of activity would be more than pleased, to be available to make contributions to such an evaluation and assessment process, yes.

The CHAIRMAN. Thank you very much. We appreciate that very fine testimony. Do you have something to add?

Mr. DOYLE. No sir.

The CHAIRMAN. You represent a fine group of people who have done a lot to help our country in this area.

(The formal statement of Dr. Faiman follows:)

STATEMENT OF ROBERT N. FAIMAN, P.E., VICE PROVOST FOR RESEARCH AND SPECIAL PROGRAMS, UNIVERSITY OF NEW HAMPSHIRE, AND PAST CHAIRMAN, PROFESSIONAL ENGINEERS IN EDUCATION PRACTICE SECTION, NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, ON BEHALF OF THE NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

It is my pleasure and privilege to speak today on behalf of the National Society of Professional Engineers and for the nearly 70,000 individual members comprising the Society. We thank you for the opportunity to present our views on S–2302.

An Office of Technology Assessment for the Congress would provide a significant additional resource to aid the Federal legislative process. It could provide more effective utilization by the Congress of the scientific and engineering resources of the U.S. as a policy research tool for the more intelligent selection of options leading to attainment of national goals and for the protection and promotion of public welfare. But perhaps even more importantly, such an Office would represent a philosophical and organizational commitment. Coupled with the resources of the administrative branch, universities, and groups and individuals in the private sector, such commitment may serve to bring to the entire technical-social interraction problem truly meaningful and acceptable data for the exercise of political and social judgments at the national level.

Since, at least in an idealized context, the profession of engineering is dedicated to serve in the solution of problems, not only in a limited individual technical role, but for the benefit of society in the broadest sense, the concepts embodied in this proposed law are of the deepest importance to us.

The membership of the National Society of Professional Engineers consists of professional engineers engaged in virtually every aspect of engineering practice and administration as well as educational and governmental service. It is organized at the national, state and chapter levels, and represents a concerned competent group who share a dedication to serve their accepted professional and civic obligations.

The former Chairman of the House Subcommittee on Science, Research and Development, who was instrumental in initially promoting the OTA concept, Emilio Daddario, at an Engineering Foundation Conference in my beautiful state of New Hampshire in 1969, spoke most effectively of the four faces of technology assessment: the physical, economic, social, and ethical. As a professional engineer I could not agree more with these categories—they represent the basic criteria within which the proposed solution to any engineering problem must be

evaluated and judged. But for the individual or even relatively large group of cooperating professionals, irrespective of the level or breadth of their professional expertise, the full spectrum of ramifications or implications may not be clearly or easily visible. We have learned through experience that solution of only a part of a problem may actually make the whole situation worse.

Our society has become so complex and interdependent that some overall process of analysis, judgment, and management of our resources—both physical and intellectual—must be established. It must be recognized, at the same time, that there are obvious dangers inherent in carrying this out. Analysis, judgment, and management processes based on incomplete or biased data and information may foreclose consideration of possible optimum solutions. It may even lead to irrational or arbitrary, perhaps dictatorial, direction or limitation on actions and activity.

In my opening paragraph I referred to what might in one sense be considered a spin-off effect from such an Office. This effect—the establishment of meaningful and acceptable data on which the decision making processes of our society could be based—might be its more important long range contribution. Anyone of us in a decision making role, whether administrative or legislative, is regularly—and rightly—constrained and influenced by the opinions, beliefs, and feelings of those with or for whom we work. And it has been both wisely and cynically observed, that the facts of a situation are not what matter: It's what people think they are that is important.

As a society we have not—in the face of the almost seemingly unlimited outpouring of new knowledge and new problems—devised mechanisms for establishing conclusions and facts which a reasonable majority may consider and accept. The identification of potentials for good and bad, weighing the alternative courses of action available following appraisal of scientific, engineering, social, economic, national defense, and moral considerations, is an urgent and critical necessity.

The Office of Technology Assessment, as proposed by the bill under consideration here today, S–2302, and by HR 10243 which passed in the House on February 8, 1972, could well serve as the springboard for the development of this mechanism. It could, as our judicial system does admirably well, entertain competing and oftentimes conflicting points of view, and within the framework of adversary balance, produce data and information upon which a reasoned and acceptable conclusion may be based. Congressman John W. Davis, in referring to the House approval of HR 10243, described the function of the Office of Technology Assessment as "one of setting out channel markers in the legislative waters Congress must sail". I would hope that this Office could achieve such status and repute that its reports and data might well be widely recognized and accepted and form the basis for effective consensus and action in many other public and private sectors.

The Office of Technology Assessment, as an arm of the Congress, which is representative of the totality of public interest, would appear to be the basis for a mechanism which has so far apparently eluded us. I would urge that the potential educational and leadership function of such an Office not be underestimated.

Many of the previous remarks have obviously been broader than the specific topic of the proposed legislation. I hope that they have not obscured our full endorsement of the concept that such direct support as the Office of Technology Assessment could provide to the Congressional process is in its own right of great importance.

In closing I will briefly refer to the proposed organization and method of operation. In our testimony on H.R. 17046 during 1970 hearings, we expressed some concerns with respect to the makeup and continuity of the Board (Sec. 4) as well as procedures for appointment and accountability of the Director (Sec. 5(a)). Specifically, we suggested that a term of office be specified for the Board's public members in order to deter self-perpetuation and undue political influence; and that the Director be appointed by the President from a slate of acceptable candidates nominated by the Board.

S–2302 provides for term limitation for the public members, but we repeat our concern over Board appointment of the Director. Maximum integrity and effectiveness of the Office must be assured if the Office is to merit the technological-scientific and general community's acceptance; the status and stature of Presidential appointment will aid in this.

For the same reason, the effective implementation of Section 3(f) directing the use of "competent personnel and organizations outside the Office public or private . . . " is of paramount importance. The validity and integrity of its recommendations will obviously be accepted in direct ratio to the diversity and competence of its inputs.

Again, my personal appreciation as well as that of the National Society of Professional Engineers, for this opportunity to appear before this distinguished Committee today. Individually and collectively, through our Society, engineers stand ready to support fully any efforts to more effectively assess and utilize technology for the benefit of us all.

The CHAIRMAN. Next we have Dr. Kantrowitz, director of AVCO Everett Research Laboratory.

STATEMENT OF DR. ARTHUR KANTROWITZ, DIRECTOR, AVCO EVERETT LABORATORY, VICE PRESIDENT AND DIRECTOR, AVCO CORP.

Mr. KANTROWITZ. I am very grateful to have the opportunity to appear here today in support of this important legislation.

I agree that it is a desperately important thing that the Congress acquire better sources of technical advice than have been available to it in the past. I have previously testified before a Subcommittee on Government Research, chaired by Senator Harris on this issue in 1967.

I would like to emphasize this today that the key problem which will have to be faced by such an office is the need to establish the facts in the presence of scientific controversy, that in the important cases that were frequently referred to in consideration of this bill, cases such as the SST and the ABM, the striking thing is that you can get scientific advice which is diametrically opposed, and the major question before the Office of Technological Assessment will be how to find the facts in the presence of vigorous scientific controversy.

What you seek is not simply another vote as to what the facts may be, but a statement of such high presumptive validity that it will provide an important basis for the great policy decisions that the Congress must make.

If the procedures that are adopted by this office are similar to those that have been adopted so frequently in the past, of asking an organization to make a study for you or appointing a scientific committee, I think that there is a grave danger that you will get just another vote, and the importance of that vote might depend on the prestige of the people that are involved.

But it will always be possible for another group to get up an equally prestigious vote on the other side.

I would like to offer a suggestion as to how this office might procede to render a statement of the facts to Congress that would have a higher presumptive validity than the standard procedures.

If issues are not controversial, it is very easy to get at what the facts are, but when the issues are controversial, then the situation is very different.

You will have in every case groups in the Congress on one side and on the other. Take as an example pro or con the SST. If these groups of the Congress are asked to name those scientists who are influential with them, for example, those scientists who led some members to conclude that the SST might increase the incidence of skin cancer.

Those Members of the Congress could appoint a scienist advocate for their side of the story, not for what you should do about it, but just for what the facts are.

Again the people who are pro the SST, for example, could similarly appoint a scientific advocate who would present their side of the story.

If you had two advocates in this way who had the confidence of the groups in the Congress which represent sharply differing points of view, then one could undertake something like a judicial procedure in which these advocates could present their cases and cross-examine each other. They will both be learned experts and their cross-examination of each other could help in providing a source of information which I think would be superior to any study that is conducted in a *nonadversary manner.*

I would suggest that these scientific advocates be heard by a group of scientific judges, people who are used to the role of scientific evidence, but people who have not worked in the field; people who do not have a prejudice about the matter before them. These judges could be chosen by the advocates and the director of OTA.

I think that if we could work out a procedure which is modeled on the judicial procedure for proceeding in the presence of scientific controversy, we would make a great advance over the present advisory committee procedures which, while useful, have frequently not achieved a sufficient presumptive validity to settle the matter and frequently have simply added another vote.

I would like to reiterate again that I think the spirit behind this legislation is something of great importance. I am delighted that it has proceeded this year. I think we all owe Congressman Daddario and others who have pushed this legislation a tremendous debt.

I feel however that we have not yet faced the central issue, as to how we get at the facts in the presence of controversy, and I would urge that we look back to the Anglo-Saxon tradition of how we get at the facts in the presence of controversy.

We have elaborated a judicial procedure which has in many cases acquired sufficient prestige so that it is a respected statement of facts.

I think we have much to learn from that procedure, and I would hope that the issue of facing sharply up to the fact of what you need this agency for is the situation where you have serious controversy; and that a technique by which the Congress can deal in the scientific community will be created.

The CHAIRMAN. Do you think this agency, where you have two conflicting views, could reach agreement and find answers for us?

Mr. KANTROWITZ. You will not always get the advocates to agree, but if the advocates can participate in the selection of judges, then they would be to some extent bound by the decision of those judges.

If the judges are people who are distinguished scientists but have earned their distinction in some other field, so that they know the rules of scientific evidence, then these people could have their day in court so to speak.

They could cross examine each other. They could challenge each other's position, and the judges would thereby become highly skilled in the controversial matters.

I do think that such a procedure—and I am talking now for matters of great importance such as the SST or the ABM—can be a much pref-

erable procedure to one where you get a report that is delivered by any organization, however well intentioned.

The CHAIRMAN. I do not think the SST question will ever be settled anyway. We had so much conflicting testimony on that, involving air pollution, noise, everything you could catalog was brought in on that both pro and con—trying to get the legislation passed or defeated.

Mr. KANTROWITZ. It does seem to me that you would have a very great advantage if you would get the scientific leaders who take one or the other point of view to cross-examine each other in the presence of a scientific body which can really have a better chance of finding the truth in the presence of controversy between very sophisticated advocates.

The CHAIRMAN. It would be very helpful certainly.

I appreciate very much your being with us and giving us that fine testimony.

This completes the witnesses we have for the hearing. If we have other witnesses here, I would be glad to hear them.

This committee will stand adjourned. I want to say again how much I appreciate your being here.

(Thereupon at 12:05 p.m., the hearing was adjourned.)

(Additional letters and statements relating to S. 2302 and H.R. 10243, subsequently received by the committee, are as follows:)

U.S. SENATE,
COMMITTEE ON COMMERCE,
Washington, D.C., March 17, 1972.

HON. B. EVERETT JORDAN,
Chairman, Committee on Rules and Administration,
Washington, D.C.

DEAR MR. CHAIRMAN: I was pleased to learn that your Committee is considering legislation to create an Office of Technology Assessment. Such legislation is clearly needed. I have long had an interest in this area and I would appreciate it if my enclosed statement would be considered by the Committee and made part of the S. 2302 Hearing Record.

Thank you for your consideration.

Sincerely yours,

WARREN G. MAGNUSON, *Chairman.*

STATEMENT OF HON. WARREN G. MAGNUSON, A U.S. SENATOR FROM THE STATE OF WASHINGTON

Mr. CHAIRMAN: I appreciate the opportunity to submit a statement to this Subcommittee regarding the two bills that would establish an Office of Technology Assessment for the Congress and would amend the National Science Foundation Act of 1950. I believe that the problems dealt with by these measures are urgent and I commend the initiative of the distinguished chairman in seeking a prompt and effective legislative remedy.

All of us are aware of the contributions of science and technology to our Nation's manifold needs, giving flower to the dreams, hopes and talents of countless citizens, creating jobs, and providing freedom from hunger, from drudgery of hard labor, from disability and disease. Our spirit of innovation has earned international respect. In all these matters, government has been the handmaiden to advance our powerful technological enterprises, by sponsoring research and development, providing incentives to industry to facilitate beneficial applications and by regulating potentially harmful effects.

These matters have been of deep personal interest for many years. I had the privilege of introducing legislation shortly after World War II that led to the creation of the National Science Foundation. Committees on which I have served have had the responsibility for setting policy and appropriating funds that would strengthen our research capabilities and direct the fruits of scientific discovery to our national security and to the welfare of individual citizens and the Nation as a whole.

In recent years, I have raised questions as to whether the apparatus of government is adequate to our needs in two contrasting situations: in one, new technology was belatedly discovered to have produced unwanted and unexpected consequences of pollution or hazards to health and safety, threats to the quality of life and unwitting inequities in benefits or costs. We also encountered the perplexing situation of scientists, engineers and managerial skills, trained as a public investment by the Federal Government, which are unemployed at the same time we have unsolved problems of urban decay, traffic congestion, rising costs of medical care, environmental degradation, imbalances in energy supply and demand to which these same capabilities might well be deployed.

The bills now before your Subcommittee are essential and timely in strengthening the ability of the Congress to cope with these dilemmas, and I want to lend my support to their enactment. At the same time, I should like to develop a broader perspective as to the problems, to note additional measures, such as I have proposed in other legislation, if we are to make progress in tempering our technological prowess with political wisdom and update our institutions in phase with both technological and social change. Finally, I want to suggest a number of amendments and considerations to the propositions before the Subcommittee that I believe necessary if the Office is to meet Congressional needs.

As to the general problem, preliminary results have recently been made available to me from graduate research studies being undertaken on the interaction of technology and society at the University of Washington under guidance of Dr. Edward Wenk, Jr. who previously served the Congress as its first advisor in science and technology. Their results showed the following.

Technological projects involving heavy public investments were often initiated without a clear statement of goals, without adequate technical information on feasibility, without inquiry as to possible environmental and social impacts, without estimates of external costs and without identifying much less consulting the citizens who might be adversely affected, without considering the interactions between the public and private sectors, in effective and economical delivery of the desired results, without recognition that technological initiatives to serve one goal may inadvertently subvert another statutory goal since there was little policy coordination. They point out that pre-investment studies such as undertaken by the private sector were often not conducted by the government with the necessary breadth, objectivity and promptness that would assist those having to make decisions before engagement in the heat of public debate. Where such studies were completed, they were often lacking in estimates of risks or uncertainties and in formulation of alternatives.

Their study recalled that the Congress has often discovered that new technologies generated self-sustaining interests as a product of the organizing force of the technology, itself, then perpetuating the continuation or expansion of public funding long after the initial objectives were achieved. They also noted that the Congress has responded to the fact that society is no longer willing to accept technological change on the basis that it is always good for you, if the costs exceed the benefits or if the quality and humane content is threatened for present or for future generations. The public increasingly wants access to the facts. Enactment of the National Environmental Policy Act of 1969 is one example of that response, although this measure treats primarily preservation of the physical environment.

Finally, there was evidence that lack of perception of the adverse effects of technology has led to a sharp antagonism toward science and technology that in extreme form has been irrational and would seek to turn technology off. That backlash could be injurious to this country and must be met by positive actions.

This array of problems well reinforces my own impressions as to the problem, from my experience in Congress. In response, I believe we need a powerful new national policy and new institutions. Such a policy must consider the opportunities and gaps in achieving social goals by carefully steering technology so as to minimize adverse consequences. We need coherent policy to guide all of the separate technological initiatives that may unwittingly interfere with, even cancel out, each other. In short, we need a policy for pre-crisis rather than post crisis management of our technology.

To implement such a policy, we need more and better information. To generate such facts, we need to compensate immediately for our underinvestment in research and development focused on civilian problems. We must also seek new incentives whereby the private sector must be called upon to deliver services where the market mechanism is imperfect because the market is diffuse and risks

uncertain. Finally, we need more intimate public participation in this decision making enterprise, particularly at the regional, state and local level, so as to gain a better insight as to what people want and don't want.

To make such a policy work, we will need to help all three branches of government in fulfilling their respective roles. Especially, we need the benefit of strong independent, future-oriented analysis. Not only must we be assisted to look ahead, we need help in looking sideways beyond the normal boundaries of imminent transactions, to identify what indirect effects are generated and on whom,

The Commercial Technology Assessment Act of 1971, S. 1800, that my colleague Senator Hart and I introduced in a start toward meeting the broader challenge I have outlined. The Commerce Committee will begin hearings this session to illuminate the need for national policy and consider additional legislative steps.

There is no basic conflict, however, between the concept of S. 1800 and the legislation you are considering to help the Congress directly, and I do not think you should delay in reinforcing our own fact-probing, objective research arm. With the increasing number and complexity of issues coming before us, we must narrow the range of uncertainties and broaden the range of options. If the proposed Office performs effectively, it would do both.

The bills now before you have several shortcomings in this respect, and I should like to offer the following considerations in whatever bill you report out.

First, I subscribe to the intent of the House bill to place control over this function unequivocally in the hands of Congress. Nevertheless, the original composition of the proposed Technology Assessment Board before the House amended it is preferred—including the heads of the General Accounting Office, Congressional Research Service, the Office of Technology Assessment, and several public members. But I agree that the appointment of the public members by the President critically diluted Congressional control. Public members should be appointed by the Congress. If you choose the alternative of a Board composed only of members of Congress, then I think the Director of the Office of Technology Assessment should be added as a nonvoting member.

Secondly, I want to emphasize the key role of the Director. The Office's performance, validity of its research, candor, imagination in looking ahead critically depend on the talents of the incumbent. Moreover, the Director must have a deep comprehension of the Constitutional functions of the Congress and be sensitive to its style and many pressures from the Executive Branch and elsewhere. We should seek the best possible candidate, and do everything in the charter to facilitate operation free of intimidation. Making that Office strong in no way replaces our legislative processes. On the contrary, its strengths will help us in our own functions to provide a rational underpinning to the decisions we make and reinforce public confidence in these decisions. The House bill seriously waters down the role of the Director, in his not being on the Board, even ex officio, and in his not having authority to inaugurate studies. Perception of these problems must preceed legislative response, among other things, so that research could be undertaken in time to reduce the unknowns before the issue breaks out in debate in the halls of Congress. The Office should not be a fire-alarm system to respond to crisis, and be involved in the pulling and hauling of adversary proceedings. The Director should be less like a staff officer of a Congressional committee and have more the stature, independence and support we have given the heads of GAO and CRS.

Next, we should recall that the process of technology assessment requires a blend of technology with many different values of our pluralistic society. The Office should thus be provided under any circumstances with a statutory advisory board, not for setting policy as required of the TAB, but with a varied composition that would give the Director continuing access to advice from individuals representing different points of view, the social sciences and humanities as well as natural sciences.

Fourth, I want to take note of the expectation that most studies will be performed by the Office on grant or contract, thus picking the best brains all over the country. But I must remind this Subcommittee that the processes of technology assessment are quite new and complex because of their interdisciplinary nature, and that qualified research teams are still limited. Fortunately, the National Science Foundation has begun to support research on assessment methodology and on the processes of interaction of technology with society. I believe that there must be more direct high level support and sustained fund-

ing if the necessary capabilities are to be created outside of government and if the required diversification of subject skills and distribution to meet specialized regional problems are to be realized. I thus strongly support Section 8.

I also support Section 9 concerning an annual report, although I believe that Congress should take additional action requiring that the Office of Science and Technology be strengthened in its assessment function and be required to prepare an annual report of the Federal involvement in technology affairs, to complement the report by the National Science Board on the health of the scientific enterprise.

Finally, I believe that Section 7 on the role of the Library of Congress is too detailed and may raise expectations that cannot be fulfilled without substantial expansion of their staff and funding. While that may be warranted, I believe such actions are beyond the intent of this measure.

Again, may I commend the chairman and Subcommittee for this initiative. It is an important first step if the Congress is to meet the many proposals of the Executive Branch that are sent to the Congress for action as though there were no alternatives, and without supporting documentation as to impacts. This step is in the public interest if we are to steer technology to serve society.

THE LIBRARIAN OF CONGRESS,
Washington, D.C., March 20, 1972.

Hon. B. EVERETT JORDAN,
Chairman, Committee on Rules and Administration,
U.S. Senate, Washington, D.C.

DEAR SENATOR JORDAN: This is in response to your request to submit for the record our current views on the establishment of a technology Assessment Board and Office. As you are aware from my letters to you of August 12, 1970 and September 10, 1971, we support the concept of technology assessment and a strengthened mechanism to increase the informational and analytical resources of the Congress. I noted in my September 10 letter that the provisions of the Legislative Reorganization Act of 1970 afford enhanced opportunities for the Congressional Research Service to work for the Congress toward a more extensive role in the function of technology assessment than is assigned to it under that bill. However, we of course recognize that this is a matter for Congressional determination.

I would like to comment on one aspect of the bill, S. 2302, under consideration before your Committee. Section 7 of that bill is the same as Section 7 in H.R. 10243 which was passed by the House. As presently stated, we believe the wording in this section could cause confusion between the proposed Office of Technology Assessment and the Congressional Research Service. To remove this possibility we suggest substituting a new Section 7 (see enclosure) which eliminates the list of nine specific tasks specified for CRS in H.R. 10243. It also gives recognition that under its responsibilities under the Legislative Reorganization Act of 1970 (explicitly referenced), the CRS will provide to the OTA the same range of services that it now renders committees and Members. The substitution also highlights CRS giving to OTA early warning of the probable impacts of the applications of technology that might require legislative action, and recommendations of subjects requiring and suitable for technology assessment.

I am advised that during the hearings before your Subcommittee on March 2 several witnesses suggested adding an "Advisory Council" to assist the Board in its duties. I believe the suggestion has merit since it would add expertise from the public sector. I believe there is merit to the suggestion that was made that the Comptroller General and the Director of the CRS be members, or at least ex-officio members of the Advisory Council, as this would assure a closer working relationship among these three informational and analytical arms of the Congress.

I appreciate your giving me this opportunity to provide further comment on the proposed legislation.

Sincerely yours,

L. QUINCY MUMFORD,
Librarian of Congress.

Suggested Substitution in H.R. 10243 and S. 2302

UTILIZATION OF THE LIBRARY OF CONGRESS

SEC. 7. (a) Pursuant to the objectives of this Act, the Librarian of Congress is authorized to make available to the Office such services and assistance by the Congressional Research Service as may be appropriate and feasible.

(b) The foregoing services and assistance to the Office shall include all of the services and assistance, *appropriate to the duties and function of the Office,* which the Congressional Research Service is presently authorized to provide to *the committees and joint committees of* the Congress, and shall particularly include, without being limited to, the following:

(1) *research and analytical services to assist the Office in providing early warning of the probable impacts of the applications of technology that might require legislative action, and*

(2) *recommendations to the Office of the subjects requiring and suitable for technology assessments.*

(c) The Director of the Congressional Research Service is authorized to establish within the Congressional Research Service such additional divisions, groups, or other organizational entities as may be necessary to carry out the objectives of this Act, including the functions enumerated in this section.

(d) Nothing in this section shall alter or modify *the responsibilities of the Congressional Research Service under section 321(a) of the Legislative Reorganization Act of 1970 (84 Stat. 1181) to prepare and provide information, research, analyses, and reference materials and services, including analyses and materials relative to technology assessment, to the committees, joint committees, and Members of the Congress.*

(e) Services and assistance made available to the Office by the Congressional Research Service in accordance with this section may be provided with or without reimbursement from funds of the Office, as agreed upon by the Chairman of the Board and the Librarian of Congress.

(Italic indicates new language.)

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, D.C., October 8, 1971.

HON. B. EVERETT JORDAN,
Chairman, Committee on Rules and Administration,
U.S. Senate.

DEAR MR. CHAIRMAN: This will reply to your request dated August 27, 1971, for comments on S. 2302, 92d Congress, a bill to be cited as the "Technology Assessment Act of 1971."

S. 2302 proposes the creation of an Office of Technology Assessment within the legislative branch of the Government for the purpose of equipping Congress with a means of securing competent, unbiased information concerning the potential application and impact of technology. The information thus secured would be utilized whenever appropriate in the legislative assessment of matters pending before the Congress.

The bill provides that the basic duty of the Office of Technology Assessment is to give an early warning of the probable impact, positive and negative, of technological applications and to develop related information which may assist Congress in determining the relative priorities of programs before it.

The bill further provides for a Technology Assessment Board to formulate and promulgate the policies of the Office. The Board comprises 11 members, viz: two Senators, two Representatives, the Comptroller General, the Director of the Congressional Research Service of the Library of Congress, the Director of the new Office, and four public members to be appointed by the President with the approval of the Senate.

The Director is to be appointed by the Board for a term of 6 years and placed at Level II of the Executive Schedule ($42,500 per year). A Deputy Director to be appointed by the Director with the approval of the Board would be placed at Level III of the Executive Schedule ($40,000 per year).

In addition to the fact that under this measure the Comptroller General is to be one of the members of the Board and the General Accounting Office will furnish financial and administrative services to the proposed Office, it is our feeling

that many of our activities under section 312 of the Budget and Accounting Act, 1921, will generate information that will assist the Office in its functions.

Specifically, under section 312, the Comptroller General is responsible for:

(1) investigating all matters relating to the application of public funds,

(2) making investigations and reports ordered by either House of Congress or by committees having jurisdiction over revenues, appropriations, or expenditures, and

(3) directing assistants from his Office, upon request of these committees, to furnish them such advice and information as may be requested.

In addition, under section 204 of the Legislative Reorganization Act of 1970 (Public Law 91–510), the Comptroller General is responsible for reviewing and analyzing the results of Government programs, including the making of cost benefit studies, upon the request of either House of Congress or of any committee having jurisdiction over such programs, or upon his own initiative.

Basic to all our reviews is whether funds expended are achieving the program objectives intended by the Congress. Because many of the programs and activities for which the Congress has authorized funds involve the promotion or control of technology, the application of technology to meet an existing problem or need, or the treatment of problems brought about by technological change or programs, our work necessarily involves us in the area and the methodology of S. 2302. Our reviews of programs from the standpoint of achievement of objectives can and often do result in providing information which suggests the need to revise or strengthen a program or its administration or to improve its effectiveness. In some cases this information leads us to recommend a change in the governing legislation itself. As program objectives become more concerned with and provide recognition of the impact of technological application our Office will, in the ordinary course of its activities, automatically gear our review to include disclosures which show the impact of technology.

The following comments pertain to specific provisions of S. 2302:

Subsection 6(b) would authorize the Director, in accordance with such policies as the Board shall prescribe, to employ and fix the compensation of such technical and professional personnel as he may deem necessary without regard to the provisions of title 5, United States Code, governing appointments in the competitive service, and the provisions of chapter 51 and subchapter III of chapter 53 of such title relating to classification and General Schedule pay rates. We are not aware of the need to exempt technical and professional personnel from these provisions. Generally, there should be some ceiling on salaries and it should be possible to obtain qualified technical and professional personnel within the structure of the General Schedule.

Section 7 sets out in considerable detail the services that the Congressional Research Service of the Library of Congress shall perform for the Office. In testimony of December 4, 1969, before the Science, Research and Development Subcommittee of the House Committee on Science and Astronautics the Comptroller General stated that the then Legislative Reference Service was uniquely equipped to provide information and analyses of a background nature for use in evaluating new proposals but that our Office was perhaps better equipped to undertake longer-range studies of ongoing programs, to assess benefits and costs, the need for management improvement and similar considerations. With regard to the functions of our Office, its facility to assist in the purpose of this bill has been stated earlier in this letter.

For these reasons and to obviate any question of the authority of GAO to provide services to the Office in addition to the financial and administrative services provided for under section 10, it is suggested that subsection 7(a) be revised to list the Comptroller General and the General Accounting Office along with the Librarian of Congress and the Congressional Research Service. This revision could be accomplished by the substitution of the following language for section 7(a):

"Pursuant to the objectives of this Act, the Librarian of Congress through the Congressional Research Service and the Comptroller General through the General Accounting Office are authorized to make available to the Office such services and assistance as may be appropriate and feasible."

Subsection 7(b) details at some length the role and function of the Congressional Research Service. While these precise functions might well be spelled out administratively, it is our feeling that as a matter of administration it would be better to leave this matter as flexible as possible. Accordingly, we suggest the deletion of subsection 7(b).

Adoption of the above suggestions would also require adding a reference to the General Accounting Office to subsections (c) and (d) of section 7 and to the heading preceding the section.

We are pleased that a provision for GAO access to records of contractors and other parties for audit purposes has been included in the bill as section 6(f).

We defer to the judgment of Congress on the merits of the proposed legislation, but we are ready to work in close cooperation with the proposed Office of Technology Assessment if the bill is enacted.

Sincerely yours,

ELMER B. STAATS,
Comptroller General of the United States.

THE AMERICAN PHYSICISTS ASSOCIATION,
Arlington, Va., March 16, 1972.

COMMITTEE ON RULES AND ADMINISTRATION,
Old Senate Office Building,
U.S. Senate.

GENTLEMEN: The American Physicists Association (APA), an association dedicated to the professional welfare of physicists, wholeheartedly endorses the Bill to establish an Office of Technology Assessment for the Congress.

APA feels that this bill, culminating so many years of Congressional concern and study, provides a first necessary step toward a National Science Policy, and that its provisions will be used with wisdom to that goal. Evidence of neglect of this effort abounds—the greatest and best trained technological resource in the world nearly unproductive, the urgent needs of our society unfulfilled, and the national economy faltering and uncommitted.

Gentlement, this is not the proud vision of the rewards to the nation of dedicating oneself to a professional lifetime of harnessing Nature's secrets and American ingenuity.

It is just because the United States is the technological leader of the world that it is first to recognize and grapple with this crisis, that in the next one hundred years free enterprise can not be free exploitation of resources, natural or human, that these resources must be recycled, conserved, and not left idle, and that it will take all the human resourcefulness that has characterized our past and more to make us proper wardens of our future.

The initiative shown by Congress in introducing this bill heralds the commitment sorely needed in the technological and industrial community, and therefore the national economy. It is the responsibility of Congress to see that this bill provide an agent of service to the American citizen, and not a tool for further exploitation.

Very truly yours,

JOHN D. E. FORTNA, Ph.D.,
Director.

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.,
Washington, D.C., March 14, 1972.

Hon. B. EVERETT JORDAN,
Chairman, Subcommittee on Computer Services and Committee on Rules and Administration, U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: The aerospace industry is a high technology products industry and employs the largest number of scientists and engineers among U.S. industries. The industry recognizes the need for meaningful technology assessments on national programs. We therefore fully support the intent of H.R. 10243, passed by the House of Representatives, to establish an Office of Technology Assessment for the Congress, which is now under consideration by the Senate Rules and Administration Committee.

We believe that H.R. 10243 sets forth in Section 2 an excellent declaration of purpose and that Sections 4 through 11 describe an appropriate mode of organization, operation, and interface relationships with existing organizations.

However, we are concerned that certain provisions in Section 3 can be interpreted in a way which would be counter to the intent as we understand it. Specifically, we believe that the addition of a new second sentence in Paragraph (c), Section 3, to the effect that, "Qualified and expert opinions will be sought

and presented in a manner to provide objective assessments," would clarify the intent.

Additionally, we believe that sub-items (3), (4) and (5) in Paragraph (c), Section 3, should be revised to read as follows:

"(3) assess technological methods of implementing specific programs;
(4) assess programs for achieving requisite goals;
(5) make estimates of the impacts of methods and programs;"

These suggested modifications are offered to clarify the intent of the proposed legislation, recognizing that the Office is not intended to duplicate the existing analysis and program planning functions within the Government, but rather to assess the programs and the technological methods of their implementation.

We appreciate your consideration of these suggestions.

Yours very truly,

KARL G. HARR, Jr.

NATIONAL SCIENCE FOUNDATION,
Washington, D.C., March 1, 1972.

Hon. B. EVERETT JORDAN,
Chairman, Committee on Rules, and Administration,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: This is in further reply to your letter of August 31, 1971, requesting the comments of the National Science Foundation on S. 2302, the "Technology Assessment Act of 1971."

The Foundation supports fully the objectives of S. 2302, namely, to provide an organization whereby Congress can be kept currently and accurately informed about the physical, economic, social and political effects of applications of technologies, to the end that such information is available for use in the legislative process. Whether Congress wishes and needs to formalize arrangements to secure support and assistance in the area of technology assessment at this time is a matter on which it is in the best position to judge. The following comments are addressed to the feasibility of what is proposed in the bill, the availability of alternate mechanisms, and questions of duplication, as well as the possible effect of the bill upon the activities of the Foundation.

We would begin on a note of caution with respect to the potentially wide gap between the expressed objectives of the bill and the probable actual accomplishment of them. In our opinion, technology assessment represents a goal toward which we must all work, rather than an established system wherein quantitative techniques exist which can confidently establish standards, accurately anticipate the effects of innovation, and precisely determine the correct choice of alternate tehnology. Of course, we do not mean to imply that evaluation of the first-order effects in certain situations is not feasible; such evaluations are in many cases not only feasible, but highly desirable and necessary. We would only stress that any group, such as the proposed Office of Technology Assessment, must initially recognize the limitations of existing methodologies and the need for collateral and supplementary research and studies in these areas.

Another note of caution concerns avoidance of undesirable duplication of ongoing activities of other agencies having similar missions, such as the Environmental Protection Agency. Any new institution charged with responsibility for technology assessment will want to supplement the efforts of existing mechanisms for such assessments and not seek to preempt the field. The Congress has already provided for part of the functions covered by S. 2302 in P.L. 91–190, the National Environmental Policy Act of 1969. While the scope of this act is substantially limited to major Federal actions, the act clearly encompasses, in our judgment, essentially all the features associated with the process of technology assessment of the environment. The problem of undesirable duplication is always present. The potential is greater where more than one of the branches of the Federal government is involved.

To assure more effective coordination, Section 8 could be broadened to require continuing liaison with the Environmental Protection Agency and other agencies concerned with technology assessment, in addition to the National Science Foundation.

We would make one other specific comment on S. 2302, as drafted, and that is to request that section 8(b) of the bill, which would amend section 3(b) of the National Science Foundation Act of 1950, be changed to delete the phrase,

"whenever feasible" appearing at line 4, page 17 of the bill, and to substitute therefor the word "solely." The affected sentence would then read in part:

". . . When initiated or supported pursuant to requests made by any other Federal department or agency, including the Office of Technology Assessment, such activities shall be financed solely from funds transferred to the Foundation by the requesting official as provided in section 14(g). . . ."

We urge this change because the legislation as now drafted could conceivably police a great burden on available NSF funds by making it very difficult for the Foundation to avoid diverting its funds to projects requested by another Federal agency where that agency does not find it feasible to transfer the necessary funds. Moreover, the present language of S. 2302 could also cause a disruption of the regular authorization and appropriation process. Our recommended change would return the wording of section 3(b) of the National Science Foundation Act to its present limitations. This, of course, would not preclude the Foundation from itself initiating and supporting "specific scientific activities in connection with matters relating to . . . the effects of scientific applications upon society" with the use of its own funds, even though the project had been called to its attention by another agency.

The Office of Management and Budget has advised us that there is no objection to the submission of this report from the viewpoint of the Administration's program.

Sincerely yours,

H. GUYFORD STEVER, *Director.*

NATIONAL ACADEMY OF ENGINEERING,
Washington, D.C., March 15, 1972.

HON. B. EVERRETT JORDAN,
Chairman, Committee on Rules and Administration,
U.S. Senate, Washington, D.C.

MY DEAR MR. CHAIRMAN: As you know, the National Academy of Engineering has long shared with you the belief that the Congress requires its own source of technical advice and the capacity to assess the technological implications of the issues which come before it. Needless to say, therefore, I regretted that I was unable personnally to share with you and your Committee at your March 2nd Hearings my views concerning S. 2302, the Technology Assessment Act of 1971.

In lieu of such testimony, it is my pleasure to transmit my statement in behalf of this landmark legislation. I respectfully hope it will be possible that these views can be included in the official record of your Hearings.

Sincerely,

CLARENCE H. LINDER, *President.*

STATEMENT OF CLARENCE H. LINDER, PRESIDENT NATIONAL ACADEMY OF ENGINEERING

Mr. Chairman, I welcome this opportunity to comment on some of the issues raised in your consideration of S. 2302, the Technology Assessment Act of 1971. As you may know, the National Academy of Engineering, principally through its Committee on Public Engineering Policy (COPEP) has studied the implementation of concepts of technology assessment with the view of providing better information to Congress, the executive and the public on the consequences of alternative actions involving technology. Our COPEP report[1] on the subject discussed the need for technology assessments, how they should be conducted, and what methodologies promised greatest success.

A number of the conclusions arrived at by our Committee and presented in its report are relevant to the current discussion regarding technology assessment legislation. With respect to the role of technology assessment, we concluded:

"As a result of studies conducted by committees of the National Academy of Engineering, the Committee on Public Engineering Policy believes that technology assessment can help Congress to perceive, appraise, and initiate actions required to secure the greatest values from technology. Technology assessment can be expected to perform important roles by:

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[1] "A Study of Technology Assessment," a report of the Committee on Public Engineering Policy, National Academy of Engineering, published by the Committee on Science and Astronautics, U.S. House of Representatives (July 1969).

"(1) *Clarifying* the nature of existing social problems as they are influenced by technology, possibly with indications of legislation needed to achieve satisfactory control.

"(2) *Providing* insights into future problems, to make possible the establishment of long-term priorities and to provide guidance for the allocation of national resources.

"(3) *Stimulating* the private and public sectors of our society to take those courses of action for the development of new technology that are most socially desirable. Such actions may be creative or defensive. Creative actions would be those that follow from the awareness of new opportunities for social development; defensive actions would be those involving restrictions on the use of technological developments.

"(4) *Educating* the public and the government about the short-term and long-term effects of the range of alternative solutions to current problems."

We also emphasized the positive potential of technology assessments in developing the creative possibilities of technology:

"Technology assessment consists of a mixture of warning signals and visions of opportunity. Warning signals arise when the analysis predicts trends leading toward adverse consequences. Similarly, the analysis can point to actions that give promise of substantial improvements in the national quality of life. It is most important that assessment participants pursue with equal fervor the development of both the creative possibilities of technology and the defensive needs of society. Preoccupation with emerging problem areas, particularly those that seem to require regulatory legislation, can easily stifle innovative technical and social contributions. By contrast, the creative use of the technology assessment process would provide a meeting ground between public and private interest to work out mutually desirable courses of action."

With respect to the management of technology assessment, we presented the following recommendations:

"Full-scale technology assessments should be performed by carefully chosen, single-purpose, and specially qualified *ad hoc* task forces that will be disbanded upon completion of their assignments. The detailed characteristics of such groups are discussed in Part II.

"To select and oversee groups that will *perform* technology assessments, a core *management* organization is recommended. No permanent organization can be envisioned that could provide adequate expertise to execute full-scale assessments in all of the fields that may be required. We believe that it would be useful, therefore, to establish [an Office of Technology Assessment.]

"Since assessments must be designed, from their initial stages on, to meet the legislative and procedural needs of Congress, this management organization should be an arm of the Congress itself. That organization must also be placed in a position to have direct relationships with Congress as well as with the performers of the assessments, so that its results are produced in an environment free from political influence or predetermined bias. Specifically, the organization should be able to contract for assessments on any subject chosen by Congress and to select organizations for the performance of the work without political consideration. *Such an arrangement should permit the separation that is desired between the preparation of the assessments and their eventual use by Congress.*"

I believe the Office of Technology Assessment can develop a reputation for high quality and objectivity, a reputation which it will need to serve Congress most effectively in dealing with the veritable flood of issues which will require evaluation. To do so will require the difficult task of assembling distinguished leadership and highly qualified, multidisciplinary personnel. This will require time and a measure of continuity to permit the board and its director to develop an administrative and methodological philosophy and then to build a professional team. Once developed, however, I believe the Congress has every right to expect of such a professional staff a creative contribution both with respect to developing improved data and assessment methodology and to anticipating emerging technical issues before they reach the point of active Congressional deliberation, as well as the matters of current concern to the communities of the Congress.

While the fundamental purpose of the Office of Technology Assessment is to serve the needs of Congress. I believe that those needs, the public's needs, and the interest of maintaining the Office of Technology Assessment's professional integrity will all be well served by those provisions which contemplate the is-

suance of annual reports and making "freely available to the public" the results of all surveys, studies, reports, and findings. Finally, I would stress the need, beyond the authority of this legislation, for the Congress to amply fund this important new Congressional capability.

Thank you, Mr. Chairman, for this opportunity to present, for the consideration of the Committee, my views and those of the Committee on Public Engineering Policy of the National Academy of Engineering .I am pleased to note that joining me in these views are Dr. Edward Wenk, Jr.,[2] chairman of COPEP, and Dr. Chauncey Starr,[3] former COPEP Chairman and, currently, Vice President of the NAE.

NATIONAL GOVERNORS' COUNCIL ON SCIENCE AND TECHNOLOGY,
Knoxville, Tenn., March 6, 1972.

Hon. EVERETT JORDAN,
Chairman, Senate Committee on Rules and Administration, U.S. Senate, Washington, D.C.

DEAR SENATOR JORDAN: This letter is to record my support of H.R. 10243 "The Technology Assessment Act of 1971," now being considered by your Committee. Congressman Davis' accompanying report (No. 92–469) considers the many important implications of this bill, and, as such, reflects a noteworthy effort to set forth the rationale for an Office of Technology Assessment within the Legislative Branch of the Federal Government.

I am also enclosing for the record a copy of my letter to Congressman Davis, in which I note the possible implications of H.R. 10243 to state government. I consider strengthening the role of state and local governments in scientific and technological affairs as critical to improving our Federal system, and I hope that the states will ultimately benefit from passage of the "Technology Assessment Act of 1971."

Respectfully submitted.

E. ROGERS RUTTER,
Director, New Hampshire Intergovernmental Science Project.

NATIONAL GOVERNORS' COUNCIL ON SCIENCE AND TECHNOLOGY,
Knoxville, Tenn., March 6, 1972.

Hon. JOHN W. DAVIS,
Chairman, Subcommittee on Science, Research and Development, Rayburn House Office Building, Washington, D.C.

DEAR MR. DAVIS: Thank you for your recent letter concerning the bill (H.R. 10243) to establish an Office of Technology Assessment within the Federal Legislative Branch, with a copy of your House report (No. 92–469) on the subject. I am encouraged by the progress of the bill to date, and wish to take this opportunity to go on record in support of this important legislation, as further indicated in the enclosed letter to Senator Jordan.

The states, however, have an important stake in technology assessment, as the states have a critical role in the delivery of federal programs to their local citizens.

At the state level, there are two distinct areas of public need for technology assessment capabilities. The first is at the legislative level—state legislatures find themselves with relatively few resources with which to assess the implications of state enabling acts either in response to federal legislation, or specific local needs. The second is at the executive level—with statutory or designated responsibility for the administration of programs (federal, federal-state, and state) which have increasing scientific and technological implications, state agencies could derive immense benefit from the concepts reflected in the "Technology Assessment Act." I am sure you are aware of those important implications, I only hope that passage of the Act will encourage the states to take similar actions to strengthen their own assessment capabilities, and perhaps they may be directly assisted in doing this through future appropriate modifications of the federal legislation. There would appear to be opportunity for linkages between the OTA and state law libraries and legislative reference services, and continued and expanded National Science Foundation incentives for state-level innovations in the application of both improved and better managed technology.

Sincerely yours,

E. ROGERS RUTTER,
Director, New Hampshire Intergovernmental Science Project.

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[2] Professor of Engineering and Public Affairs, University of Washington, Seattle.
[3] Dean, School of Engineering and Applied Science, University of California at Los Angeles.

NATIONAL ASSOCIATION OF MANUFACTURERS,
New York, N.Y., March 15, 1972.

Hon. B. EVERETT JORDAN,
Chairman, Committee on Rules and Administration,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: The National Association of Manufacturers is vitally concerned with the efforts and direction of scientific research and technology which are manifestly essential to the national well-being.

With respect to S. 2302, to establish an Office of Technology Assessment for the Congress, we would like to call attention to a policy statement recently adopted by the NAM Board of Directors on the subject of "Assessing the Utilization of Science and Technology." The statement says:

"Industry is concerned with assuring the effective utilization of scientific and technological resources which inevitably bear on economic growth, quality of life, national strength, and the broadening of knowledge.

"In pursuit of this objective, we encourage wise planning and the cooperative undertaking of research and development endeavors among industry, government, and educational institutions.

"We support the continued assessment of the impact of scientific and technological policies, plans, and programs by the government, industry, and other segments of the community. In this respect, representatives of industry must study and take action on their findings unilaterally and in cooperation with public and private organizations."

Accordingly, if an Office of Technology Assessment is established as proposed by S. 2302, we would urge that the industrial research community be considered a source of special expertise and counsel in the deliberations of that body.

We would appreciate this letter being made a part of the hearing record on S. 2302.

Sincerely,

WILLARD M. BRIGHT, *Chairman.*

UNITED AIRCRAFT,
East Hartford, Conn., March 1, 1972.

Hon. B. EVERETT JORDAN,
U.S. Senate,
Washington, D.C.

MY DEAR SENATOR JORDAN: The following remarks pertain to H.R. 10243 (Technology Assessment Act of 1971), the subject of current consideration by your Sub-committee on Computer Services.

It is my understanding that the purpose of this legislation is to create an office which will provide the Congress with "effective means of securing competent, unbiased information concerning the effects—physical, economic, social and political, of applications of technology . . . basic responsibilities and duties of the office shall be to provide an early warning of the probable impacts, positive and negative, of the application of technology . . .".

No one could question the desirability of this objective. But many of us who have spent our lives working to introduce new and improved technological capabilities into the public sector are concerned about what its actual effect will be.

One of the inherent characteristics of innovation is that it implies a departure from current practice, and in the most significant cases, not infrequently involves substantial deviation from the orthodox view. The history of such innovations is rich in examples of instances in which fundamental and ultimately useful developments were vigorously resisted by contemporary authority. I am afraid the simple fact is, that we are just not smart enough to do what this legislation contemplates doing. And if the Congress establishes a body which it believes can do this, there is grave risk that this will lend further authority and power to the forces which have always resisted change.

Philosophically, I cannot unreservedly condone efforts to pass a priori judgment upon potential benefits and difficulties associated with new applications of technology. However, at least the hazard implicit in such legislation can be reduced if the Congress will structure the implementing legislation so as to prevent the proposed office from falsely assuming the character of a national oracle—where, in fact, no such absolute judgment is possible.

To achieve this purpose, I would like to propose that Paragraph c of Section 3 be modified to include after the next to last sentence the following words:

Such information shall be presented in such a way as to give equal and fair expression to all qualified opinion.

The inclusion of this language will, I am sure, not change the intent which Congress has in creating this body, but will insure that the office does not usurp itself the right to render arbitrary judgment which it enforces by withholding from the Congress equally valid opinion.

I enclose a staff paper which we prepared about a year ago which illuminates many aspects of this subject to which Congress has not been exposed in many of its hearings on this subject.

I earnestly hope that the Committee will give careful consideration to the potential strangulating effect of such an office and carefully consider how the Congress can achieve its legitimate information wants without this undesirable effect.

Sincerely,

ERLE MARTIN.

TECHNOLOGY AND FOREIGN COMPETITION

(By C. B. Smith)

INTRODUTION

One hears these days, an increasing amount about the evils of technology. Concerns, both real and imaginary, about pollution, job motivation, and the loss of cherished values have coalesced into an appealing new aphorism—the quality of life—which many fear is being laid assunder by the rampant growth of technology. The suggestion is that the government should do something. Congress has responded,[1] the National Academy of Sciences [2] and the National Academy of Engineers [3] have studied, and what has emerged is a proposal for Federal "technology assessment."

For some, the bureaucratic solution has the appeal of paternal simplicity. But in the minds of many who have been directly involved in the long and normally painful process of implementing innovative changes, it implies still another layer of resistance to change. They question whether anyone is really that smart, whether increasing the inflexibility of our society is in its long term interest, and, most immediately, whether in the light of growing international competition we can afford to further inhibit the one aspect of the manufacturing process in which we can still hope to excel. Perhaps the best way to convey THEIR concern is to restate the proposition in more familiar terms. It could be noted that ideas, at one time or another, have been at least as disruptive as machines; yet who today would seriously recommend "idea assessment." No? Well, their concern about technology assesment is based on exactly the same kind of reservations.

For several years now, the "concerned ones" have held the stage. The pendulum is full over. It is time to consider the "other side of the coin" before emotions get frozen into unwise laws, and the jobs of millions of working people placed in jeopardy. What follows is the viewpoint of those who believe that technology, far from being the Devil, is the true giver of a superior quality of life.

THE STARTING POINT

The single most important characteristic which has brought man to his unique position among animals has been his ability to utilize natural resources to his own advantage. The history of technology traces the gradual evolution of this capability—which, for sundry reasons, has for the moment found its most fruitful flowering in the United States. With only 6% of the world's population, this country generates and consumes over one-third of the inanimate energy working for man's benefit. There is an endless set of statistics which can be cited to indicate the unique affluence of the society which has resulted. In spite of the sneers of some, all bathe generously in the benefits—which are the envy and ultimate objective of the rest of the world.

COMPENSATION, PRODUCTIVITY AND COMPETITIVENESS

The United States' unique good fortune is, however, precariously perched on a combination of anomalies which must be kept in balance if its competitive

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[1] Technology Assessment, Committee on Science and Astronautics, U.S. House of Representatives, 90th Cong., 1967 . . . ditto 91st Cong. . . . Bill H.R. 18469 now pending.

[2] Technology, Process of Assessment and Choice, National Academy of Science, July 1969.

[3] A Study of Technology Assessment, National Academy of Engineering, July 1967.

position in the world market is to be maintained. The balance which is placed in jeopardy by the attack on technology is that between compensation and productivity. We, in this country, are presently able to pay ourselves between three and five times the rate of compensation which our counterparts in other parts of the world are able to justify (see Table I). Our unique standard of living is derived directly from this differential.

Other things being equal, extracting this kind of personal profit would render us totally noncompetitive in the world market. Fortunately, other things are not equal. Up to now at least, the U.S. has been able to maintain a compensatingly higher rate of productivity. The term productivity as thus used includes not only manufacturing productivity in the usual sense, but also innovative productivity. A product which is both unique and necessary can be sold anywhere, at any price. If the U.S. is to remain competitive, the balance between compensation and overall productivity must be maintained. Or, in more personal terms, if the U.S. is to continue to enjoy the type of compensation benefits which it presently possesses, it must maintain its counterbalancing productivity advantage. If it should lose this counterbalancing capability, it would lose its manufacturing export market—currently running at about $25 billion per year. This would mean (assuming all-up labor costs at $25,000 per year per employee) the loss of roughly one million manufacturing jobs. The second casualty would be some significant part of its domestic market. There are today 20 million Americans employed in the manufacture of transportable products which are directly subject to import competition. Tariffs, such as are now beginning to be discussed in Congress, can provide a temporary shield, but would also guarantee loss of the already fading export market, and in the process precipitate a major internal depression. The arithmetic of the process is alarmingly simple. There are currently 78.3 million employed and 4.9 unemployed Americans. Give up the export market and write off 1.0 million more jobs—one out of every five in manufacturing. The overall unemployment rate would then be 4.9 plus 1.0 divided by 83.2 or 7.1%. Such an unemployment rate would lead to a major market depression and additional layoffs. The ultimate snowballing effect is a complicated, but clearly unappetizing, problem in economic analysis.

HISTORIC TRENDS

Few disagree on the above generalities (although they are sometimes overlooked). But when one gets down to the "whys," and therefore "whats," it becomes necessary to move onto more speculative ground. WHY, it must be asked, has the U.S. been able to maintain the overall productivity advantage which has enabled it to compete in the world market, while paying itself markedly higher rates of personal compensation? And, WHAT are the essential features which must be preserved if that advantage is to be retained?

It is perhaps best to begin by noting that the U.S. has not always enjoyed a favorable manufacturing balance of trade. Prior to 1900, this country was primarily an exporter of raw materials and an importer of manufactured products. During this period the country's manufacturing trade ratio ran substantially below one (ssee FIG. 1). But in the econd half of the 19th Century, the concept of assembly-line production of interchangeable parts, originated in the U.S. by Whitney and Colt, took hold—providing a solution to the new world shortage of craftsmen. This concept found rapid acceptance in this country, but did not in Europe which, on the whole, clung to the craft production of quality products. The U.S.'s resulting ability to produce in quantity with a relatively small and relatively unskilled labor force led to an unprecedented reduction in unit labor costs[4] (see Fig. 1); and the introduction of new, low-priced products opened up vast new markets, both at home and abroad. The result was a complete reversal in the manufacturing trade ratio. By the beginning of the 20th Century, the U.S. was enjoying a manufacturing trade ratio substantially greater than one.[5] Just as Great Britain's energetic acceptance of steam power and the factory system enabled her to reap the initial fruits of the Industrial Revolution, the U.S.'s early acceptance of assembly line production methods enabled it to capture a

[4] Ratio of labor cost to value added in manufacture.

[5] It is interesting to note that 1900 also marks the founding by General Electric of the first industrial research laboratory, followed shortly thereafter by the duPont, Corning, and Bell Laboratories. Thus was born the concept of innovative productivity as a supplement to manufacturing productivity, and a normal part of business growth. It is noteworthy that all of these companies have remained highly competitive long after the initial inspiration of their founding fathers.

handsome share of the international market in manufactured products. We reap the rewards today.

It is pertinent to note that there were dislocations and growing pains then, too. Thoreau early felt the passing of the simple unordered life, the Hudson River painters satisfied a widespread craving for the vanishing wilderness, and in a climactic test, the refined culture of the country's agricultural aristocracy vanished from the face of the earth.[6] In exchange, the average person got electric lights, modern plumbing, and cheap clothing—and today few really want to go back to the days of preether operations. World War II introduced a discontinuity which masks all normal economic effects. The U.S. came out of the war with an extremely high—although artificial—manufacturing trade ratio, which has since been steadily decreasing as the productive capacity of the rest of the world came back. At the same time, the acceptance of mass market objectives, the organization of large trading blocks, and the steady reduction in transportation costs have opened up for the U.S.'s competition, markets fully compatible with mass production techniques. The net result has been that the U.S. is losing its mass production advantages and is today seeing its manufacturing trade ratio rapidly falling for the first time in its history (see Fig. 1). This trend signals a genuine, as yet only vaguely recognized, crisis in the American economy. If it continues, Volkswagen and Sony will be remembered as only the first of an avalanche of foreign products penetrating the U.S. marketplace. The consequences to the American dream are obvious.

The U.S. shipbuilding industry provides us with a gruesome example of this process run full course. In the days of the clippers, U.S. ships were the envy of the world. But with the introduction of iron and steam (Lewis Mumford's blackest enemies), the British forged ahead on the basis of their more advanced technology, leaving the U.S. far behind. Today, operating within the framework of the U.S. wage pattern, the shipbuilding industry, less obviously adaptable to mass production techniques, lags well behind average U.S. manufacturing productivity[7]—while facing rebuilt Japanese and European yards, reputed to have higher productivity than the U.S. yards. In the absence of any kind of overall productivity advantage, the U.S. shipbuilding industry is today totally unable to compete. Building a bulk cargo carrier in the U.S. currently costs roughly 50% more than overseas. As a result, not only have we lost our foreign market but U.S. buyers themselves now purchase 10 out of every 11 ships from foreign yards.[8] The industry continues to exist only by virtue of large subsidies and legislative protection—props which can be provided only when there are healthy industries to support a few special cases. Valiant efforts are now being made to rejuvenate the shipbuilding industry—and the focus of these efforts is on improved productivity. Before leaving this case, it is perhaps worth noting that the British in turn lost their dominance of the shipbuilding industry, not as a result of any revolutionary new invention but by simply failing to continue to invent—thus allowing other countries to catch up with the technology, and then by virtue of their lower labor costs to take over the market.[9] The U.S. typewriter,[10] sewing machine, fabrics & apparel, domestic electronics, and automotive fields are in various phases of succumbing to the same fate.

THE PROBLEM

There is ample evidence, some of which has been cited above, that the declining productivity advantage of the U.S. is a basic trend—one which if it persists will lead to a continuing declining foreign trade position, and ultimately to

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[6] Anglo Saxon culture has been uniquely rich in its critics of technological change. England had its John Ruskin who complained that the furious temper of the age was changing "Merrie Olde England into the Man with the Iron Mask." And of course Karl Marx, who developed a whole sociopolitical theory on the basis of what proved to be the temporary dislocations of a changing society. In more recent times, Charlie Chaplin created an indelible characterization of the intellectuals' concept of mechanized production while Lewis Mumford provided a beautifully written—although thoroughly obsolete—script which has become the bible of the true believers. When it came down to the working level in today's context, however, we find Walter Reuther saying, "Let me make our position clear. We welcome automation as a major force for growth in our economy, holding forth the promise of increasing abundance for all if we use it wisely and well." (Congressional Testimony, 86th Cong.)

[7] Statistical Abstracts, 1969, table 1109.

[8] Marine Engineering/Log, June 15, 1970, p. 175.

[9] Between 1913 and 1969, British Merchant tonnage launched declined from 58 percent to 6 percent of the world's total. The U.S. share is less than 4 percent.

[10] With the notable exception of the electric typewriter—the product of recent R. & D.

a loss of at least 1.0 million manufacturing jobs and at least a percentage point increase in unemployment. It is clear that the quality of life in the U.S. will suffer a serious blow if this trend is allowed to run to completion.

CAUSES

The next questions are the hard ones. WHY is this happening and WHAT can be done about it? First of all, it should be noted that hard statistics indicate that within the manufacturing sector, high labor costs, while a fact, do not in themselves appear to be an immediate cause. Overall, until very recently the United States has maintained a good competitive position in unit labor costs of manufactured products (see righthand end of Fig. 1). This means that productivity has substantially kept pace with wage increases.[11] What does appear to be happening is that the manufacturing productivity of the competition is increasing (see Table II). As in the case of the British shipbuilding industry, a superior product can in time be matched by simply copying. So what is superior today may be mundane tomorrow. To stay ahead, you must keep going—forward. It is this race which the U.S. is now in the process of losing.

ROLE OF R&D

Some insight as to what might be done about this trend can be obtained by looking at the results of various practices which have been followed by different industries in this country. This too can be done on the basis of hard statistics (see Fig. 2) which reveal a clear correlation between manufacturing trade ratio and R&D investment.[12] Although many peripheral factors undoubtedly affect each of the individual cases noted on this figure, there is a clear upward trend of trade ratio with R&D investment. It is evident that those industries which have maintained the greatest effort to upgrade the quality of their product have maintained the highest trade ratios. Innovation, resulting from R&D investment, is thus a demonstrably successful means of maintaining a high trade ratio—in spite of a wide wage differential and declining manufacturing productivity advantage. No other alternatives are apparent.

SOURCES OF R&D INITIATIVE

Pure competitive motivation leads to a large amount of private support for R&D (45% in 1968[13]). Such expenditures protect the corporate entities, but not necessarily the country as a whole. Corporations can and, in some cases, have established overseas assembly plants when no other means of offsetting wage differentials are available.[14] In such cases, the benefits to the U.S. economy is largely lost. One of the main reasons this practice has not been more widespread is that the U.S. Government in its own R&D and procurement programs has provided a selectively favorable environment for domestic innovative production. By so doing, it has insured that the required new skills and facilities will be located within the U.S. This in turn gives the U.S. producers the necessary temporary advantage to offset the international labor rate differential. Government R&D thus plays a unique role in insuring the domestic germination and initial exploitation of innovation. Private R&D and capital follows.

Since World War II, government R&D expenditures have been large and the industries which have been involved have maintained uniquely high trade ratios (see Fig. 2). In addition to forcing domestic germination of innovation, these national programs have provided a great demand for innovation. Necessity, they say, is the mother of invention; and there is no doubt that the highly speculative and extremely demanding objectives which the Federal Government has supported in its DOD, NASA, and other agency programs have forced many new develop-

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[11] Certain labor costs, notably in the construction industry, are completely out of hand, however. What this will eventually do to the unit labor cost of industry subject to foreign competition is a matter of grave concern to all.

[12] A full discussion of the interrelated mechanisms through which technological advance affects productivity in the broad sense, as well as the specific input factors determining technological advance, will be found in Nelson, Peck and Kalachek's, "Technology Economic Growth and Public Policy." The Brookings Institution, 1967.

[13] NSF 70–28, August 1970.

[14] Last year one of the maor U.S. automotive companies invested more in capital expansion overseas than in the United States.

ments.[15] In addition, these programs have provided the start-up market and bypassed many of the inhibitions which would normally delay application; and have thus contributed directly and indirectly to the international competitiveness of U.S. industry.

BACKGROUND SUMMARY

In general, there is substantial evidence to indicate that the way to remain competitive in the international marketplace is to invest in product improvement. Where compensation is disproportionately high, survival depends on the rate of product improvement not just equaling but exceeding that of the competition.

TECHNOLOGY ASSESSMENT

The case for technology assessment is of long standing and most would say is not without idealistic merit. Those who have reservations about such do so, not on the basis of what it is supposed to do, but on the basis of what past experience [16] indicates it is likely to do—inhibit innovation and reduce U.S. competitiveness.

In addition, those who oppose federal regulation of innovation question whether unilateral action on the part of the U.S. could really suppress any marketable technological development. They note that much as the U.S. might like to turn the clock back, or sideways, or what have you, it is going to be hard for this country to tell that other 94% of the people of the world they should not do everything they can to achieve the benefits which we enjoy. The nations that are now growing rapidly have shown few signs of sentimental wavering, and it is hard to believe that they are not going to continue to struggle to achieve, one way or another, what we already have—which means that they are going to become progressively more competitive. Attempting to stop technological change by unilateral action is thus not unlike attempting to limit armament development, minus much of the moral justification, not to mention personal hardship identity, supporting the latter.

Finally, those who warn against unilateral inhibition of the innovative process challenge the implied assertion that we do not already have control of our technological future. After all, they point out, the detrimental use of DDT is being suppressed, jet transports have long followed noise abatement procedures, and we don't have television monitors mounted in the wall of every living room. The method which has produced such a flowering of innovation in the U.S. has

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[15] The list of civil innovations derived directly from major Federal R. & D. programs is long. Since World War I, DOD and NASA alone have been primarily responsible for making commercially available—aluminum, titanium, and fiber composites; aircraft engines of all types, direct conversion fuel cells, and nuclear power; radar, VHF communications, and precision navigation systems; satellites for communications, navigation, and weather observation; and computers. Relative to the latter, Ivan Berenyi in a recent study of the world market in computers (Scientific American, October 1970) observed, in commenting on U.S. leadership, that "Every maor early design was financed, directly or indirectly, by the Department of Defense. The computer is unquestionably a by-product of military research and development in the first postwar decade." This initial effort was greatly expanded by NASA in the Apollo program. As a direct result, U.S. computer exports have risen from $48 million in 1960 to $728 million in 1969 with a trade ratio of almost infinity.

[16] Democratic institutions, insofar as they seek to provide the maximum freedom for individual initiative, have provided fertile ground for technological advance. But where they have become involved in controlling innovation, they have a bad record of undue sensitivity to short-term interests. In England, at one time or another, the introduction of steam propulsion, electrification, and telecommunications were all inhibited by protective legislation. R. J. Forbes illustrates th esituation with the following fascinating quote. In 1849 the new telegraph lines in Kentucky were taken down . . . "because it robbed the air of electricity, the rains are hindered, and there ain't been a good crop since the wire was put up." (A History of Science and Technology, Pelican No. A499). "Expert" advisors have an equally dubious record of perspicacity. In the late 19th Century, Lord Kelvin, in the great AC/DC debate, supported DC and led the official English system into a morass from which it has not yet fully recovered. Returning again to the United States, we find on June 10, 1940, Theodore Von Karman, the unquestioned dean of aeronautical engineering, putting his name to a National Academy of Sciences report containing the following statement . . . "In its present state and even considering the improvements possible when adopting the higher temperatures proposed for immediate future, the gas turbine could hardly be considered a feasible application to airplanes mainly because of the difficulty in complying with the stringent weight requirements imposed by aeronautics." Fortunately for the United States, the Academy of Sciences did not have legislative control. Most electronic engineers now living are acutely aware of the long struggle which Armstrong had with officialdom to obtain FCC approval of FM transmission, and every housewife over 40 can recite the legislative history of oleomargarine. The building codes on the books of almost every major city in the United States stand today as a stark warning of the potential effect of legislated control of innovation.

On the current scene, the "debate" over the SST have fully displayed the kind of "scare issues" which can always be raised to delay any new undertaking, while two of the Nation's normally most farsighted Senators, one Democrat and one Republican, fought to scuttle the effort to save the shipbuilding industry.

been to encourage innovation, and then clamp down on those undesirable side effects which *actually* develop. Innovation is thus considered innocent until proven guilty, rather than guilty until all possibility of fault is disproven. Admittedly there are some ill effects, but these they see as small in comparison to the long-term consequences of the delay associated with trying to resolve every conceivable hypothetical calamity.

ALTERNATIVE

On the other hand, increasing population density and increasing demand for environmentally affecting services make unintended side effects, which would have been of little consequence 50 years ago (when the population was half of its present value), of more consequence today. To achieve the same degree of control, the reaction time to mistakes must be reduced. This can be done without attempting to prejudge—by maintaining strict environmental policing. Under this concept, innovation would be allowed to proceed uninhibited, but the total effect of the resulting changes would be closely watched and corrective action, where proven necessary, taken promptly.

PRESENT SITUATION

The issue of federal control of innovation, as such, has unfortunately never really been debated. In the meantime, the one-sided dialogue on the failures of technology has had its effect in the public arena. The current fuel shortage is the first hard impact. But from a long-range viewpoint, the more important effect has been a growing disenchantment and a leveling off in R&D effort. In the last five years, federal R&D has decreased from 12.6 to 8.7 percent of the federal budget[17]—at a time when the rest of the world appears to have read the American message well. All of the U.S.'s international competitors are now increasing their R&D expenditures, both in absolute amounts and as a percent of GNP (see Table III). In contrast, total R&D expenditures in the U.S. in 1970 are expected to amount to 2.7% of Gross National Product,[18] continuing the steady downward trend of the last few years. Productivity in most countries of the world is similarly increasing faster than in the U.S. (see Table II); and in Japan almost three times as fast.

SUMMATION

The most essential benefit which any society can confer on any of its citizens is a secure job at the maximum possible compensation. Job, and in the long run national, security depends on maintaining the ability to produce competitively. As the era of the U.S.'s monopoly of the mass market passes, it will have to depend more and more on innovative productivity to maintain its overall productive advantage and support its disproportionately high rates of compensation. This means it must encourage, certainly not discourage, innovation—in its attitudes, laws, and budgets. This will bring change, the overall effect of which should be beneficial and the side effects of which can be controlled by prompt environmental policing. The future quality of life in America depends first and foremost on the successful pursuit of a course which will preserve its ability to produce competitively.

TABLE I.—COMPERATIVE COMPENSATION

	Relative of average hourly compensation in manufacturing (United States =100)			
	1950	1957	1964	1969
United States	100	100	100	100
Canada	61	73	63	69
France	22	33	36	41
Germany (Federal Republic)	22	25	37	44
Italy [1]	25	26	36	37
Japan	8	8	12	18
Sweden	33	42	54	68
United Kingdom	26	28	33	32

[1] Data for wage earners, compared to U.S. production workers.

Source: Division of Foreign Labor Statistics, Bureau of Labor Statistics, September 1970, unpublished.

[17] NSF—Federal funds for research and development, 69–31, August 1969.
[18] National Patterns of R. & D. Resources, NSF 69–30, September 1969.

TABLE II.—COMPARATIVE PRODUCTIVITY GROWTH RATES

	Rate of change of output per employee, 1960–67 [1]
Germany	4.0
France	4.4
Italy	6.2
Japan	8.6
United Kingdom	2.6
U.S.S.R.	----
United States	2.9

[1] Statistical Abstract of the United States—1970.

TABLE III.—COMPARATIVE R. & D. EMPHASIS, TOTAL R. & D. EXPENDITURES, GOVERNMENT AND PRIVATE

[As a percent of gross national product]

	1962 [1]	1966 [2]	1967 [2]	1968 [3]	1970 [3] (estimate)
Germany	1.3	1.8	2.7	----	----
France	1.5	2.4	2.6	----	----
Italy	[4] 0.6	0.7	0.8	0.9	----
Japan	----	1.3	1.4	----	----
United Kingdom	2.2	2.7	2.7	----	----
U.S.S.R.	----	3.0	3.1	----	----
United States	[5] 3.1	3.0	3.0	2.9	[5] 2.7

[1] Freeman & Young; The Research and Development Effort in Western Europe, North America, and the Soviet Union, Organization for Economic Co-operation and Development, Paris, 1965.
[2] Bartocha, B; Unpublished data courtesy National Science Foundation subject following reservation, these ratios are based on data from the individual countries. Since there could be differences in definitions among countries, these percents may not be completely comparable.
[3] National patterns of R. & D. resources, NSF 69-30, September 1969.
[4] For 1963 SRI research brief No. 11, April 1968.
[5] Government/private split, percent of GNP:

	1962	1970
Government	2.0	1.5
Private	1.1	1.2
Total, United States	3.1	2.7

(Note.—For distribution in "International R. & D." see Stanford Research Institute, research brief No. 11, April 1968.)

TREND IN U.S. FINISHED MANUFACTURES TRADE RATIO

REF – HISTORICAL STATISTICS OF U.S.

TABLES U61–72 1–10

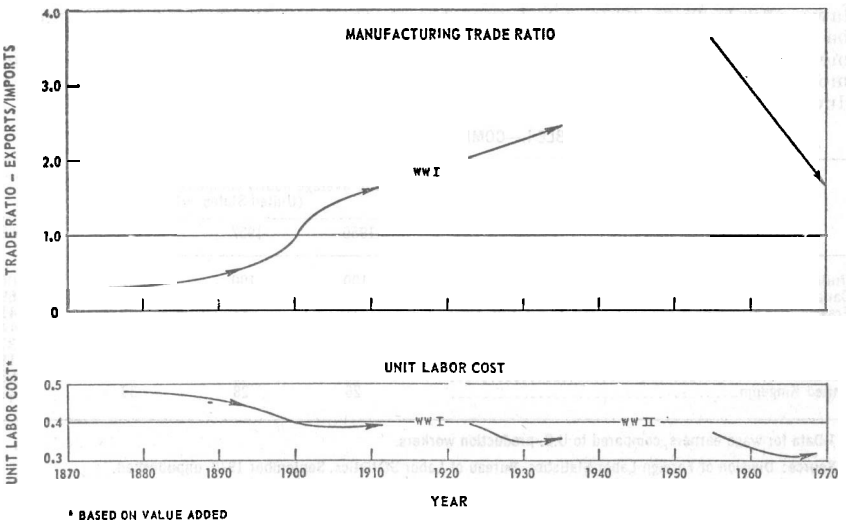
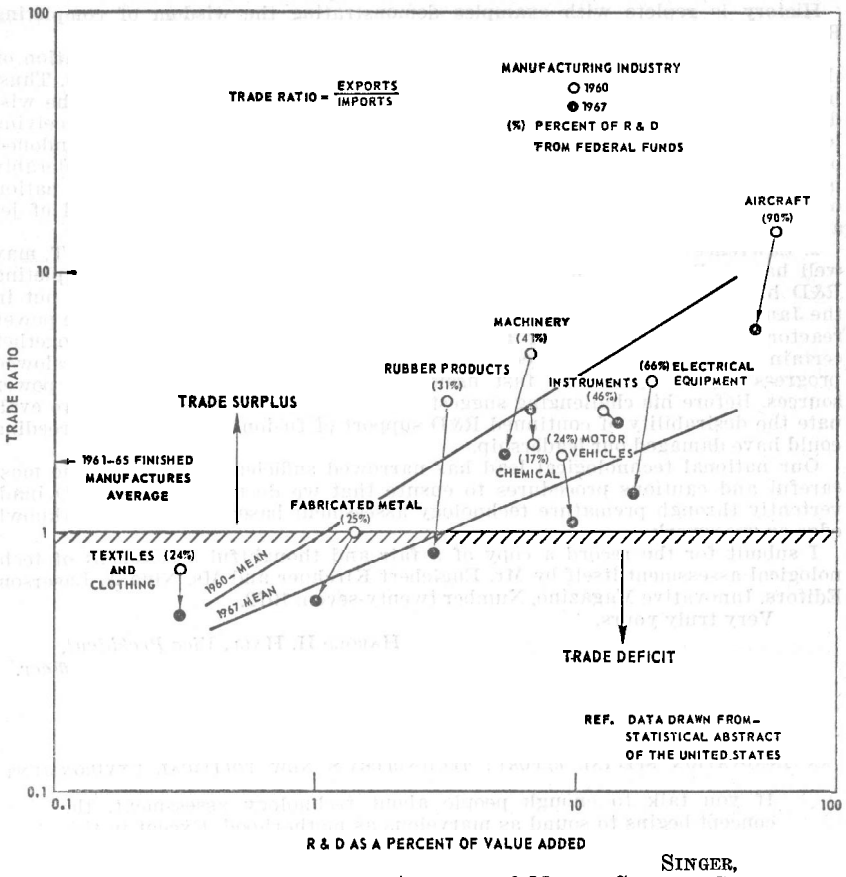


FIG. 2

BALANCE OF TRADE VS RATE OF R & D EXPENDITURE



SINGER,
AEROSPACE & MARINE SYSTEMS GROUP,
March 8, 1972.

Hon. B. EVERETT JORDAN,
Chairman, Committee on Rules and Administration,
U.S. Senate, Washington, D.C.

DEAR SENATOR JORDAN: The following viewpoints are offered for inclusion in the testimony you are receiving concerning H.R. 10243, Technology Assessment Act of 1972.

The key benefits and dangers of the proposed legislation are well expressed in its own statement of objective:

". . . duties of the office shall be to provide an *early warning* of the *probable impacts,* positive and negative of the *application* of the technology," (Emphasis added.)

Reasonable people cannot question the desirability of an even-handed "early warning of the probable impacts, positive and negative . . .". At the same time, the dangers inherent in premature assessment are obvious. While present fads for emotional anti-Technology persist, it is vitally important that technology assessment not be permitted to become a tool to inhibit research and develop-

ment. The best safeguard of the national interest would be to add language to the bill which would require completion of substantial and comprehensive R&D activities before an assessment of the Technology could be initiated.

The national concern is and properly should be to question the consequences of *applying* the technology, not of exploring the technology. Legislative concern about producing, distributing, and regulating the technology should trigger formal assessment exercises, but only when the facts and insight resulting from a mature R&D effort are available.

History is replete with examples demonstrating the wisdom of completing R&D first, in order to avoid irrelevant anxieties. Two will suffice.

1. Accounts have circulated for many years to the effect that the invention of the jet aircraft engine really consisted of the invention of longer runways. Thus, had there been an OTA which attempted to provide advice concerning the wisdom of continuing the R&D program *before* the feat of imagination in conceiving longer runways, they might well have advised that R&D should be abandoned because the required engines would be economically unfavorable and intolerably noisy. Premature assessment, in that instance, could have deprived the nation of leadership in the lucrative, convenient, and militarily important field of jet aircraft.

2. Lawrence M. Lidsky, Associate Professor of Nuclear Engineering, MIT, may well have called attention to another example of the importance of completing R&D before getting too far into technology assessment. He has pointed out in the January 1972 issue of Technology Review that by combining fast fission power reactors and fusion breeding reactors, it may be possible to avoid altogether certain severe difficulties in economics and safety that have heretofore slowed progress separately on the fast fission breeder reactor and on fusion power sources. Before his challenging suggestion, use of technology assessment to evaluate the desirability of continued R&D support of fusion or fast fission breeding could have damaged our leadership.

Our national technological lead has narrowed sufficiently to justify the most careful and cautious procedures to ensure that we do not strangle R&D inadvertently through premature technology assessment based on incomplete knowledge or guesswork.

I submit for the record a copy of a fair and thoughtful assessment of technological assessment itself by Mr. Englebert Kirchner and Ms. Nina A. Laserson, Editors, Innovative Magazine, Number twenty-seven, 1972.

Very truly yours,

HAROLD H. HALL, *Vice President,*
Chief Technical Officer.

Enclosure.

III. TECHNOLOGY ASSESSMENT AT THE THRESHOLD

AN INNOVATION SPECIAL REPORT: TECHNOLOGY'S NEW POLITICAL ENVIRONMENT

> If you talk to enough people about technology assessment, the concept begins to sound as marvelous as motherhood. Except in this case, nobody knows how to get pregnant. Still, as this discipline takes hold, staff editor—Nina Laserson—reports that the federal government is assessing technology, and the private sector may have to follow suit.

Technology assessment had its beginnings in a mood of congressional pique, burgeoned into a minidiscipline as it was picked up by academics, and has now reappeared on Capitol Hill. It is something that anyone concerned with technology will be hearing a lot about in the months to come, and may even be forced to do some of. And if this embryonic discipline ultimately fulfills even a portion of the expectations it has already engendered, the reverence with which some people on the Hill discuss it might well be justified.

By examining the relationship between technology and the environment—physical, social, and political—technology assessment may affect all of us: It could provide an early warning system for environmental mishaps and define the necessary monitoring or surveillance mechanisms. It could supply the kind of foresight that prompts the rejection of harmful technological projects as well as the exploitation of those most likely to be beneficial. Finally, it is seen as a tool with which the decision maker can set technological priorities and allocate resources, and the legislator can draft laws and regulations more sensitive to our society's mix of values.

But these are ideals, and the considerable literature on technology assessment is so far mostly full of theory and promise; actual results are only beginning to dribble in. Although the articulation of this concept is important, it would be a mistake to think that some very wise men have already developed a parallel methodology that—if we'd only apply it—would guide us down the path of reason.

The definition of technology assessment is elusive. It's as though one asked twenty people "What would you like your crystal ball to do?" Generally, it is assumed that technology assessment will develop into a systematic investigation of technological impacts on the complete environment (social and political, as well as economic and physical) and will disclose the benefits and risks inherent in the range of technological alternatives. Traditional experimental investigation will be valuable as documentation, but it is not seen as part of the central process of assessment; rather synthetic tools of prediction and integration—trend extrapolation, intuition, modeling, and so forth—are likely to emerge as key techniques.

The technology to be assessed is generally assumed to include the whole range of environmental intrusions—power plants, dams, and the like. However there is some feeling that social inventions (social security, FHA–VA policies, et al.) should be thrown into the assessment bag, as these, too, are complex applied "techniques," with profound primary and secondary consequences.

An assessment may be problem initiated (what can we do about the power crisis?) or technology initiated (how can we use a fast breeder reactor?) Within each of these categories an assessment can be either prospective or retrospective. It doesn't take an awfully clear crystal ball to predict that it will be easier to do assessments that are problem initiated (we seem to have more problems than technologies) and restropective (there's a lot of assessing we should have done in the past but didn't).

It is important to understand the various ways technology assessment differs from traditional forms of analysis and prediction, such as long-range planning, technological forecasting, systems analysis, and simple good engineering.

First, it is most directly concerned with second-, third-, and higher-order impacts, as distinguished from the prime effects which are already preplanned, intentional, or costed out in the initial proposal. We have learned that remote impacts can be more powerful, more pervasive, and more durable than the intended benefits of a suggested development, and are only now beginning to trace back derivative consequences of older technologies to discover that some of the more deleterious "side-effects" could have been regulated out of the system—if we had only known.

Second, technology assessment incorporates the needs of an increasingly wide range of constituencies. Some consider it the first step towards "participatory technology," and everyone believes it is an effort to direct technology toward that set of values perceived as "the public interest." Past assessments, typically economic or military, concerned themselves with direct costs or benefits to a select—usually elite—group. As the indirect costs of technology have spread to penalize the "innocent bystander," technology without representation begins to look most un-American.

Besides being "multiconstituencied," technology assessment is interdisciplinary, as a result of our less-than-perfect record of solving problems through application of standard academic techniques. This poses a number of problems. Methods must be found to integrate the widely different intellectual traditions of the different disciplines, as well as the diverse modes of handling data. Integration should proceed without scaring off the specialists and attracting only a mixed bag of generalists into the technology assessment fold. In the past, attempts to reconcile the disciplines have often been met with disdain by experts who dislike having the elegance of their field prostituted through application.

Qualitative data, value judgments, and intractable parameters abound. (Contrary to some government opinion, assessment is not something that can be easily accomplished by giving The Rand Corporation a lot of money.) The man who is used to describing everything in terms of partial differential equations is not likely to embrace "quality of life" indicators. Guy Black, senior staff scientist at the Program of Policy Studies in Science and Technology at George Washington University, describes technology assessment as "precisely that kind of problem which graduate students sometimes suggest for their PhD disertations, and which responsible faculties steer them away from."

Unlike many other methods of analysis, technology assessment is seen not as a technical device, but as a policymaking tool. The methodological precursors

of this concept seem rather more closely connected with administrative processes (systems analysis, PPBS, and the like) than with technical ones. Additionally, technology assessment is clearly an outgrowth of our sociopolitical situation, not our technical expertise, and is very much tied up with political goals.

In the past, many such goals—bigger weapons systems, better satellites—were virtually inseparable from the technical activities that supported them. Going to the moon was a direct application of technical know-how as well as a romatic aspiration. With our changing objectives—it won't be quite as easy to sell the public on Mars—the straight-line technological component has been minimized.

There are no longer any major political goals that people feel science and technology is the only key to. This particular attitude finds further expression through national institutions; in the late 1950s these institutions were set up so that technology could be expediently applied to what we perceived as national objectives. In the early 1970s there are more institutional hurdles to overcome.

As national goals have become only technology-related, rather than technological, society's appreciation of the technical practitioner has changed. The scientist's mystique has deteriorated to the point where Capitol Hill wants to assess his contribution, not merely fund it. It wasn't all that long ago when laymen couldn't understand the scientist's jargon, and ideas like the bomb were simply incomprehensible. People seemed to believe that if you collected a group of good scientists and engineers, and gave them all the money they asked for, anything was possible. Scientists did little to dispel this notion.

Colossal naiveté has, in some instances, been replaced by colossal mistrust. Technology is viewed as a force which—while it may be weaker at any given point than political or economic forces—over time pushes inexorably in one direction (which used to be called "progress"). The rhetorical question "Where is technology leading us?" implies that there is a discrete (albeit unforeseen) desination and a predetermined (if uncharted) route.

Technological force is seen as threatening because, unlike the political and economic forces which often serve to cancel each other out there is no perceived counterweight to technological advance. This leaves two simplistic alternatives: Give technology a free rein (and pray for the best) or stop it. Technology assessment may be viewed as a way of coming up with less extreme alternatives. Indeed, the consequences of technology assessment will be decisions—not techniques.

Then, too, technology assessment is a response to many of our problems which *look* as though they were caused by technology. In fact, technology is regarded as the most likely culprit because of all the contributions to a given problem, the technological one is often the most visible, easily described, and the only quantifiable one. As a pragmatic, social response to these problems, technology assessment gives expression to the fear that we may not be able to cope—at least not by applying the quick technological fix, as we have in the past. With this sort of problem orientation, the concept of technology assessment is likely to be most often identified with preventive measures and programs rather than as many of its spokesmen are quick to emphasize, the pursuit of "progress."

ASSESSMENT BY THE EXECUTIVE: CURING BUREAUCRATIC TUNNEL VISION

Since most big technological programs involve the federal government, and since the government does have an obligation to respond to the public, it would seem the logical first home for a technology assessment capability. In fact, in its report "Technology: Processes of Assessment and Choice," an ad hoc panel of the National Academy of Sciences included among its recommendations that technology assessment activities be performed at several governmental focal points within the executive and legislative branches of the government. Hopefully, this dispersion of assessment activity would provide counterweights to the bureaucratic tunnel vision encountered within the various departments taken separately, and would increase the set of constituencies taken into account during the assessment process.

Nevertheless, as we begin 1972 the number of really broad-based programs of technology assessment performed within the federal government can be counted on the fingers of one mutilated hand. As Vary Taylor Coates of George Washington University's Program of Policy Studies in Science and Technology points out, "although the ideal is a total, comprehensive, and continuing assessment of major technologies and of potential applications, in practice partial and short-range

assessments are constantly being performed throughout the federal government. . . . The process of assessment is at present fragmented and diffuse. Assessments are made in many contexts, for many purposes, and by many subsystems or mechanisms."

Activities supportive of technology assessment abound: throughout government, on all levels, panels of "experts" are called together to address themselves to future-oriented "broad" questions. Every so often, the Environmental Studies Board of the National Academy of Sciences pulls together a report of the full range of impacts of a proposed project. Interagency task forces assemble to perform what one might refer to as augmented technological forecasts. Departmental staffs are learning how to use their environmentalists—and even hiring a sociologist or two.

But the places where technology assessment would appear to be a logical—even necessary—capability are notably lacking in any systematic effort to get this sort of program under way. The Office of Management and Budget (OMB), for instance, is in a relatively unique position as a body of decision makers who are literally in a position to portion out the government's income, evaluating programs with major technological components against other such programs. But OMB does no formal technology assessment, and, with its lack of technical expertise, depends on the Office of Science and Technology (OST) for this sort of input. What, then, is OST doing by way of technology assessment? Virtually nothing, Edward E. David, Jr., the President's science adviser and director of the office, demurs; adding that the operating agencies ought to be encouraged to performed this type of activity.

Surely the Pentagon, with all of its technological effort, must be attempting technology assessment, if for no other reason than to help obtain the appropriations which seem to be a bit harder to come by these days. The scope of DOD's technology base is certainly broad enough to demand these efforts—in substance, the Pentagon's investigations encompass most branches of engineering, as well as the physical, biomedical, environmental, and behavioral sciences; in dollars this department's expenditure for "research and early development" is said to come to nearly one and a half billion dollars, its advanced development projects cost several hundred million more.

The Pentagon's Directorate of Defense Research and Engineering (ODDR&E) is, in fact, preparing a series of Technology Coordinating Papers, designed to give DOD a handle on what research they are doing, what it is accomplishing, how it can be better managed and more efficiently performed. This is the closest the Pentagon comes to performing technology assessment, each paper concerning itself with a discrete technological area (such as biomedical research), and describing its utility and technical applications (with some emphasis on finding out where the Pentagon's money is going).

It becomes clear that Defense is not really assessing technology; rather, it is making a necessary effort to come to grips with its own size. Not really certain of the activities within the farther reaches of DOD, ODDR&E finds technology inaccessible as well as unassessable.

Amidst this dearth of extensive systematic assessment, three programs—all linked to the executive branch of the government—stand out as offering promise for technology assessment as an ongoing national endeavor. Two of these programs—initiated by the National Science Foundation (NSF) and by the Council on Environmental Quality (CEQ) as chartered through the National Environmental Policy Act—represent attempts at actual, broadbased assessment. The third was directed at developing a generic methodology for assessment (a technology assessment technology), and was performed at OST in conjunction with MITRE Corporation under the aegis of Gabor Strasser, OST's technical assistant to the director. (Unfortunately, OST's involvement with technology assessment ended with Strasser's departure for Battelle Memorial Institute late last year.)

1. OST's technology assessment methodology

When Strasser joined OST, technology assessment became his responsibility. Not quite sure what to do with it, Strasser found in the literature two types of concerns: some writers considered how important, difficult, and diffuse it was; others tried to come up with a wiring diagram explaining where they would put this capability, assuming it existed. But Strasser wanted another question answered. Given that assessment is important, given that there is some logical place to locate it and given that someone has come up with funds, a secretary, and a typewriter, what does the assessor do when he goes to work Monday morning?

OST and MITRE chose to deliver their methodological recommendations in

the form of a procedural report and five pilot studies. They felt it was inadvisable to force-fit systems analysis or other OR procedures to this new discipline, because there were plenty of intractable elements, barely qualifiable, and certainly not amenable to expression in precise quantitative terms. A case study approach, on the other hand, would produce a document of intrinsic interest, but with little applicability elsewhere.

Accordingly, a combinatorial scheme evolved, wherein five case studies would be used to extract the major generic steps involved in the assessment process. The subject of the pilot studies include automative-emission-control mechanisms, industrial enzymes, mariculture, water pollution control, and computer and communications networks. The areas were chosen for diversity of both problem possibilities and potential impacts; among the range of questions the assessors were asked to address were: What is the state of the art? What are likely applications? Which community or interest groups are likely to be affected?

The OST study made a special effort to do two things: First, it endeavored to employ as many criteria as possible in assessing the various impacts. It avoided both the disciplinary habit of stressing one dimension, and the interdisciplinary expedient of combining several dimensions into a simple cost/performance ratio. Then, in their evaluation of alternative solutions, the assessors were careful to consider the feasibility of implementation—involving political, institutional, and public opinion factors.

The investigators drew a variety of conclusions, among which were: That assessment is an iterative process . . . the succession of steps should be completed several times. An appreciation of the soft science aspects is as important as hard science know-how (the racial considerations regarding the housing industry, for example, are as useful as knowledge of construction techniques). Ideally, assessments are ongoing, not one-time affairs.

In the end, they were able to distill seven major technology assessment steps from the quintet of studies implemented. The steps (illustrated throughout this article) ranged from the establishment of ground rules to the analysis of specific social impacts.

But where will OST go from there As mentioned, David gives no hint of any follow-up. But then again, in an election year things get a bit muddled. It's difficult to push for ideas that address the macro-long-term environment during the fourth year of an administration since the party that's in is looking for quick payoff ideas. When the new men come in—or when the old ones come back for a rerun—the "big picture" is usually brought back into focus. Perhaps then OST will opt for another look at assessment.

2. NSF grants for assessment

NSF is one of the few agencies that have decided to plunge headlong into the assessment process—concluding, presumably, that this method will have a higher yield than the funding of studies proposed to develop methodologies separately. Through its Research Applied to National Needs (RANN) division, the foundation is distributing grants for assessments that are specifically designated as policy tools to provide guidance to a particular decision maker or set of decision makers. The recipients of these assessments have been local governments, such as that of Baltimore, or operating agencies, such as the Bureau of Reclamation.

To ensure a workable assessor/policy maker interface, RANN insists that those who receive its grants familiarize themselves with the decision-making apparatus, even before the funds are handed out. The actual policy makers or men who will act on the assessment, as well as the relevant public interest groups, are brought into the assessment process during various review stages, if not earlier. The purpose of this is two-fold: the decision makers can advise—not censor—the study along the way, and thoroughly acquaint the assessors with their needs. In addition, the early involvement of these people prepares them for the report's final conclusions, thereby paving the way for more ready acceptance of the assessment. "We don't want our investigators to take on the role of encyclopedia salesmen," comments Joseph Coates, program manger of Exploratory Research and Problem Assessment at RANN.

NSF has been able to sponsor several "model" assessments, one of which—Snowpack, done for the Bureau of Reclamation is nearing completion as this article is written. The conditions of this study would warm the heart of any purist: it was started before work on the project under investigation had begun: consequently, it had not been initiated in response to any catastrophe or political dilemma; additionally, it seems to have been admirably comprehensive. The assessment evaluated proposed weather modification designed to increase snowfall

in the Colorado River Valley. The first-order, desired impact (more water at Point X) was investigated, as were such diverse impacts as those impinging on recreation, transportation, education, health, and miscellaneous regional biota.

RANN is sponsoring similarly comprehensive assessments in such areas as offshore oil production and alternatives to the internal combustion engine. These ventures into the realm of interdisciplinary, multiconstituency research seem to represent a departure in the modus operandi of the traditionally discipline-oriented foundation. RANN's technological assessor is not encouraged to squirrel himself—and NSF's funds—off in a pristine laboratory somewhere; he is asked to plunge willy-nilly into the murkier area of factional interests and value judgments.

3. CEQ's statutory assessments

The most broad-based form of technology assessment currently practiced—and one which has already had a noticeable effect on policy making—is the body of environmental impact statements required by Section 102 of the National Environmental Policy Act of 1969. NEPA established the Council on Environmental Quality, and provided that *all* agencies of the federal government file with this council a report on "legislation and other Federal actions significantly affecting the quality of the human environment." This means that the proposed construction of a relatively small, discrete artifact such as a highway or a dam requires a statement. It also means that a report of the potential implementation of a new technology—such as the AEC's breeder reactor—is filed with the Council.

What makes the impact statements sound very much like technology assessment is that they specifically require a great deal more than an analysis of first-order effects on the physical environment. Besides the "environmental impact" per se, the reports must include "any adverse environmental effects which cannot be avoided should the proposal be implemented, alternatives to the proposed action, the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."

Since its inception, CEQ has received in excess of 1,200 such statements, which it distributes to all agencies and interested parties in and out of government. The Council formulates and solicits comments concerning the statements, hopefully ensuring that their preparation becomes an iterative process. With the benefit of these reported data, the Council advises OMB and the President as to the advisability of a project under consideration. "Our role," says Gordon J. F. MacDonald, one of the Council's three members, "is advisory, with no veto power. We oversee the assessment process and deliver substantive comment to the executive."

As assessments, the impact statements are far from ideal; taken as a new body of literature, they exhibit virtually no uniformity in terms of quality, scope, or cost—some of them are merely old data in new packages. Many of them tend towards the evaluation of the straight forward technology and direct dollar costs implicit in the various projects because, as MacDonald comments, "it's easy to assess the hydraulics of a dam or the nitrogen depletion of the water going over the dam. But these are trivial problems compared to the question of the changing land-use patterns resulting from the construction or the fluctuating rural/wilderness balance."

It is easy to be overly critical of these initial assessment attempts. The idea is new, and agency administrators are no doubt confronted with problems of management and nuances of approach quite foreign to them. Then, too, agency resources have not been expanded in proportion to this new demand. A minimum impact statement is liable to cost $50,000, while typical assessments probably run in excess of $150,000. Then there is the Trans-Alaskan Pipeline Statement, completed at an estimated expenditure of $6 to $7 million.

The Pipeline Statement, and the hearings it engendered, are the latest in a series of events, responsible for halting construction of the oil line. Not that we won't someday have a supply of fuel dripping south from our northernmost state, but the pipeline as envisioned has been evaluated and the project now under consideration differs in detail and concept from that originally proposed.

CEQ's reaction to a Corps of Engineers statement helped to halt the Tocks Island project, designed to construct a dam over the Delaware River. What makes this particular assertion of CEQ's advice notable is the character of the Corps as the original pork barrel agency, accustomed to scattering artifacts throughout the land. Although it has always operated with a low profile, the

Corps has been able to enlist the faithful support of Congress—even to the extent of building dams in clear violation of treaties with Indian tribes.

It turned out that the proposed dam would result in eutrophication of the waters upstream and the deterioration of land downstream, and that the Corps' impact statement concerned itself with the technology of the dam, not the subsequent problems of its more remote neighbors. The upstream water facilities were, furthermore, inadequate to handle the problems that would result were the dam constructed. CEQ advised that implementation be halted until such problems were adequately resolved—implicit in this advice was the recommendation that if the Corps of Engineers was willing to pay for the upgrading of the treatment facilities upstream, the dam would become less objectionable. The Corps stopped the project.

The Calvert Cliffs decision, a court ruling on the inadequacy of an impact statement, has already had significant ramifications for the nuclear power industry. Last July, the Court of Appeals for the District of Columbia told the AEC that it was unable to reach decisions regarding project licenses because the AEC statement did not include sufficient consideration of environmental values. The agency will now have to do a balanced cost-benefit analysis on power needs versus the environment for each plant proposed. If nothing more, this will involve a shift of manpower and project emphasis within the agency.

As part of the balancing act AEC was directed to perform, they now seem to be ready to crawl out of bed with the industry they sponsor. Last month, AEC chairman James Schlesinger told a chagrined power industry of some of his attitudes which, if not the direct products of Calvert Cliffs, contained some striking coincidences of phraseology and import.

"Those of you who regard the response to the Calvert Cliffs as indicating a climactic change in the relationship between the industry and the AEC could well be right. . . . the move toward greater self-reliance for the industry had a certain historic inevitability. Such a process is always painful. It is, however, necessary. One result will be that you should not expect the AEC to fight the industry's political, social, and commercial battles . . . it is not the responsibility of the AEC to ignore in your behalf an indication of congressional intent or to ignore the courts. We have had a fair amount of advice on how to evade the clear mandate of the federal courts. It is advice we did not think proper to accept. . . . I believe that broadside diatribes against environmentalists [are] not only in bad taste but wrong."

The substantive omissions that the courts brought to light in Calvert Cliffs, and that the CEQ pointed out with reference to the Tocks Island project, strongly suggest that an operating agency may not be the best assessor of its own activity. Vary Coates questions "whether such an agency can adequately evaluate its own projects, since it is primarily interested in its own survival and each expert assessor has a bias in favor of his profession and his job."

What, then, can possibly motivate agencies to work toward honest impact statements—real assessments? The precedents set by Calvert Cliffs and Tocks Island will help, of course. A passel of vocal Sierra Clubbers may embarrass an agency into action. "But there's only one real force," asserts Gabor Strasser, "withholding money. When the agencies find that their budget isn't approved because their impact statements are found wanting, then all of a sudden we'll have a phenomenal capability in each agency to run these analyses."

ASSESSMENTS BY CONGRESS: INFORMATION FOR DECISIONMAKERS

In our society, technological policy choices are made through a reconciliation of many competing interests and conflicting values as mirrored in the Congress. How is the theoretically "unbiased," rational technology assessment process going to fit into a legislative system where 535 biased viewpoints come together to reach consensus?

Congress has been toying with technology assessment for nearly five years. In fact, Philip B. Yeager, counsel for the House Committee on Science and Astronautics, is credited with having coined the term in a report delivered by the Subcommittee on Science, Research, and Development headed by former Congressman Emilio Q. Daddario. In 1967 Daddario introduced a bill which would establish a technology assessment board to advise Congress. He spoke of this bill "not as a piece of perfected legislation but as a stimulant to discussion." As the 92nd Congress goes into its second session this month, it will probably be faced with another bill calling for the establishment of an Office of Technology Assessment and accompanied by a virtually identical piece of legislation written for intro-

duction into the Senate. These bills may even pass. (The most optimistic guess is that the House will say yes in January, and the Senate several months later.)

The inter-bill interval has not been an idle period. The Subcommittee on Science, Research, and Development commissioned three extensive and well-done studies of technology assessment (concept and implementation) performed by the Legislative Reference Service of the Library of Congress, the National Academy of Sciences, and the Committee on Public Engineering Policy of the National Academy of Engineering. The Subcommittee, furthermore, has heard a great deal about the subject—the combined hearings and miscellaneous papers weigh several pounds in their final version.

The technology assessment bill was introduced in 1970 as a more or less "serious piece of legislation." In the legislative shuffle, it was attached to the Reorganization Act, and then thrown out on a point of order. It is likely that sponsors of the Act did not want to draw the complexity of an entirely new congressional entity into the already complicated business of structuring the Congressional Research Service.

Last year, the bill surfaced once more as H.R. 10243, went into the Rules Committee, and emerged unscathed rather late in the session. The Committee on Science and Astronautics was advised to hold off introduction of the bill until 1972, since the rush to adjourn, with the traditional flurry of emergency legislation—compounded somewhat by an unexpected turn of economic events—was bound to overshadow H.R. 10243. Prior to its impending reappearance, it is appropriate to examine the reasons Congress wants a technology assessment capability, and the factors working for and against its effective implementation.

As stated in the House bill, Congress believes that "emergent national problems, physical, biological, and social, are of such a nature and developing at such an unprecedented rate [that] it is therefore imperative that Congress equip itself with a new and effective means for securing competent, unbiased information concerning the effects . . . of the applications of technology." The basic responsibilities of the Office are seen as the development of an early warning system sensitive to the existing and probable impacts of technology and the formulation of information to assist Congress in determining the relative priorities of the programs it must vote on.

The Office would operate as a contracting agency, handing out assessment assignments to various independent laboratories. Assessments could be initiated either by congressional committee chairmen or by members of the board (composed of a director, two senators, two members of the House, the comptroller general, the director of the Congressional Research Service, and four Presidentially appointed "persons eminent in one or more fields of science or engineering or experienced in the administration of technological activites.")

Certainly, the body of laymen who appropriate the funds for approximately two-thirds of our national R&D effort deserve some sort of technical advice. This is a thought not new with the OTA bill: Indeed, members of Congress have, in the past, entertained notions of congressional think tanks, a congressional OST, and Nobel laureates in residence. As congressmen find increasing evidence that information passed on to them from the executive somehow gets distorted en route, their desires for such advice have become more vocal.

Most understandably this view of OTA as Congress' own, private, information-getting body is a factor decidedly in favor of the bill's passage. In the past, important technological decisions have been made in the executive branch and simply presented to Congress as items meriting support. Confounded by the mechanism of executive privilege, and pressured by lobbies and other special-interest groups, Congress would often be kept unaware of possible technological alternatives and societal options.

The bill may also pass simply because it has no visible opposition. It is inoffensively worded, and has the unanimous endorsement of its House Committee members. According to a Senate Rules Committee spokesman, their version "has moderate sponsorship, and is endorsed by both flaming liberals and arch-conservatives."

H.R. 10243's very inoffensiveness, however, has placed it in the category of non-controversial legislation, with the result that it has not picked up much momentum. Urgent legislation could continue to give the bill the low-priority status it has assumed thus far. It's not as sexy, say, as a bill designed to meet the economic situation. A congressional staffer comments that the bill has poor visibility—outside of its committee a minority of the congressmen are conversant with the legislation. Elsewhere on the Hill is has been suggested, not without some cynicism, that what the bill needs to get it through is a prompt environmental crisis.

Introduction during an election year may further delay consideration of the bill, as it is not a partisan measure designed to haul in the votes. Yet the only substantive stumbling block the legislation seems likely to encounter is opposition to a provision enabling OTA to subpoena information necessary to an assessment from industry. Although this portion of the bill—drafted by the Justice Department—offers recourse through the courts for industries feeling that their proprietary toes have been stepped on, it is a provision that in all likelihood will be excised from the bill to enhance the probability of its passage.

A more interesting question than whether or not the bill will pass is whether, assuming its enactment, OTA will work the way its sponsors envision it. The problem then becomes twofold: Is it at all possible to put together, as congressional proponents believe, an independent, unbiased body of assessors? If so, can this group actually influence legislation?

The first condition—that of OTA's lack of bias, or value freedom—is a nearly impossible one to meet. In theory, there are two possible ways to establish an impartial, unbiased board. One could staff it with unbiased people. Or one could select its members so that they represent a mix of biases that could, in the long run, cancel each other out. If an OTA can be "objective" at all, then it will have to approximate this ideal state through the latter method; for even if it is possible to posit a value-free science, one can hardly find a value-free practitioner of that science. Since we can hardly expect OTA's operations to blithely step outside their chauvinism for assessment purposes, probably the Office's best bet would be to gather together as all-inclusive a mix of antagonisms as possible.

If and when an OTA is established, assuming it somehow manages to get hold of some full-fledged assessments, its success will depend on nothing more than whether it can influence the legislative process—directly by pulling votes, or indirectly by adding to the knowledge base of the policy makers.

Lewis M. Branscomb, director of the National Bureau of Standards, reminds us that "the congressman's actions are going to be a combination of his own personal judgment, based on anything he can learn in a very short period of time, and weighted by the sum of all the pressures placed upon him by his peers and his constituency." The way he arrives at his political decisions doesn't necessarily make technical sense. As in the example below, the process of compromise can sometimes be quite arbitrary:

The 1953 Flammable Fabrics Act indicates that fabrics are to be tested by locating them on a stainless steel sheet at a 45° angle to the horizontal, igniting one end, and timing the burning process. Why 45°? Very simple—the consumerists wanted it vertical, because burning is very fast that way. The manufacturers wanted it horizontal for the obvious reason. It happens, in this case, that 45° is a technically acceptable compromise, but one can imagine situations where the political resolution would not be as technically serendipitous. Unless an OTA can lend an added dimension to the resolution of conflicts such as this, it might well function merely as a supplier of ammunition for the side of an argument most in need of backing data.

The Office could also fall into operating as a congressional complaint bureau. Congressmen, listening for rumbles of discontent from their constituencies, could call for assessments only on such concerns that have already found their way into the cocktail-party, weekly-editorial circuit. Besides turning OTA into a reactive performer of individual job requests, such assessments would in all probability fall into the too-little-too-late category. When public sentiment grabs hold of a crisis, it is a pretty fair guess that it's advanced to a point beyond which an assessment can be of optimal utility. What, for example, are the chances of OTA sponsoring an assessment as appropriately timed as, say, NSF's Snowpack study?

OTA will not be operating in a vacuum—it will be supported by a rather tempestuous political forum. Will working for 535 bosses force the Office to concern itself with pedestrian and noncontroversial issues alone? The Science and Astronautics Committee—whose members are not chosen for their political skills—is politically weak compared to other congressional behemoths. It is unlikely that OTA's voice could be long heard were it too loud or too objectionable.

Not only has Congress gotten along without an OTA for a considerable period of time, it has adapted its rhetoric to virtually exclude the sorts of inputs provided by assessment. Indeed it becomes apparent that through the SST debate, through the discussions of Cannikin and the ABM, the environmentally concerned "opposition" has developed a modus operandi which may actually

work against technology assessment. Ways of dealing with the press, styles of rhetoric, and paths for information dissemination have become systematized in ways that may be politically more powerful than the cold, hard look. Where, then, does assessment fit into the forensic structure?

There are murmurs that OTA can only be as good as its first leader—he is going to have to set the tone, determine the extent to which the outfit can run a credible operation. Having the responsibility to ask for assessments not requested by Congress gives him a certain amount of power, if taken advantage of. Opinion has it that the leader will be plucked out of private industry—presumably from a corporation with an extensive research involvement. It is relatively certain that he will have a good working knowledge of the government, and it is probable that in view of Congress's somewhat defensive attitudes toward the executive and its methods of distributing information, the Senate will exert its advise-and-consent prerogative to the fullest if the President appoints someone with whom he's been too chummy for very long.

A leader out of the private sector might naturally be expected to enlist industry's faith in the Office. For whether the ability to subpoena information from unwilling sources remains with the bill, or is thrown out in one of the rewrites to passage, OTA will not be operating in a pure research environment, and will have to rely to some extent on the willingness of private enterprise to accommodate its needs.

With the odds seemingly stacked against OTA's effective operation, why should Congress have it? Because (at least some) congressmen feel their paucity of technical information is critical. And because any mechanism which has the slightest chance of bringing issues to a decision point before catastrophe results is worth a try. And because the increasing complexity and interdependency of legislative actions require more analysis than ever. And because—since it's a new idea, a new approach, and a fresh, unentrenched group of bodies—it could well deliver "early warnings," and might even work the way its sponsors predict. For a while, at least.

And recollection of previous "technological" debate only serves to underscore the fact that there is a need for something like an OTA. Richard L. Garwin of IBM wonders whether we can ever "achieve rational analysis or avoid personal vilification once a question reaches the level of controversy of the SST. It would be a substantial improvement, however, if a better and more responsible background of information, analysis, and program alternatives could be laid for a decision within the Administration and for availability to the Congress and to interest groups outside."

Laurence H. Tribe, professor of law at Harvard and executive director of the NAS Technology Assessment Panel, sees the lesson of the SST as demonstrating that when environmental and social values just happen to line up with the economic ones—direct dollar costs—the environmental interests appear to "win." But we need a more effective representation to these interests, that will perhaps be filled by an OTA.

And—although this is logically difficult—imagine the range of issues of crises-to-be that are not subject to timely congressional attention. OTA will be worth its appropriation if it happens to stumble upon one one or two.

ASSESSMENTS BY INDUSTRY: WARDING OFF "FUTURE SHOCK"

Opinion in Washington is divided as to whether industry should get at all involved with technology assessment, or whether the government alone (as the guardian of the public interest) should be the focal point of such activity. Proponents of the latter viewpoint—a minority, it seems—argue that industry shouldn't have to pour a lot of money into a potentially low-payoff process and, besides, the private sector really can't be trusted.

The first objection, that technology assessment can't pay for itself, is, for at least some industries, as short-sighted as maintaining that market research per se produces no profit. In a sense, technology assessment done for and by industry can be regarded as market research extended to include the unfolding social and political environment. The second objection, that of industry's inherent untrustworthiness, assumes that private technology assessment must be performed for essentially altruistic purposes. But technology assessment as a component of the rampant social consciousness much touted these days need not be an issue.

So far industry has expressed two viewpoints on technology assessment: the contract research outfits welcome it as a new source of direct business: companies

whose prior experience indicates that assessment of anything leads inexorably to more stringent regulation, fear it.

Nevertheless, it seems clear that technology assessment ought to be performed by profit-making organizations to the extent that it can (a) expose exploitable technological options, and (b) enable a corporation to anticipate restraints imposed by legislatures, regulatory agencies, and public pressure groups.

There are surface justifications for the fear that a working program of technology assessment will further circumscribe industrial activity. As we enter a period where a burgeoning complex of statutory restraints describes an increasingly comprehensive range of industrial endeavor, there is little doubt that technology assessment could be a step in providing more rules and regulations. But right now it seems more likely that the process will act to inform the regulatory process—make it less stringent in some areas, more stringent in others, and less arbitrary all around. Laurance Tribe asserts that, with or without technologly assessment, "stricter regulation is inevitable. But if we allow technology to go unassessed much longer, the kind of statutes we will wind up with will be much more severe, much more draconian, and much less open to creativity than the kinds of regulation that will emerge if industry cooperates in efforts to sensitize the government through technology assessment."

In "sensitizing" regulation, technology assessment might conceivably work to augment design standards with performance criteria. Take the building codes as an example of "assessed" technology. . . . There are many possible ways of building homes; in the public interest, the government has decided that they ought to be built safely, and has therefore written a set of regulations defining what "safety" means in design terms. The regulations are specific: they determine what material the load-bearing walls of a house should be built of, for instance. These regulations close out creativity in the sense that a manufacturer discovering a new means of supporting a certain number of pounds per linear foot and attenuating sound by a comfortable number of decibels is prevented from implementing the results of his research: Design standards do not take into account new materials that can perform as acceptably as those specified. If, as an alternative approach, technology assessment can work towards determining the criteria which people want their houses to meet, it is possible that a system of regulations could be constructed that would subject industry to a different set of restraints, dictating what society wants out of the technology, and leaving the solutions to the problem far more open than they are now.

But the law does not affect industrial technology merely by issuing directives that regulate some step in the research-development-production-diffusion sequence. The use of law in altering monetary incentives might well affect technology assessment activities. The recent economic trend has been towards an "internalization" of costs by the manufacturer and the immediate consumer, especially costs identified with the manufacture and disposal of a given product. Internalization simply implies that costs once borne by an unsuspecting public (such as air pollution) will be placed on the heads of the manufacturer or user responsible (such as the auto companies and auto purchasers.)

Furthermore, trends in legal branches such as contract, tort, and property law make it apparent that profit-making enterprises will have to assume more and more responsibility for the adverse consequences of their activities. Breach of contract, for example, no longer requires an explicit contract, and innocent bystanders, not merely direct buyers of a product, have legal recourse to a manufacturer should his product malfunction. Additionally, the classifications of injuries to be compensated have broadened, and the legal and political demands to make restitution have become more compelling.

Nor does the government's influence over the private sector stop at the writing of directives or the alteration of economic incentives: Legislated changes in the various decision-making structures can have a profound effect as well. As an example, the recent Toxic Substances Control Act and the Marine Protection Act both require industry to demonstrate that its activities are not dangerous (as opposed to the earlier legislation which placed the burden of proving danger on the government). These Presidentially initiated proposals might well inspire private technology assessment.

What all this adds up to is the fact that the business environment has changed radically and further changes are imminent. It would be well for the private sector to have a means of anticipating these changes, so it can adapt to them before accommodation becomes too painful, or too costly.

As conceived, technology assessment appears to be a tool that can preempt industrial "future shock," Frederick W. Giggey, principal in Peat, Marwick,

Mitchell & Co. (a firm which has recently completed the first survey of technology assessment done in the public *and* private sectors) put it quite strongly: "Industry has to move from merely reacting to legislation, to programs of broader more sophisticated technology assessment so that they can become part of the decision-making process early on. Regulation will be made with or without industry's participation, of course. And if they don't attune themselves to what's coming, they may wake up one day to find a radically altered free enterprise system."

In the face of this warning, what has industry already done? Not enough, reports Giggey. Most of the assessment is addressed to environmental concerns—primarily pollution—as they are most fashionable. The range of individual, social, political, and economic impacts is pretty much ignored. To the degree that corporations have been performing assessments, these have been done to meet, allay, or deter legislation. There is little evidence that industry is inclined to contribute to its formulation or to set up an early warning system of any sort.

And the private sector has responded to the usual motivators; assessments have been performed to specify the first-order economic variables, and have been narrow in scope as far as their possible socio-political impact is concerned. They have been performed as augmented market research, typically to test acceptability of a new product or process. They have been done so that firms can consider themselves "good corporate citizens," which usually translates "to meet local ordinances."

Although more than half of the firms surveyed by Peat, Marwick, Mitchell, & Co. indicate that they have been pursuing technology assessment, quite often industries have been relabeling traditional activities—technology forecasting, and the like—as technology assessment. Alternatively, they have been applying traditional techniques to this new problem.

Intuition seems to be a frequently used methodology; brainstorming is the parallel technique. The consultation of "experts" characterized the typical assessment effort, with little inclination to draw in special-interest groups, such as environmentalists or consumerists. As infrequently as these groups were consumed, the public at large was included even more rarely. Familiar processes (such as systems analysis and operations research) were employed, as were the more faddish ones, such as Delphi techniques.

The frequent use of precedent and literature surveys showed a heavy reliance on "old" ideas and information, as did the failure to do more than a smattering of experimental investigation. Furthermore, private assessment teams were noticeably lacking in sociologists, psychologists, economists, and so forth. The fact that a $10 million assessment effort (concerned with the physical and esthetic environment) employed only scientists and engineers is revealing.

Industry's halfhearted approach to technology assessment should come as no surprise. An expensive activity, private technology assessment enjoys no tax incentive or reimbursement policy as yet. Assessment in response to government standards is hampered to the extent that such standards are inconsistent and prone to rapid change. Where technology assessment is performed as a staff function, the line functionaries who may be affected by the outcomes see reason for worry.

Logically, there appear to be two loci for a broad-based industrial technology assessment capability. Large corporations, with secure market positions and highly visible images, may well find assessment to be in their best interest—both as a device for opening up technical options and as a public relations gambit. Trade associations, representing such groups as the power, information, or chemical industries, may come to regard technology assessment as a useful component of their lobbying activity.

But ultimately, the decision of whether industry—or anyone else—ought to jump wholeheartedly onto the technology assessment bandwagon depends on an as yet unanswered, possibly unanswerable, question: Will this activity have a decisive impact on present or future problems? The answer, of course, is contingent on a seemingly endless list of imponderables. Can an assessment methodology evolve? Will an assessment be able to specify an optimal technological course? If it does, will our decision-making processes, governmental or industrial, choose this course more often than not?

In a problem-ridden environment, real technology assessment is an expensive long-term gamble. If it fulfills all those expectations—and chances are it will meet some—then, like everything else, it's surely worth the risk.

Beyond This Report

Conscientious attention to the Washington scene will provide the most reliable clues to the continually evolving environment of technology

Anyone who must or wants to follow the evolution of federal R&D policy in all areas of technology on a day-to-day basis is best served by the Washington staffs of *The New York Times* and *The Washington Post*. If you don't have to stay on top of the news to quite that extent, your best general sources on these policies are the weekly *National Journal*, the "News and Comments" section of *Science* (also a weekly), and *Science & Government Report*, a biweekly Washington newsletter published by Daniel S. Greenberg, a former editor of "News and Comments."

The best picture of the government's plans and actions on R&D of course is conveyed every year by *The Budget of the United States Government* and the section on "Federal Research and Development Programs" in the companion volume of *Special Analyses*. Both publications are available from the Government Printing Office.

For most people interested in R&D, the amount of detail is forbidding in the full-scale *Budget* but a bit inadequate in the *Special Analyses*. A happy medium is struck by *An Analysis of Federal Research and Development Funding by Budget Function* (NSF 71-25), which has just been put together by the National Science Foundation's Division of Science Resources and Policy Studies for fiscal 1960–72 and is available from GPO. NSF plans to update this analysis on an annual basis, in effect extending *Federal Funding and National Priorities*, by Leonard Lederman and Margaret Windus (Praeger, 1971, $15), which still gives the best analysis of federal R&D in the recent past but stops short with fiscal 1971.

Various aspects of the basic policy problems of government-sponsored R&D are discussed in R. R. Nelson, M. J. Peck, and E. D. Kalachek, *Technology, Economic Growth and Public Policy* (Brookings, 1967, $6.95); *Science, Growth and Society* (OECD Publications Center, 1971, $2.25), a report prepared for the Organisation for Economic Co-operation and Development by a group headed by Harvey Brooks; and *Toward a Science Policy for the United States*, a 1970 report by the House Subcommittee on Science, Research, and Development, which is available from GPO. On the crucial question of the proper scale for the government's involvement in R&D, fresh light is thrown in two recent articles by Yale economist Richard R. Nelson: "'World Leadership,' the 'Technological Gap' and National Science Policy," in the July 1971 issue of *Minerva*, and "Governmental Support of Advanced Civilian Technology: Power Reactors and the Supersonic Transport," co-authored with George Eads in the summer 1971 issue of *Public Policy*.

The baffling economics of R&D are surveyed by a number of authors in NSF's *A Review of the Relationship Between Research and Development and Economic Growth/Productivity*, an expanded version of which should be available from GPO by about April. The bluntest statement of how little we know about the economic effects of R&D probably is Lester C. Thurow's "Research, Technical Progress, and Economic Growth," in the March 1971 of *Technology Review*. How much we need to know is illustrated by "Our R&D Economics and the Space Shuttle," by Klaus P. Heiss, in the October 1971 issue of *Astronautics & Aeronautics*, which gives a good idea of the highly sophisticated econometric tools now required to justify large federal R&D investments. In John E. Morrissey's "An R&D Tax Credit to Spur Productivity and Employment," the March 1971 issue of the same magazine carried the most extensive statement to date of the probably hopeless case for R&D tax incentives.

"Probable Levels of R&D Expenditures in 1972: Analysis and Forecast," on which the second part of this special report is based, is available from Battelle-Columbus.

If the discussion of technology assessment has prompted the industrial manager to ask how his operation might be affected by this new development or why his organization ought to invest in such a capability, several authors who have tackled the regulatory implications of assessment may provide a partial answer. In this vein, Laurence H. Tribe discusses the types of legal intervention that could influence assessment in "Legal Frameworks for Assessment and Control of Technology" (*Minerva*, April 1971). Milton Katz decribes the relationship between certain liability laws and the assessment process, emphasizing the value

of law as an incentive or deterrent to industry in "The Function of Tort Liability in Technology Assessment", (*The University of Cincinnati Law Review*, No. 4, 1969).

Frederick W. Giggey talks about assessment in terms of corporate social responsibility, and the potential for a new kind of social accounting. This article in the winter 1972 issue of *World*, available from Peat, Marwick, Mitchell, & Co. (Washington, D.C.), references the results of that firm's survey discussed in the preceding page. Another accounting system is suggested by Chauncey Starr in "Technology Assessment—I: Weighing the Benefits and Risks of New Technologies" (*Research Management*, November 1970) where he describes a cost/benefit index for technological impingements on society.

For the reader curious to see what an actual assessment looks like, Raymond Bowers and Jeffrey Frey of Cornell University have evaluated the impact of microwave solid-state devices in articles scheduled to appear in *Scientific American* (February 1972) and an early 1972 issue of IEEE's *Spectrum*. At George Washington University, Vary Taylor Coates has put together a "Technology Assessment of Space Stations," available from their Program of Policy Studies in Science and Technology.

Coates' paper is one of a flood of staff discussion papers, monographs, and occasional papers frequently emitted from the GWU group. Among those of interest to the nonexpert are Melvin Kranzberg's "Historical Aspects of Technology Assessment," Coates' "Examples of Technology Assessment in the Federal Government," and Harold P. Green's "The Adversary Process in Technology Assessment." The latter suggests that what we really need is a technology assessment agency that will act as a responsible devil's advocate or technological ombudsman. Louis H. Mayo has written a lengthy discussion of the "Scientific Method, Adversarial System, and Technology Assessment," in a GWU monograph.

Congress' involvement with assessment can be traced back to Emilio Q. Daddario's first basic statement ("Technology Assessment") in which he discusses the congressional need for such a capability, the potential scope of an assessment effort, and his subcommittee's plans. The paper, published in 1967, can be obtained from the Government Printing Office. Also available from the GPO are the Legislative Reference Service's report to the Daddario subcommittee ("Technical Information for Congress") and that submitted by the National Academy of Sciences ("Technology: Processes of Assessment and Choice"). The former is a thorough study of how congressional decisions regarding specific technological projects (such as Project Mohole, the Salk Vaccine, and the test ban treaty) are made. The latter, recommending an institutional framework for technology assessment, is summarized by Harvey Brooks and Raymond Bower in *Scientific American*, February 1970. Raphael G. Kasper has compiled the views of eleven assessment "authorities" in *Technology Assessment: Understanding the Social Consequences of Technological Applications* (Praeger, $16.50). Due for publication early this year, the book emphasizes the problem of developing a congressional assessment capability.

As with any respectable discipline, technology assessment is about to get its own journal. Called *Technology Assessment Review*, it will be published by Mouton in The Hague, The Netherlands, hopefully by Feb. 1 of this year. The journal should be of some use, if for no other reason than to gather the voluminous assessment literature together in one place.

ENGLEBERT KIRCHNER,
NINA LASERSON.

EXECUTIVE OFFICE OF THE PRESIDENT,
OFFICE OF MANAGEMENT AND BUDGET,
Washington, D.C. March 24, 1972.

Hon. B. EVERETT JORDAN,
Chairman, Committee on Rules and Administration,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: Your letter of August 27, 1971, requested the views of this Office on S. 2302, a bill that would establish an Office of Technology Assessment for the Congress.

We defer to the Congress as to the need for such an Office and as to whether it should be established as a separate entity or be placed within one of the existing

agencies of the Congress. Our comments are directed to those provisions of the bill that would directly involve the executive branch.

Two provisions raise difficulties. Section 4(a)(5) of the bill would provide that the President appoint four members of the Technology Assessment Board from the public, by and with the advice and consent of the Senate. It is clear from statements of congressional supporters of S. 2302 and similar bills that the Office of Technology Assessment is intended to be strictly an arm of the Congress. Consonant with this objective it is recommended that the section be amended to provide that appointments to the Board be made by the Congress.

Sec. 8(b) of the bill would amend the National Science Foundation Act of 1950 to authorize the Foundation to support activities in specified areas at the request of other agencies, including the Office of Technology Assessment, with *or without* reimbursement. Under the existing statute, agencies which request NSF to carry out specific scientific activities are required to reimburse NSF for these activities. The effect of Sec. 8(b) of the bill would be to single out areas for favored treatment, contrary to the basic orientation of the Foundation's Act.

Moreover, this provision would create an irregular legislative-executive relationship if the Foundation were to undertake activities at the request of the Office of Technology Assessment. It would seem preferable that the Office fully support its own activities, although there should be continuing interchange of plans and information among all agencies concerned with technology assessment.

In view of these difficulties, the Office of Management and Budget recommends against enactment of the proposed amendment to the National Science Foundation Act incorporated within S. 2302.

Sincerely,

WILFRED H. ROMMEL,
Assistant Director for Legislative Reference.

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