The Office of Technology Assessment: History, Authorities, Issues, and Options

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SUMMARY

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The Office of Technology Assessment: History, Authorities, Issues, and Options

Congress established the Office of Technology Assessment (OTA) as a legislative branch agency by the Office of Technology Assessment Act of 1972 (P.L. 92-484). OTA was created to provide Congress with early indications of the probable beneficial and adverse impacts of technology applications. OTA's work was to be used as a factor in Congress' consideration of legislation, particularly with regard to activities for which the federal government might provide support for, or management or regulation of, technological applications.

The agency operated for more than two decades, producing approximately 750 full assessments, background papers, technical memoranda, case studies, and workshop proceedings spanning a wide range of topics. In 1995, amid broader efforts to reduce the size of government, Congress eliminated funding for the agency. Although the agency ceased operations, the statute authorizing OTA's establishment, structure, functions, duties, powers, and relationships to other entities (2 U.S.C. §§471 et seq.) was not repealed. Since OTA's defunding, there have been several attempts to reestablish OTA or to create an OTA-like function for Congress.

During its years of operations, OTA was both praised and criticized by some Members of Congress and outside observers. Many found OTA's reports to be comprehensive, balanced, and authoritative; its assessments helped shaped public debate and laws in national security, energy, the environment, health care and other areas. Others identified a variety of shortcomings. Some critics asserted that the time it took for OTA to define a report, collect information, gather expert opinions, analyze the topic, and issue a report was not consistent with the fast pace of legislative decisionmaking. Others asserted that some of OTA's reports exhibited bias and that the agency was responsive only to a narrow constituency in Congress, that reports were costly and not timely, that there were insufficient mechanisms for public input, and that the agency was inconsistent in its identification of ethical and social implications of developments in science and technology. In debate leading to OTA's defunding, a central assertion of its critics was that the agency duplicated the work of other federal agencies and organizations. Those holding this position asserted that other entities could take on the technology assessment function if directed to do so by Congress. Among the entities identified for this role were the Government Accountability Office (then the General Accounting Office), the Congressional Research Service, the National Academies, and universities.

Congress has multiple options for addressing its technology assessment needs. Congress could opt to reestablish OTA by appropriating funds for the agency's operation, potentially including guidance for its reestablishment in the form of report language. If it pursues this option, Congress would need to reestablish two related statutorily mandated organizations: the Technology Assessment Board (TAB), OTA's bipartisan, bicameral oversight body; and the Technology Assessment Advisory Council (TAAC), OTA's external advisory body. In 2019, the House included $6.0 million for OTA in the House-passed version of the Legislative Branch Appropriations Act, 2020 (H.R. 2779); no funding was provided in the final act. Congress might also opt to amend OTA's authorizing statute to address perceived shortcomings; to revise its mission, organizational structure, or process for initiation of technology assessments; or to make other modifications or additions.

Alternatively, Congress could choose to create or develop an existing technology assessment capability in another legislative branch agency, such as the Government Accountability Office (GAO) or Congressional Research Service. Since FY2002, Congress has directed GAO to bolster its technology assessment capabilities. From 2002 to 2019, GAO produced 16 technology assessments. In 2019, GAO, at the direction of Congress, created a new office, Science, Technology Assessment, and Analytics (STAA), and announced plans to increase the number of STAA analysts over time from 49 to 140.

In addition, Congress could increase its usage of the National Academies of Science, Engineering, and Medicine by funding an expanded number of congressionally mandated technology assessments. Alternatively, Congress

could opt to take no action and instead rely on current sources of information—governmental and nongovernmental—to meet its needs.

In 2018, Congress directed CRS to contract with the National Academy of Public Administration (NAPA) for a study to "assess the potential need within the Legislative Branch to create a separate entity charged with the mission of providing nonpartisan advice on issues of science and technology. Furthermore, the study should also address if the creation of such entity duplicates services already available to Members of Congress." The NAPA study recommended bolstering the science and technology policy efforts of CRS and GAO, as well as the establishment of an Office of the Congressional Science and Technology Advisor (OCSTA) and a coordinating council. NAPA stated that it did not evaluate the option of reestablishing OTA due to Congress' efforts since 2002 to build a technology assessment capability within GAO.

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Introduction

Congress established the Office of Technology Assessment (OTA) in October 1972 in the Technology Assessment Act of 1972 (P.L. 92-484) to provide

> competent, unbiased information concerning the physical, biological, economic, social, and political effects of [technological] applications" [to be used as a] "factor in the legislative assessment of matters pending before the Congress, particularly in those instances where the Federal Government may be called upon to consider support for, or management or regulation of, technological applications.[1]

The agency operated for more than two decades, producing approximately 750 full assessments, background papers, technical memoranda, case studies, and workshop proceedings. In 1995, amid broader efforts to reduce the size of government, Congress eliminated funding for the operation of the agency. Congress appropriated funding for FY1996 "to carry out the orderly closure" of OTA. Although the agency ceased operations, the statute authorizing OTA's establishment, structure, functions, duties, powers, and relationships to other entities was not repealed.[2]

Since OTA's defunding, some Members of Congress, science and technology advocates, and others have sought to reestablish OTA or to establish similar analytical functions in another agency or nongovernmental organization. This report describes the OTA's historical mission, organizational structure, funding, staffing, operations, and perceived strengths and weakness. The report concludes with a discussion of issues and options surrounding reestablishing the agency or its functions. The report also includes three appendices. **Appendix A** provides a historical overview of discussions about the definition of "technology assessment," a topic fundamental to OTA's mission and to any organization that would seek to fulfill OTA's historic role. **Appendix B** describes selected trends and factors that may contribute to a perceived need for technology assessment. **Appendix C** provides a history of legislative efforts to reestablish OTA or its functions since the agency was defunded. **Appendix D** provides a list of technology assessment products produced from 2002 to 2019 by the Government Accountability Office (GAO). Congress's guidance to GAO on technology assessment during this period is provided in the section "Congress, GAO, and Technology Assessment."

Overview of Science and Technology Advice to Policymakers

Groundbreaking emerging technologies—in fields such as artificial intelligence, quantum computing, gene editing, hypersonics, autonomy, and nanotechnology—are widely anticipated to have substantial economic and social impacts, affecting the ways people work, travel, learn, live, and engage with others and the surrounding world. The impacts are likely to be felt by people of all ages, across most industries, and by government. Science, technology, and innovation have

[1] 2 U.S.C. §471.

[2] OTA's authorities remain in the U.S Code at 2 U.S.C. §§471-481. Nevertheless, the conference report (H.Rept. 104-212) accompanying H.R. 1854 (104th Congress) refers to "the elimination of the OTA" in the context of a severance package for employees of OTA. (H.R. 1854 was vetoed but its contents became law subsequently in identical form as H.R. 2492 (P.L. 104-53). According to *CQ Almanac,* the bill was the second of the 13 regular appropriations bills to be sent to the President by Congress. In vetoing the bill, President Clinton called it "a disciplined bill, one that I would sign under different circumstances," but added that, "I don't think Congress should take care of its own business before it takes care of the people's business." ("Congress Cuts Legislative Funds." *CQ Almanac 1995*, 51st ed., Congressional Quarterly, 1996, pp. 11-61-11-65, library.cqpress.com/cqalmanac/cqal95-1099783.))

been of interest to government leaders throughout the nation's history. The federal government has looked to people and organizations with expertise in the development and application of new technologies to gain insights into their implications and potential public policy responses—both to accelerate and maximize their expected benefits and to reduce or eliminate expected adverse effects. Such policies may include, among other things

- the funding of research and development (R&D) to accelerate the arrival and deployment of technologies and to identify their uses and potential implications;
- infrastructure policies, such as "smart" highways and cities, focused on creating environments where new technologies can flourish;
- regulations to guide and govern the development and use of technologies to ensure human health and public safety and to protect the environment;
- tax policies and other incentives to encourage investment in technology development and adoption;
- trade policies to maximize the global economic and societal potential of new technologies by fostering market access and eliminating tariff and nontariff barriers;
- intellectual property policies to protect the interests of those investing in technology development and commercialization; and
- education and training programs to promote U.S. leadership in innovation and ensure the adequacy of the science and technology workforce, as well as to help those who are displaced by new technologies to attain the knowledge and skills needed for other jobs.

In some cases, a specific science or technology outcome may be the primary objective of a proposed policy, while in other cases science and technology may play a role in a broader policy effort to achieve other societal goals, such as environmental quality, public health and safety, economic competitiveness, or national security. Science and technology activities, programs, and sectors can be affected by tradeoffs resulting from multiple policy objectives. For example, U.S. trade policy for high technology goods and services may involve complementary and competing policy objectives related to intellectual property protection, expansion of markets, protection of U.S. national security, and advancement of geopolitical objectives.

U.S. government efforts to obtain guidance on scientific and technical issues and their policy implications extend back to the nation's founding. Some of these efforts were informal, with Presidents, Members of Congress, and executive branch officials seeking out insights of knowledgeable individuals on an ad hoc basis.

Presidents and congressional leaders also relied on more formal advice from scientific and technical societies, and business and professional organizations for insights and guidance on science, technology, and innovation-related issues. A number of organizations and their members helped fill this role in the early years of the country's development, including the American Philosophical Society, co-founded by Benjamin Franklin in 1743; the American Academy of Arts and Sciences, founded in 1780 in Boston, whose charter members included John Adams and Samuel Adams; the Academy of Natural Sciences of Philadelphia, founded in 1812; the Smithsonian Institution, established by an act of Congress in 1846;[3] and the American Association for the Advancement of Science, founded in 1848.

[3] The Smithsonian Institution was established in 1846 using funds bequeathed by James Smithson, a British scientist, to (continued...)

In 1863, Congress chartered the National Academy of Sciences and directed that "the academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States."[4] Three related entities were subsequently formed to complement the knowledge and capabilities of the National Academy of Sciences: the National Academy of Engineering,[5] the National Academy of Medicine,[6] and the National Research Council.[7] These four organizations are collectively referred to as the National Academies of Science, Engineering, and Medicine (NASEM) or simply, the National Academies. They are nonprofit, nongovernmental entities.

In addition, throughout the 20th century, Congresses and Presidents, using statutory and executive authorities, respectively, established executive branch organizations to provide scientific insight and advice to the President, as well as informing Congress and federal departments and agencies. Advisory and coordinating organizations included the National Advisory Committee for Aeronautics (NACA, est. 1915),[8] the Science Advisory Committee (SAC, est. 1951),[9] the President's Science Advisory Committee (PSAC, est. 1956),[10] the Intergovernmental Science, Engineering, and Technology Panel (ISETAP, est. 1976),[11] the President's Committee on Science and Technology (PCST, est. 1976),[12] and the President's Council of Advisors on Science and Technology (PCAST, est. 1990).[13] Other organizations were established in statute. For example,

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the "United States of America." Smithson directed the funds be used "to found at Washington, under the name of the Smithsonian Institution, an Establishment for the increase and diffusion of knowledge." Smithson died in 1829; Congress accepted the funds in 1836. However, Congress engaged in debate over the proper use of the funds for 10 years before the Institution was finally established. (Source: Smithsonian Institution, https://www.si.edu/about/history.)

[4] "An Act to Incorporate the National Academy of Sciences," March 3, 1863, http://www.nasonline.org/about-nas/leadership/governing-documents/act-of-incorporation.html.

[5] Established in 1964.

[6] Established as the Institute of Medicine (IoM) in 1970; renamed as the National Academy of Medicine in 2015.

[7] The National Academy of Sciences approved the establishment of the National Research Council (NRC) in 1916, "to bring into cooperation government, educational, industrial, and other research organizations with the object of encouraging the investigation of natural phenomena, and increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the national defense, and such other applications of science as will promote the national security and welfare." The NRC was approved by President Woodrow Wilson that year. In 1918, Wilson recognized the National Research Council's contribution to the U.S. efforts in World War I and perpetuated it as an organization in Executive Order 2859.

[8] Following the onset of hostilities in World War I but prior to the U.S. entry into the war, Congress established NACA through P.L. 271 (63rd Congress), a naval appropriations act, on March 3, 1915.

[9] President Harry S. Truman established the Science Advisory Committee in 1951 as part of the Office of Defense Mobilization. (Harry S. Truman Library, "Letter to the Chairman, Science Advisory Committee," April 20, 1951, https://www.trumanlibrary.gov/library/public-papers/89/letter-chairman-science-advisory-committee.)

[10] Following the Soviet Union's launch of Sputnik satellites, President Dwight D. Eisenhower moved the function to the White House and renamed it the President's Science Advisory Committee.

[11] Congress directed the OSTP director to establish ISETAP through the National Science and Technology Policy, Organization, and Priorities Act of 1976 (P.L. 94-282, Sec. 205) in 1978. ISETAP was dissolved and reestablished by Executive Order 12039 with its functions transferred to the President under Sections 5A of Reorganization Plan No. 1 of 1977.

[12] Congress established PCST through the National Science and Technology Policy, Organization, and Priorities Act of 1976 (P.L. 94-282, Sec. 205).

[13] PCAST was first established by President George H.W. Bush in 1990. (Executive Order 12700, "President's Council of Advisors on Science and Technology," 55 *Federal Register* 2219, January 23, 1990.) Presidents Clinton, George W. Bush, Obama, and Trump reestablished (sometimes with slight modifications) or extended PCAST during their Administrations.

the National Science Board (NSB, which oversees the National Science Foundation) was established by the National Science Foundation Act of 1950; a key statutory mandate of the NSB is to "render to the President and to the Congress reports on specific, individual policy matters related to science and engineering and education in science engineering, as Congress or the President determines the need for such reports."[14] In addition, many science and technology agencies in the executive branch have deep expertise across a wide spectrum of technologies; several of these have policy-oriented offices or programs.

While Congress had its own science and technology advisory resources—including the Congressional Research Service (CRS) and the General Accounting Office (GAO, now the Government Accountability Office)—prior to the establishment of OTA, many federal science and technology advisory organizations and agencies were under the authority and direction of the President.[15] Accordingly, during the decade preceding the establishment of OTA, a number of lawmakers expressed a need for Congress to have its own agency to conduct detailed science and engineering analyses and provide information tailored to legislative needs and the legislative process—to supplement the functions performed by GAO and CRS.[16] For example, in a 1963 hearing, Representative George Miller, chairman of the House Committee on Science and Astronautics, stated

> We are concerned with whether or not hasty decisions are handed down to us, but one of our difficulties is how to evaluate these decisions. We have to take a great deal on faith. We are not scientists … [but] I want to say that in our system of government we have our responsibility. We are not the rubber stamps of the administrative branch of Government… [We] recognize our responsibility to the people and the necessity for making some independent judgments … [but] we do not particularly have the facilities nor the resources that the executive department of the government has.[17]

In August 1963, Senator Edward L. Bartlett, introduced a bill to establish in the legislative branch a congressional Office of Science and Technology:

> The scientific revolution proceeds faster and faster … and the President, in requesting authority for these vast scientific programs undertaken by the Government,… has available to him the full advice and counsel of the scientific community…. The Congress has no such help. The Congress has no source of independent scientific wisdom and advice. Far too often congressional committees for expert advice rely upon the testimony of the very scientists who have conceived the program, the very scientists who will spend the money if the program is authorized and appropriated for.… Congress as a body must equip itself to legislate on technological matters with coherence and comprehension.[18]

In December 1963, Senator Bartlett testified at a hearing of the Committee on House Administration Subcommittee on Accounts on the establishment of a congressional science advisory staff:

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[14] 42 U.S.C. §1863(j)(2).

[15] The CRS Science Policy Research Division (SPRD) was established in 1964. In 1999, CRS reorganized, embedding SPRD analysts in CRS units in which science and technology issues were an important part of broader issue areas (e.g., energy, environment, health), while retaining a smaller cadre of analysts in a science and technology unit focused primarily on science and technology policy issues writ-large (e.g., policies associated with research and development funding and activities, technology transfer, innovation).

[16] Gregory C. Kunkle, "New Challenge or the Past Revisited?" *Technology in Society*, vol. 17, no. 2, 1995.

[17] U.S. Congress, House Committee on Science and Astronautics, "Panel on Science and Technology, Fifth Meeting," 88th Cong., 1st sess., 1963), January 22, 1963, pp. 38-41.

[18] Senate, *Congressional Record* (August 13, 1963), pp. 14809-14810.

> Faceless technocrats in long, white coats are making decisions today which rightfully and by law should be made by the Congress. These decisions dealing with the allocation of our scientific and technical resources must be made…. I think the Congress should make these decisions. I think they should be made in a rational manner. I think they should be made by an informed legislature which understands the implications, the costs, and the priorities of its judgments.

Similarly, in a 1970 hearing of the House Subcommittee on Science, Research, and Development on H.R. 17046 (91st Congress), a bill to establish OTA, subcommittee chair Representative Emilio Daddario stated

> This Subcommittee has recognized a need to pay more attention to the technological content of legislative issues. Since 1963, a large portion of the Subcommittee efforts have been to develop avenues of information and advice for the Congress with outside groups, We have recognized the important need for developing Independent means of obtaining necessary and relevant technological Information for the Congress, without having to depend almost solely on the Executive Branch. In my view, it is only with this capability that Congress can assure its role as an equal branch in our Federal structure.[19]

During the 1972 House debate on establishing OTA, Representative Chuck Mosher reiterated the need for Congress to have its own science and technology advisory responsive solely to Members of Congress and congressional committees:

> Let us face it, Mr. Chairman, we in the Congress are constantly outmanned and outgunned by the expertise of the executive agencies. We desperately need a stronger source of professional advice and information, more immediately and entirely responsible to us and responsive to the demands of our own committees, in order to more nearly match those resources in the executive agencies.
>
> Many, perhaps most, of the proposals for new or expanding technologies come to us from the executive branch; or at least it is the representatives of those agencies who present expert testimony to us concerning such proposals. We need to be much more sure of ourselves, from our own sources, to properly challenge the agency people, to probe deeply their advice, to more efficiently force them to justify their testimony—to ask sharper questions, demand more precise answers, to pose better alternatives.[20]

Peter Blair, author of *Congress' Own Think Tank: Learning from the Legacy of the Office of Technology Assessment,* asserts that this perspective contributed to the establishment of OTA and other congressional science and technology analytical functions:

> [Many] viewed the creation of OTA, as well as the subsequent creation of CBO, and the expansion of [the Congressional Research Service] and [General Accounting Office][21] at around the same time, as part of a congressional reassertion of authority responding to Richard Nixon's presidency.[22]

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[19] U.S. Congress, House Committee on Science and Aeronautics, Subcommittee on Science, Research, and Development, "Technology Assessment," 91st Cong., 2nd sess., May 20, 1970, https://congressional.proquest.com/congressional/result/congresultpage:pdfevent?rsId=16DC64F36DE&pdf=/app-bin/gis-hearing/0/3/0/4/hrg-1970-sah-0004_from_1_to_340.pdf&uri=/app-gis/hearing/hrg-1970-sah-0004.

[20] House, floor debate, *Congressional Record*, February 8, 1972, p. H867, as cited in Barry M. Casper, "The Rhetoric and Reality of Congressional Technology Assessment," *The Bulletin of the Atomic Scientists*, vol. 34, no. 2 (February 1978), p. 21.

[21] In 2004, Congress redesignated the General Accounting Office as the Government Accountability Office through the GAO Human Capital Reform Act of 2004 (P.L. 108-271). The agency retained its initialism, GAO.

[22] Peter D. Blair, *Congress's Own Think Tank: Learning from the Legacy of the Office of Technology Assessment*, ed. Albert N. Link (2013), p. 26.

While advocates for the creation of OTA asserted that its functions would be complementary to GAO and CRS, others expressed concerns about the costs of setting up another bureaucracy and suggested that the roles envisioned for OTA might be done by the existing agencies, perhaps at a lower cost. Some proposed, instead, that the functions intended for OTA be given to CRS or GAO.[23]

The Office of Technology Assessment

For several years in the late 1960s and early 1970s, Congress explored and deliberated on the need for, and value of, technology assessment as an aid in policymaking decisions. In 1972, Congress enacted the Technology Assessment Act of 1972 (P.L. 92-484, codified at 2 U.S.C. §§471 et seq.), establishing the Office of Technology Assessment as a legislative branch agency.

The meaning of the term "technology assessment" is fundamental to the types of research and analysis that OTA or a successor organization might perform. There is no single authoritative definition of the term. In practice, an implicit definition is provided in the Technology Assessment Act of 1972:

> The basic function of the Office shall be to provide early indications of the probable beneficial and adverse impacts of the applications of technology and to develop other coordinate information which may assist the Congress.[24]

In the act, Congress found and declared that technological applications were "large and growing in scale; and increasingly extensive, pervasive, and critical in their impact, beneficial and adverse, on the natural and social environment." Accordingly, Congress deemed it "essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems."[25]

Further, Congress found that existing legislative branch agencies were not designed to provide Congress with independently developed, adequate, and timely information related to the potential impact of technological applications.

For these reasons, Congress authorized the establishment of OTA to "equip itself with new and effective means for securing competent, unbiased information concerning the physical, biological, economic, social, and political effects of such applications." The information provided by OTA would serve "whenever appropriate, as one factor in the legislative assessment of matters pending before the Congress, particularly in those instances where the Federal Government may be called upon to consider support for, or management or regulation of, technological applications."[26]

In assigning functions, duties, and powers to OTA, Congress further refined its concept of technology assessment; these are described later in this report. For a discussion of the history and varying perspectives on the meaning of the term, see **Appendix A**.

[23] Gregory C. Kunkle, "New Challenge or the Past Revisited?" *Technology in Society*, vol. 17, no. 2, 1995.

[24] 2 U.S.C. §472(c).

[25] 2 U.S.C. §471.

[26] Ibid.

Statutory Organization and Authorities

As previously noted, the authorization for OTA's existence, structure, and functions remains in effect. This section provides an overview of OTA's structure, function and duties, powers, components and related organizations, and other information, as articulated in the agency's organic statute and codified at 2 U.S.C. §§471-481. Because these authorities remain in effect, despite the fact that OTA itself no longer exists, this section describes the authorities using the present tense.

Structure, Functions, and Duties

The Technology Assessment Act of 1972 authorizes the establishment of an Office of Technology Assessment, composed of a Director and a Technology Assessment Board (TAB). The TAB is to "formulate and promulgate the policies" for OTA to be carried out by the Director.[27]

OTA's functions and duties include

- identifying existing or probable impacts of technology or technological programs;
- ascertaining cause-and-effect relationships, where possible;
- identifying alternative technological methods of implementing specific programs;
- identifying alternative programs for achieving requisite goals;
- making estimates and comparisons of the impacts of alternative methods and programs;
- presenting findings of completed analyses to the appropriate legislative authorities;
- identifying areas where additional research or data collection is required to provide adequate support for its assessments and estimates; and
- undertaking such additional associated activities as directed by those authorized to initiate assessments (see below).[28]

Powers

The statute authorizes OTA "to do all things necessary" to carry out its functions and duties including, but not limited to

- making full use of competent personnel and organizations outside of OTA, public or private, and forming special ad hoc task forces or making other arrangements when appropriate;
- entering into contracts or other arrangements for the conduct of the work of OTA with any agency of the United States, with any state, territory, or possession, or with any person, firm, association, corporation, or educational institution;
- making advance, progress, and other payments which relate to technology assessment;

[27] 2 U.S.C. §472(b).

[28] 2 U.S.C. §472(c).

- accepting and utilizing the services of voluntary and uncompensated personnel necessary for the conduct of the work of OTA and providing transportation and subsistence for persons serving without compensation;
- acquiring by purchase, lease, loan, or gift, and holding and disposing of by sale, lease, or loan, real and personal property necessary for exercising the OTA's authority; and
- prescribing such rules and regulations as it deems necessary governing the operation and organization of OTA.[29]

The act also authorizes OTA "to secure directly from any executive department or agency information, suggestions, estimates, statistics, and technical assistance for the purpose of carrying out its functions." It also requires executive departments and agencies to furnish such information, suggestions, estimates, statistics, and technical assistance to OTA upon its request.[30]

Other provisions prohibit OTA from operating any laboratories, pilot plants, or test facilities,[31] and authorize the head of any executive department or agency to detail personnel, with or without reimbursement, to assist OTA in carrying out its functions.[32]

Technology Assessment Board

Under the act, the Technology Assessment Board (TAB) is to consist of 13 members: six Senators (three from the majority party and three from the minority party), six Members of the House of Representatives (three from the majority party and three from the minority party), and the OTA Director. The Director is to be a nonvoting member. The Senate members are to be appointed by the President pro tempore of the Senate; House members are to be appointed by the Speaker of the House of Representatives.

The act authorizes the TAB to "formulate and promulgate the policies" of OTA. It also authorizes the TAB, upon majority vote, to "require by subpoena or otherwise the attendance of such witnesses and the production of such books, papers, and documents, to administer such oaths and affirmations, to take such testimony, to procure such printing and binding, and to make such expenditures, as it deems advisable." It authorizes the TAB to make rules for its organization and procedures and authorizes any voting member of the TAB to administer oaths or affirmations to witnesses.

The chair and vice chair of the TAB are to alternate between the House and Senate each Congress. During each even-numbered Congress, the chair is to be chosen from the House members of the TAB, and the vice chair is to be chosen from the Senate members. In each odd-numbered Congress, the chair is to be chosen from the Senate members of the TAB, and the vice chair is to be chosen from among the House members.

No TAB was established after the 104th Congress. The House did not formally appoint members in the 104th Congress, but Senate membership in the TAB was continuous and therefore the Senate members served as OTA's board until the agency ceased operations in 1995.[33]

[29] 2 U.S.C. §475(a).

[30] 2 U.S.C. §475(d).

[31] 2 U.S.C. §475(c).

[32] 2 U.S.C. §475(e).

[33] Peter D. Blair, "After the Fall: Post OTA Efforts to Fill the Gap," in Co*ngress's Own Think Tank: Learning from the Legacy of the Office of Technology Assessment (1972-1995)*, ed. Albert N. Link (Palgrave Macmillan, 2003), p. 19.

Director, Deputy Director, and Other Staff

Under the act, the TAB is to appoint the OTA Director for a term of up to six years. The act authorizes the Director to exercise the powers and duties provided for in the act, as well as such powers and duties as may be delegated to the Director by the TAB. The TAB has the authority to remove the Director prior to the end of the six-year term.

The act authorizes the Director to appoint a Deputy Director. The Director and the Deputy Director are prohibited from engaging in any other business, vocation, or employment; nor is either allowed to hold any office in, or act in any capacity for, any organization, agency, or institution with which OTA contracts or otherwise engages.[34]

The Director is to be paid at level III of the Executive Schedule and the Deputy Director is to be paid at level IV.[35] The act authorizes the Director to appoint and determine the compensation of additional personnel to carry out the duties of OTA, in accordance with policies established by the TAB.[36]

Initiation of Technology Assessment Activities

Under the act, OTA may conduct technology assessments only at the request of

- the chair of any standing, special, or select committee of either chamber of Congress, or of any joint committee of the Congress, acting on his or her own behalf or at the request of either the ranking minority member or a majority of the committee members;
- the TAB; or
- the Director, in consultation with the TAB.[37]

Technology Assessment Advisory Council

Under the act, OTA is to establish a Technology Assessment Advisory Council (TAAC). The TAAC shall, upon request by the TAB, review and make recommendations to the TAB on activities undertaken by OTA; review and make recommendations to the TAB on the findings of any assessment made by or for OTA; and undertake such additional related tasks as the TAB may direct.[38]

Under the act, the TAAC is to be composed of 12 members:

- 10 members from the public, to be appointed by the TAB, who are to be persons "eminent in one or more fields of the physical, biological, or social sciences 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";
- the Comptroller General, who heads GAO; and

[34] 2 U.S.C. §474(d).

[35] 2 U.S.C. §474(a) and §474(c), respectively.

[36] 2 U.S.C. §475(f)

[37] 2 U.S.C. §472(d).

[38] 2 U.S.C. §476(b).

- the Director of the Congressional Research Service.[39]

The public members of the TAAC are to be appointed to four-year terms. They are to receive compensation for each day engaged in the actual performance of TAAC duties at the highest rate of basic pay in the General Schedule. The law authorizes reimbursement of travel, subsistence, and other necessary expenses for all TAAC members.[40]

Under the act, a TAAC member appointed from the public may be reappointed for a second term, but may not be appointed more than twice. The TAAC is to select its chair and vice chair from among its appointed members.[41] The terms of TAAC members are to be staggered, according to a method devised by the TAB.[42]

Services and Assistance from CRS and GAO

The act authorizes the Librarian of Congress to make available to OTA such services and assistance of the Congressional Research Service as are appropriate and feasible, including, but not limited to, all of the services and assistance which CRS is otherwise authorized to provide to Congress. The Librarian is authorized to establish within CRS such additional divisions, groups, or other organizational entities as necessary for this purpose. Services and assistance made available to OTA by CRS may be provided with or without reimbursement from OTA, as agreed upon by the TAB and the Librarian.[43]

Similarly, the act directs the Government Accountability Office to provide to OTA financial and administrative services (including those related to budgeting, accounting, financial reporting, personnel, and procurement) and such other services. Such services and assistance to OTA include, but are not limited to, all of the services and assistance that GAO is otherwise authorized to provide to Congress. Services and assistance made available to OTA by GAO may be provided with or without reimbursement from OTA, as agreed upon by the TAB and the Comptroller General.[44]

Coordination with the National Science Foundation

Under the act, OTA is to maintain a continuing liaison with the National Science Foundation with respect to grants and contracts for purposes of technology assessment, promotion of coordination in areas of technology assessment, and avoidance of unnecessary duplication or overlapping of research activities in the development of technology assessment techniques and programs.[45]

Information Disclosure

The act requires that OTA assessments—including information, surveys, studies, reports, and related findings—shall be made available to the initiating committee or other appropriate committees of Congress. In addition, the act authorizes the public release of any information, surveys, studies, reports, and findings produced by OTA, except when doing so would violate

[39] 2 U.S.C. §476(a).

[40] 2 U.S.C. §476 (e).

[41] 2 U.S.C. §476 (c).

[42] 2 U.S.C. §476(d).

[43] 2 U.S.C. §477.

[44] 2 U.S.C. §478.

[45] 2 U.S.C. §479.

national security statutes or when the TAB deems it necessary or advisable to withhold such information under the exemptions provided by the Freedom of Information Act.[46]

Other

The act requires OTA's contractors and certain other parties to maintain books and related records needed to facilitate an effective audit in such detail and in such manner as shall be prescribed by OTA. These books and records (and related documents and papers) are to be available to OTA and the Comptroller General, or their authorized representatives, for audits and examinations.[47]

Funding

Congress appropriated funds for OTA from FY1974 to FY1996 in annual legislative branch appropriations acts. Funding was provided mainly through regular appropriations acts, but additional funding was provided in some years through supplemental appropriations acts. In some fiscal years, Congress reappropriated unused OTA funds from earlier appropriations, essentially carrying the funds over to the next year. In some years, appropriations were reduced through sequestration or rescission.[48]

OTA's funding grew steadily throughout its existence, from an initial appropriation of $2 million in FY1974 ($8.6 million in constant FY2019 dollars) to a current dollar peak of $21.3 million in FY1995 ($33.4 million in constant FY2019 dollars).[49] See **Figure 1** (current dollars) and **Figure 2** (constant FY2019 dollars).

OTA's budget peaked in constant dollars in FY1992 at $35.1 million in constant FY2019 dollars.[50] OTA received $3.6 million ($5.6 million in constant FY2019 dollars) in FY1996 to close out its operations. According to the Office of Management and Budget, OTA was not funded beyond February 1996.[51]

[46] 2 U.S.C. §472(e). 5 U.S.C. 552(b) provides exceptions to requirements for public disclosure of federal agency information such as sensitive national defense or foreign policy information, agency internal personnel rules and practices, and trade secrets and commercial information among other information. For more information, see CRS Report R41933, *The Freedom of Information Act (FOIA): Background, Legislation, and Policy Issues*, by Meghan M. Stuessy.

[47] 2 U.S.C. §475(b).

[48] On at least one occasion, Congress provided funds for a particular report. In FY1978, separate from OTA's regular appropriation, Congress provided $1 million for a "comprehensive evaluation of energy policy alternatives." In 1986, funding for OTA was reduced by $658,000 under a sequestration order required by the Balanced Budget and Emergency Deficit Control Act of 1985 (P.L. 99-177). In 1995, a rescission reduced OTA funding by $650,000 (Emergency Supplemental Appropriations for Additional Disaster Assistance, for Anti-terrorism Initiatives, for Assistance in the Recovery from the Tragedy That Occurred at Oklahoma City, and Rescissions Act, 1995, P.L. 104-19).

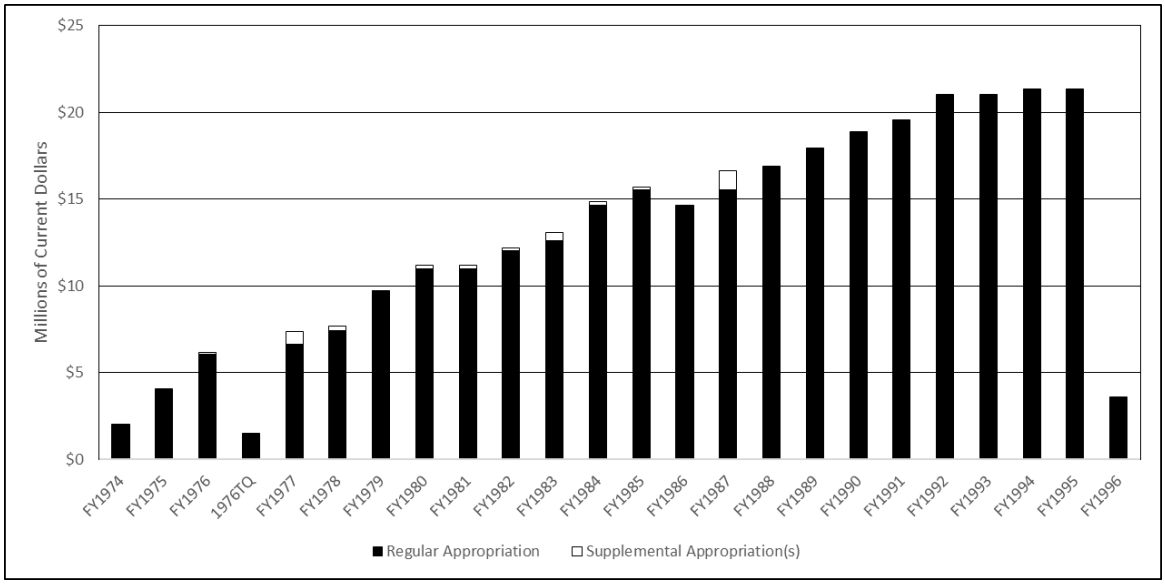
[49] Appropriations figures are prior to FY1995 rescission that reduced OTA funding by $650,000 in current dollars, and by $1.0 million in FY2018 constant dollars.

[50] CRS converted current dollars to constant FY2018 dollars using GDP (chained) price index in Table 10.1 of *Budget of the United States Government for Fiscal Year 2020*.

[51] Office of Management and Budget, *FY1998 Budget of the United States, Appendix*, "Legislative Branch," p. 21.

Figure 1. OTA Appropriations, FY1974-FY1996

Millions of Current Dollars

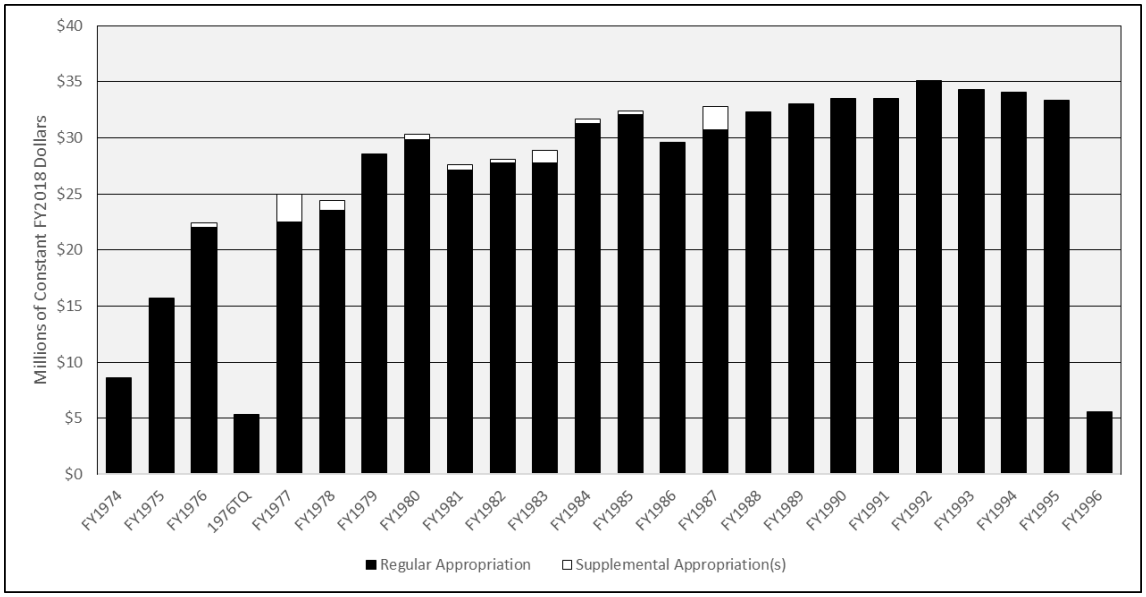


Sources: Prepared by CRS. Data from Office of Management and Budget annual *Budget Appendix* volumes; U.S. Congress, House Committee on Science and Technology, Subcommittee on Science, Research, and Technology, *Review of the Office of Technology Assessment and Its Organic Act*, committee print, prepared by Genevieve J. Knezo, Science Policy Research Division, Congressional Research Service, 95th Congress, 2nd session, November 1978, 30-911 (Washington: GPO, 1978), p. 23.

Notes: TQ = transition quarter. In 1976, the federal government moved the start of its fiscal year from July 1 to October 1. As a consequence, there was a transitional quarter (TQ) for the three-month period from July 1 through September 30, 1976. In the chart, appropriations have been reduced by $0.7 million in FY1986 due to a sequestration, and reduced by $0.7 million in FY1995 due to a rescission.

Figure 2. OTA Appropriations, FY1974-FY1996

Millions of Constant FY2019 Dollars



Sources: Prepared by CRS. Data from Office of Management and Budget annual *Budget Appendix* volumes; U.S. Congress, House Committee on Science and Technology, Subcommittee on Science, Research, and Technology, *Review of the Office of Technology Assessment and Its Organic Act*, committee print, prepared by Genevieve J. Knezo, Science Policy Research Division, Congressional Research Service, 95th Congress, 2nd session, November 1978, 30-911 (Washington: GPO, 1978), p. 23.

Notes: TQ = transition quarter. In 1976, the federal government moved the start of its fiscal year from July 1 to October 1. As a consequence, there was a transitional quarter (TQ) for the three-month period from July 1 through September 30, 1976. Current dollars were converted to constant FY2019 dollars using GDP (chained) price index in Table 10.1 of *Budget of the United States Government for Fiscal Year 2021*. In the chart, appropriations were reduced by $1.3 million (in 2019 adjusted dollars) in FY1986 due to a sequestration, and reduced by $1.0 million (in 2019 adjusted dollars) in FY1995 due to a rescission.

Staffing

CRS was unable to identify a consistent measurement of OTA staffing that spans the period during which Congress appropriated funds for the agency. **Figure 3** includes OTA staffing levels using three different characterizations that were consistent during parts of this time period. The data are from the *Budget of the United States Government* for fiscal years 1976-1998.[52] Using these measures, staffing was first reported for FY1974 at 42, and rose to 151 in FY1977. Staffing then fell through 1980 before rising again, but remained between 123 and 143 from FY1978 to FY1991. In FY1992, reported staffing jumped to 193, and rose to a reported 210 in FY1993. In FY1994, staffing fell to a reported 197 and continued to drop through the end of the agency's funding in FY1996.

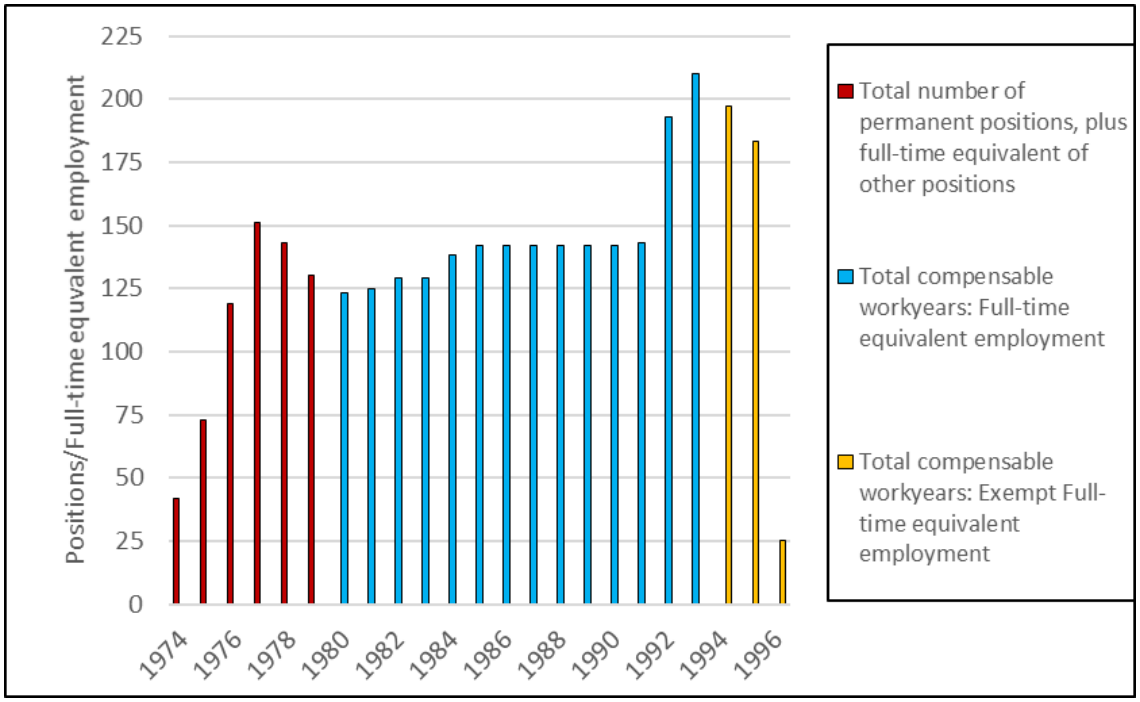
During most years of OTA's operations, Congress included an annual cap on the agency's total number of "staff employees" in annual appropriations laws, beginning with a cap of 130 in the FY1978 Legislative Branch Appropriations Act (P.L. 95-94). This cap was included in subsequent

[52] The data used in **Figure 3** for FY1974 to FY1979 are "total number of permanent positions" plus "full-time equivalent of other positions"; for FY1980 to FY1993 are "total compensable workyears: full-time equivalent employment"; and for FY1994 to FY1996 are "total compensable workyears: Exempt Full-time equivalent employment."

appropriations bills through FY1983.[53] Congress increased the cap to 139 staff employees for FY1984,[54] then increased it again to 143 for FY1985[55] and maintained this level through FY1995. The cap established a maximum limit on the number of OTA staff employees.

In addition to full-time and temporary staff employees, OTA made extensive use of contractors. As shown in **Figure 3**, OTA reported the statutory maximum of 143 employees from FY1985 to FY1991. In FY1992, a change in practice may have led to the reporting of contractors in its staffing level, resulting in the reported number of total compensable workyears exceeding total authorized (143) positions. Contractors supplemented the knowledge base of staff employees and were seen by OTA management as critical to the agency's ability to deliver authoritative products on emerging scientific and technological fields, especially with respect to OTA's technology scanning products that sought to characterize possible future science and technology paths and their potential implications.

Figure 3. OTA Staffing Levels



Source: *Budget of the United States Government*, FY1976-FY1998.

Notes: CRS was been unable to identify a consistent measurement of OTA staffing that spanned the period during which it received appropriations. The data in this figure are from the Office of Management and Budget's annual *Budget of the United States Government* for FY1976-FY1998. The terms used to describe the number of people employed by OTA in these documents over this period varied. As shown, CRS was able to identify periods in which the same terms were used.

[53] CRS found this OTA staff cap level in several, but not all, appropriations acts enacted for fiscal years 1978-1983.

[54] P.L. 98-51.

[55] P.L. 98-367.

Observations on OTA's Design and Operations

Peter Blair, in *Congress's Own Think Tank*, noted that OTA was designed with the intention of serving the unique needs of Congress:

> The agency's architects intended the reports and associated information OTA produced to be tuned carefully to the language and context of Congress. OTA's principal products—technology assessments—were designed to inform congressional deliberations and debate about issues that involved science and technology dimensions but without recommending specific policy actions.[56]

Supporters, critics, and analysts have offered a variety of views on the strengths and weaknesses of OTA. Some have found OTA's work to be professional, authoritative, and helpful to Congress. For example, in a 1979 hearing of the Senate Committee on Appropriations, Subcommittee on Legislative Branch Appropriations, Representative Morris Udall, serving as chairman of the OTA Technology Assessment Board, testified that

> The usefulness of the OTA is clear. The office has a place in the legislative process…. During my tenure on the Board, I have enjoyed watching OTA develop and building this record to the point where it is now on a decisive and effective course.[57]

Others offered a variety of criticisms, including issues related to uniqueness/duplication, timeliness, objectivity, and other factors, which likely helped to lay a foundation for its defunding. These are discussed below.

Uniqueness and Duplication

Some supporters of OTA asserted that the agency served a unique mission, complementary to those of its sister congressional agencies. A 1978 report of the House Committee on Science and Technology Subcommittee on Science, Research, and Technology reporting on its 1977-1978 oversight hearings on OTA stated

> OTA has been set up to do a job for the Congress which is: (a) essential, (b) not capable of being duplicated by other legislative entities, and (c) proving useful and relied upon. OTA should retain its basic operating method of depending to a large extent on out-of-house professional assistance in performing its assessments. Continued congressional support for OTA is warranted.[58]

Subcommittee chairman Representative Ray Thornton subsequently stated that this report "doesn't leave much doubt that the office is a valuable asset to the Congress."[59]

However, some critics asserted that the OTA mission and the work it did were already performed, or could be performed, by other organizations—such as GAO (then the General Accounting Office),[60] CRS, or the National Academies.

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[56] Peter D. Blair, *Congress's Own Think Tank: Learning from the Legacy of the Office of Technology Assessment*, ed. Albert N. Link (2013), p. ix.

[57] U.S. Congress, Senate Committee on Appropriations, Subcommittee on the Legislative Branch, *Legislative Branch Appropriations for Fiscal Year 1980*, 96th Cong., 1st sess., March 6, 1979, p. 486.

[58] Ibid., p. 514.

[59] Ibid., p. 514.

[60] The General Accounting Office's name was changed to the Government Accountability Office in 2004 by P.L. 108-271. (See also footnote 21.)

This perspective was expressed by Senator Jim Sasser, chairman of the Senate Committee on Appropriations Subcommittee on the Legislative Branch, in a 1979 hearing:

> I am, frankly, troubled by the Office of Technology Assessment. This letter from Chairman Magnuson is just one more example of the type and tenor of questioning I receive from my colleagues and others about the Office of Technology Assessment. Frankly…this recurring questioning raises doubts in my mind about the need for the Office of Technology Assessment. From time to time I hear that OTA very often duplicates studies conducted by the three other congressional analytical agencies, that is, the General Accounting Office, the Congressional Research Service and the Congressional Budget Office, or [by] executive branch agencies, such as the National Science Foundation.[61]

Concerns about duplication continued. During House floor debate on the Legislative Branch Appropriations Act, 1995, that eliminated funding for OTA, Representative Ron Packard, chairman of the Legislative Branch Subcommittee, stated

> In our efforts in this bill we have genuinely tried to find where there is duplication in the legislative branch of Government. This is one area where we found duplication, serious duplication. We have several agencies that are doing very much the same thing in terms of studies and reports.
>
> I am aware of the invaluable service of OTA, but there are other agencies that do the same thing. The CRS has a science division of their agency. GAO has a science capability in their agency. They can do the same thing as OTA….
>
> We ought to eliminate those agencies where duplication exists. This is one of those areas.[62]

In 2006, Carnegie Mellon University professor Jon M. Peha asserted that, while nonfederal organizations produce high-quality work similar to that performed by OTA, their work is not necessarily duplicative of the type of work OTA was established to perform as the characteristics of their analyses (e.g., directive recommendations, timeliness, format) are qualitatively different and their motivations may be subject to question:

> There still are more sources of information outside of government. These tend to be inappropriate for different reasons. The National Academies sometimes are an excellent resource for Congress, but for a different purpose. The National Academies generally attempt to bring diverse experts together to produce a consensus recommendation about what Congress should do. In many cases, Members of Congress do not want to be told what to do. Instead, they want a trustworthy assessment of their options, with the pros and cons of each, so they can make up their own minds. Universities and research institutes also produce valuable work on some important issues, but it rarely is generated at a time when Congress most needs it, or in a format that the overworked generalists of Congress can readily understand and apply. Moreover, Members of Congress must be suspicious that the authors of any externally produced report have an undisclosed agenda.[63]

Timeliness

Congress established OTA to help it anticipate, understand, and consider "to the fullest extent possible, the consequences of technological applications … in determination of public policy on

[61] U.S. Congress, Senate Committee on Appropriations, Committee on Legislative Branch Appropriations, *Hearing on Legislative Branch Appropriations for Fiscal Year 1980*, 96th Cong., 1st sess., March 6, 1979, p. 509.

[62] Representative Ron Packard, Legislative Appropriations Act, 1996, House, *Congressional Record*, daily edition, vol. 141, part 102 (June 21, 1995), pp. H6192-6193.

[63] Jon M. Peha, "Science and Technology Advice for Congress: Past, Present, and Future," *Renewable Resources Journal*, Vol. 24, No. 2, pp. 19-23, summer 2006.

existing and emerging national problems."[64] To do this effectively, Congress needs information, analysis, and options on a timetable with the development and consideration of legislation.

OTA supporters have noted that in recognizing the need for timeliness, the agency sought to inform congressional decisionmaking through a number of other mechanisms beyond its formal assessments. In addition to its formal assessments and summaries, OTA used the following additional mechanisms to inform Congress: technical and other memoranda, testimony, briefings, presentations, workshops, background papers, working papers, and informal discussions.[65]

Representative Rush Holt commented in 2006 that OTA's reports "were so timely and relevant that many are still useful today."[66]

While OTA reports were often lauded for being authoritative and comprehensive, some critics asserted that the time it took for OTA to define a report, collect information, gather expert opinions, analyze the topic, and issue a report[67] was not consistent with the faster pace of legislative decisionmaking:

> Probably the most frequent criticism of OTA from supporters and detractors alike is that it was too slow; some studies took so long that important decisions already were made when the relevant reports were released.[68]

In its early years, some criticized OTA for producing too many short analyses; later others criticized the agency for concentrating on long-range studies and neglecting committee needs.[69]

In 2001, the former chairman of the House Committee on Science Robert Walker noted

> Too often the OTA process resulted in reports that came well after the decisions had been made. Although it can be argued that even late reports had some intellectual value, they did not help Congress, which funded the agency, do its job.[70]

Georgetown Law's Institute for Technology Law and Policy published a report on a June 2018 workshop on strategies for improving science and technology policy resources for Congress. Several participants asserted that "OTA's model often failed to deliver timely information to Congress, as the comprehensiveness of the studies and the rigor of the peer review process meant that reports could take 18 months or more to publish."[71]

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[64] 2 U.S.C. 471.

[65] See, for example, U.S. Congress, Senate Committee on Appropriations, Committee on Legislative Branch Appropriations, *Hearing on Legislative Branch Appropriations for Fiscal Year 1983*, Part 1, 97th Cong., 2nd sess., January 16, 1982, pp. 100-136.

[66] American Institute of Physics, "Is Congress Getting the S&T Analysis It Needs?," *FYI*, August 28, 2006, https://www.aip.org/fyi/2006/congress-getting-st-analysis-it-needs.

[67] Though no data is available to characterize the time required, it was reported that OTA reports generally took 18 months to two years to complete a study. See for example, Warren E. Leary, "Congress's Science Agency Prepares to Close Its Doors," *New York Times*, September 24, 1995, p. 26, https://www.nytimes.com/1995/09/24/us/congress-s-science-agency-prepares-to-close-its-doors.html.

[68] Jon M. Peha, "Science and Technology Advice for Congress: Past, Present, and Future," *Renewable Resources Journal*, Vol. 24, No. 2, pp. 19-23, Summer 2006.

[69] Michael S. Warner, Institution Analysis, "Reassessing the Office of Technology Assessment," The Heritage Foundation, Washington, DC, November 7, 1984, p. 3, http://thf_media.s3.amazonaws.com/1984/pdf/ia32.pdf.

[70] Robert S, Walker, "Forum: OTA Reconsidered," *Issues in Science and Technology*, Spring 2001, https://issues.org/forum-21/.

[71] Aaron Fluitt and Alexandria Givens, *Improving Tech Expertise in Congress, Time to Revive the OTA?, Strategies for Improving Science and Technology Policy Resources for Congress: Report from June 2018 Policy Workshop*, Georgetown Law, Institute for Technology Law and Policy, June 2018, p. 10.

Quality and Utility

Some criticisms related to the quality and utility of OTA reports to the legislative process. This concern, and others, were reflected in a 1979 statement by Senator Jim Sasser, chairman of the Senate Appropriations Subcommittee on the Legislative Branch:

> The accusations are leveled that OTA studies are mediocre, and they are not used in the legislative process, but rather, most of them end up in the warehouse gathering dust, as so many government studies do…. I am not being personally critical of you at all, but it falls to me to respond to these criticisms which I hear from my colleagues and others.[72]

In 1984 the Heritage Foundation, a think tank, published a paper, *Reassessing the Office of Technology Assessment*, lauding the agency's independence and quality:

> OTA performs an important function for Congress. In an increasingly complex age, Congress needs the means to conduct analyses independent of those produced by industry, lobbies, and the executive branch. The quality control procedures of OTA, as a whole, seem as careful and complete as those of its sister agencies, the General Accounting Office and the Congressional Budget Office.[73]

Objectivity

There was and is a consensus that objectivity is essential to technology assessment if it is to serve as a foundation (among others) for congressional decision making. However, not all agree that objectivity is necessary to technology assessment, or even possible.

Some assert OTA's work to have been objective. This perspective is reflected in comments by Representative Mark Takano who has stated, "The foundation for good policy is accurate and objective analysis, and for more than two decades the OTA set that foundation by providing relevant, unbiased technical and scientific assessments for Members of Congress and staff."[74] Similarly, Representative Sean Casten has stated, "OTA gave us an objective set of truths. We may have creative ideas about how to deal with that truth, but let's not start by arguing about the laws of thermodynamics."[75]

A report for the Woodrow Wilson International Center for Scholars by Richard Sclove asserted that OTA's work implied a misleading presentation of objectivity:

> The OTA sometimes contributed to the misleading impression that public policy analysis can be objective, obscuring the value judgments that go into framing and conducting any [technology assessment] study…. In this regard an authoritative European review of [technology assessment] methods published in 2004 observes that [OTA] … represents the 'classical' [technology assessment] approach.... The shortcomings of the classical approach can be summarized in the fact that the whole [technology assessment] process …

[72] U.S. Congress, Senate Committee on Appropriations, Committee on Legislative Branch Appropriations, *Hearing on Legislative Branch Appropriations for Fiscal Year 1980*, 96th Cong., 1st sess., March 6, 1979, p. 509.

[73] Michael S. Warner, *Institution Analysis*, "Reassessing the Office of Technology Assessment," The Heritage Foundation, Washington, DC, November 7, 1984, p. 12.

[74] Office of Representative Mark Takano, "Reps. Takano and Foster, Sens. Hirono and Tillis Introduce the Office of Technology Assessment Improvement and Enhancement Act," press release, September 19, 2019, https://takano.house.gov/newsroom/press-releases/reps-takano-and-foster-sens-hirono-and-tillis-introduce-the-office-of-technology-assessment-improvement-and-enhancement-act.

[75] Katherine Tully-McManus, "House Members Call for Office of Technology Assessment Revival," *Roll Call*, April 2, 2019.

> needs relevance decisions, evaluations, and the development of criteria, which is at least partially normative and value loaded.[76]

Another scholar framed concerns about objectivity as a structural issue arising, in part, from single-party control of Congress during OTA's existence. The author noted the need for careful bipartisan and bicameral oversight to overcome perceptions and accusations of bias:

> Some Members of Congress raised noteworthy concerns. The most serious allegation was bias. It is not surprising that the party in the minority (before 1995) would raise concerns about bias, given that the other party had dominated Congress throughout OTA's existence…. Bias or the appearance of bias can be devastating. An organization designed to serve Congress must be both responsive and useful to the minority, as well as the majority. Representatives of both parties and both houses must provide careful oversight, so that credit or blame for the organization's professionalism is shared by all.[77]

Some critics have asserted that OTA was responsive principally to the TAB, "limiting its impact to a very narrow constituency." While the TAB membership was bipartisan and bicameral, this criticism implied that OTA's objectivity was affected to some degree by the perspectives of those serving on the TAB, adding to the notion of structural challenges faced by OTA in achieving objectivity or the appearance of objectivity.[78]

In the 1980 book, *Fat City: How Washington Wastes Your Taxes,* author Donald Lambro, a *Washington Times* reporter, criticized OTA's work as partisan:

> Many of OTA's studies and reports … concentrated on issues that were of special concern to [Senator Ted Kennedy]. The views expressed in them were always, of course, right in line with Kennedy's views (or any liberal's, for that matter)…. The agency's studies have proven to be duplicative, frequently shoddy, not altogether objective, and often ignored.[79]

The 1984 Heritage Foundation paper *Reassessing the Office of Technology Assessment* asserted that despite OTA's quality control procedures, balance and objectivity concerns remained:

> Enough questions have been raised about OTA's procedures and possible biases, therefore, to warrant a thorough congressional review of OTA.[80]

This was particularly the case, according to the Heritage paper, for products not requested or reviewed by OTA's congressional oversight board, the TAB. The paper singled out for criticism OTA's assessment of the Strategic Defense Initiative (SDI), President Reagan's plan for a weapon system that would serve as a shield from ballistic missiles. The Heritage Foundation paper asserted that the OTA report on SDI was marred by intentional political bias:

> In the [SDI] study, for example, at least one OTA program division placed the political goal of discrediting SDI ahead of balanced and objective analysis.[81]

Further, the Heritage paper asserted

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[76] Richard Sclove, *Reinventing Technology Assessment: A 21st Century Model*, Woodrow Wilson International Center for Scholars, Science and Technology Innovation Program, April 2010, pp. vii-viii, 10-11.

[77] Jon M. Peha, "Science and Technology Advice for Congress: Past, Present, and Future," *Renewable Resources Journal*, vol. 24, no. 2, pp. 19-23, summer 2006.

[78] Grant Tudor and Justin Warner, "Bring Back the OTA? Not Without a Few Changes," legbranch.org, July 16, 2019, https://www.legbranch.org/bring-back-the-ota-not-without-a-few-changes/.

[79] Donald Lambro, *Fat City: How Washington Wastes Your Taxes* (1980), p. 248.

[80] Michael S. Warner, *Institution Analysis*, "Reassessing the Office of Technology Assessment," The Heritage Foundation, Washington, DC, November 7, 1984, p. 12.

[81] Ibid., p. 1.

> It is also difficult to believe that the flaws in Carter's study and its disclosure of highly sensitive information are the result of naivete and misunderstanding on the part of the OTA. The evidence that some OTA staffers oppose the Administration's Strategic Defense Initiative seems clear and compelling."[82]

The Heritage report notes that experts from the SDI office and from Los Alamos National Laboratory questioned the technical accuracy of the report. The report then notes that three analysts selected by OTA Director Jack Gibbons to review the report (described in the report as having been "unsympathetic to strategic defense") commended Carter's study and told Gibbons that he should not withdraw the report.[83]

In 1988, citing the controversy over the OTA SDI report, Senator Jesse Helms asserted that OTA's work was not objective:

> OTA has been obsessed with proving that President Reagan's strategic defense initiative is both wrongheaded and dangerous almost since the very moment Mr. Reagan announced it in 1983. OTA has long ago lost its pretense that it is an objective scientific analysis group. By and large its reports are useless or irrelevant, but it has demonstrated over and over again that its work on SDI is both pernicious and distorted.[84]

In 2016, Representative Rush Holt disagreed with the assertion of bias in OTA's SDI report asserting, "When it came to missile defense, it was pretty clear to [OTA] that [the technology] wouldn't work as claimed, so they said so."[85]

A 2004 article in the journal The New Atlantis, "Science and Congress," stated that "the most significant reason for Republican opposition [to reestablishing OTA] is the belief that OTA was a biased organization, and that its whole approach was misguided: a way of giving a supposedly scientific rationale for liberal policy ideas and prejudices." The author offered several examples which, if viewed "through Republican eyes" support this belief.[86]

According to a report published by Georgetown Law's Institute for Technology Law and Policy, participants in a June 2018 workshop identified "the perception of partisanship" as one of two OTA weaknesses.[87]

Costs

The issue of the costs of OTA studies was a factor in early oversight of OTA by Congress. On behalf of the chairman of the Senate Appropriations Committee, the chairman of the Legislative Branch subcommittee raised concerns about "allegations that OTA had either cost or time

[82] Ibid., p. 14. The OTA Background Paper on this topic, "Directed Energy Missile Defense in Space," was written for OTA by Ashton Carter who would later become Secretary of Defense in the Obama Administration. Carter is currently Director, Belfer Center for Science and International Affairs, Harvard Kennedy School.

[83] Ibid, p. 11.

[84] Senator Jesse Helms, *Congressional Record*, vol. 134, part 55 (April 26, 1988), p. 8739.

[85] Kim Zetter, "Of Course Congress Is Clueless About Tech—It Killed Its Tutor," *Wired*, April 21, 2016, https://www.wired.com/2016/04/office-technology-assessment-congress-clueless-tech-killed-tutor/.

[86] Adam Keiper, "Congress and Science," *The New Atlantis: A Journal of Science and Technology*, no. 7, pp. 19-50, Fall/Winter 2004, https://www.thenewatlantis.com/publications/science-and-congress.

[87] Aaron Fluitt and Alexandria Givens, Improving Tech Expertise in Congress, Time to Revive the OTA?, Strategies for Improving Science and Technology Policy Resources for Congress: Report from June 2018 Policy Workshop, Georgetown Law, Institute for Technology Law and Policy, June 2018, p. 10, https://georgetown.app.box.com/s/2dt0lq0tb6p7kqdf68c7plwewseg3hxs.

overruns on a large number of their contracts" in a 1979 appropriations hearing.[88] OTA responded that contract overruns had stemmed primarily from modification of the scope of contracts. The agency asserted that its operation was based on the extensive use of outside talent, and that contractors were engaged early in an assessment to help OTA staff and supporting panels to define in more detail the nature of the assessment. This could lead to additional contractor work assignments, requiring modifications to contracts or additional contracts to enable completion of assessments.[89]

Public Input

When OTA was established, analysts argued that public input into the technology assessment process was important. The efficacy of the OTA process for gaining such input has been a topic of debate. Some have asserted in retrospect that OTA did not have an effective mechanism for taking in public comments.[90] Some former OTA staff have disputed this perception. One characterized the charge that OTA lacked citizen participation as "outrageous…. The OTA process was nothing if not participatory."[91] Another former OTA staffer, Fred Wood, recognized OTA's efforts in seeking public participation, but lamented that these efforts fell short at times:

> Public participation [by representatives of organized stakeholder groups] was one of the bedrock principles of the OTA assessment process.... Yet this aspect of OTA's methodology could be time consuming and still fall short of attaining fully balanced participation, while leaving some interested persons or organizations unsatisfied.[92]

The TAAC served as one vehicle for nongovernmental input into OTA's work. However, in a 1977 hearing, former Representative Emilio Daddario, who introduced the legislation[93] first proposing the creation of an Office of Technology Assessment, testified that the TAAC had been invented in "a hurried effort to provide for some new method of public input into OTA activities, even though unfortunately its role was ill-defined."[94]

Other Criticisms

Some have offered other criticisms of OTA. For example, a Wilson Center report identified the following additional criticisms of OTA:

- inconsistency in fully identifying and articulating technologies' ethical and social implications;
- failure to identify social repercussions that could arise from interactions among complexities of seemingly unrelated technologies;

[88] U.S. Congress, Senate Committee on Appropriations, Subcommittee on Legislative Branch Appropriations, *Hearing on Legislative Branch Appropriations for Fiscal Year 1980*, 96th Cong., 1st sess., March 6, 1979, p. 501.

[89] Ibid.

[90] See, for example, Richard Sclove, *Reinventing Technology Assessment: A 21st Century Model*, Woodrow Wilson International Center for Scholars, Science and Technology Innovation Program, April 2010, p. xi.

[91] Richard Sclove, *Reinventing Technology Assessment: A 21st Century Model*, Woodrow Wilson International Center for Scholars, Science and Technology Innovation Program, April 2010, p. 61.

[92] Ibid., p. 62.

[93] The Technology Assessment Act of 1970 (H.R. 18469, 91st Congress). This legislation was reported to the House but no further action was taken. Congress subsequently created OTA with enactment of P.L. 92-484.

[94] U.S. Congress, House Committee on Science and Technology, Subcommittee on Science, Research, and Technology, *Review of the Technology Assessment Act*, 95th Cong., 1st sess., September 27, 1977, p. 181.

- a lack of elucidation of circumstances in which a technology can induce a cascade of follow-on socio-technological developments; and
- failure to develop a "capacity to cultivate, integrate or communicate the informed views of laypeople."[95]

Congressional Perspectives on Technology Assessment Expressed During OTA Defunding Debate

At the time of OTA's defunding, some Members of Congress expressed views on which other agencies and organizations might serve the functions performed by OTA—or however much of those functions was still deemed necessary.

The following excerpts from the House and Senate reports accompanying the Legislative Branch Appropriations Act, 1996 (H.R. 1854, 104th Congress) and from floor debate on the bill provide insight into these post-OTA perspectives:[96]

The report of the House Committee on Appropriations on H.R. 1854 directed that following the defunding of OTA, any of its necessary functions would be performed by other agencies, such as CRS and GAO, and that supplemental information would be provided by nongovernment organizations:

> If any functions of OTA must be retained, they shall be assumed by other agencies such as Congressional Research Service or the General Accounting Office. Alternatively, the National Academy of Sciences, university research programs, and a variety of private sector institutions will be available to supplement the needs of Congress for objective, unbiased technology assessments.[97]

In its report on the bill, the Senate Committee on Appropriations report stated its disagreement with the House's intent to transfer OTA functions to CRS. The report asserted a variety of differences between OTA and CRS and stated that assigning OTA functions to CRS would harm CRS:

> During consideration of the bill by the House of Representatives, an amendment was adopted transferring the functions of the Office of Technology Assessment to the Congressional Research Service. The Committee disagrees with this proposal. The purposes, procedures, methodologies, management, and governance of the CRS and the OTA are quite different, and the Committee believes the merger of the two would substantially harm the Congressional Research Service.[98]

In debate on the Senate version of the bill, Senator Daniel Inouye asserted that OTA filled a unique and important role for which other legislative branch agencies were not suited:

> Some of my colleagues have suggested that we don't need an OTA.... How many of us are able to fully grasp and synthesize highly scientific information and identify the relevant

[95] Richard Sclove, *Reinventing Technology Assessment: A 21st Century Model*, Woodrow Wilson International Center for Scholars, Science and Technology Innovation Program, April 2010.

[96] H.R. 1854 (104th Congress) was vetoed by President Clinton on October 3, 1995. H.R. 2492, the Legislative Branch Appropriations Act, 1996, identical to H.R. 1854, passed the House on October 31, passed the Senate on November 2, and was signed into law on November 19, 1995 (P.L. 104-53).

[97] H.Rept. 104-141, accompanying H.R. 1854, the Legislative Branch Appropriations Act, 1996.

[98] S.Rept. 104-114, accompanying H.R. 1854, the Legislative Branch Appropriations Act, 1996.

> questions that need to be addressed? The OTA was created to provide the Congress with its own source of information on highly technical matters. Who else but a scientifically oriented agency, composed of technical experts, governed by a bipartisan board of congressional overseers, and seeking information directly under congressional auspices, [can give] the Congress and the country accurate and essential information on new technologies?
>
> Can other congressional support agencies and staff provide the information we need? I am second to none in my high regard for these agencies, but each has its own distinct role. The U.S. General Accounting Office is an effective organization of auditors and accountants, not scientists. The Congressional Research Service is busy responding to the requests of members for information and research. The Congressional Budget Office provides the Congress with budget data and with analyses of alternative fiscal and budgetary impacts of legislation. Furthermore, each of these agencies is likely to have its budget reduced, or to be asked to take on more responsibilities, or both, and would find it extremely difficult to take on the kinds of specialized work that OTA has contributed.[99]

Representative Ron Packard, chair of the House Appropriations Committee's Legislative Branch subcommittee, described the elimination of OTA as "legislative rightsizing" and asserted the availability of other congressional agencies to fill OTA's role:

> In our efforts in this bill we have genuinely tried to find where there is duplication in the legislative branch of Government. This is one area where we found duplication, serious duplication. We have several agencies that are doing very much the same thing in terms of studies and reports…. I am aware of the invaluable service of OTA, but there are other agencies that do the same thing. The CRS has a science division of their agency. GAO has a science capability in their agency. They can do the same thing as OTA.
>
> We evaluated how to best consolidate, and it was our conclusion as a committee that to eliminate OTA and absorb the essential functions into some of these other agencies that are going to continue was the best way to go….
>
> I admit OTA has done a good job. They have good, solid professionals, but those professionals can work with other agencies that will do those same functions, if they are essential. We also have the CRS, GAO, and other agencies, such as the National Academy of Sciences. There are many alternatives, or this work can even be privatized and contracted out for the services. But we do not need this agency that has now outgrown its usefulness … has now increased its mission to other areas beyond science.[100]

In the House, Representative Henry Hyde stated his support for an amendment submitted by Representative Amo Houghton that would have transferred most of the funds and analysts to CRS:

> [The amendment] cuts 50 of 190 jobs. It cuts the budget by 32 percent, from $22 million down to $15 million. And it folds its functions into the Congressional Research Service. So we cut down on the money, we cut down on the personnel, we downsize to the bone, but we do not lose the function. It just seems to me in this era of fiber optics and lasers and space stations, we need access to an objective, scholarly source of information that can save us millions and billions.[101]

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[99] Senator Daniel K. Inouye, Continued Funding for the Office of Technology Assessment, Senate, *Congressional Record*, daily edition, vol. 141, part 111 (July 11, 1995), p. S9723.

[100] Representative Ron Packard, Legislative Appropriations Act, 1996, House, *Congressional Record*, daily edition, vol. 141, part 102 (June 21, 1995), p. H6193.

[101] Representative Henry Hyde, Legislative Branch Appropriations Act, 1996, House, *Congressional Record*, daily edition, vol. 141, part 102 (June 21, 1995), p. H6194.

The amendment to transfer funds and personnel to CRS was not passed.

Congress, GAO, and Technology Assessment

Following the defunding of OTA, Congress sought help from other organizations to fill a gap for scientific and technical information that previously would have been performed by OTA. According to one analysis, Congress initially increased its use of the National Academies for obtaining such information, though shortly thereafter its usage of the National Academies returned to pre-OTA defunding levels.[102]

Another option employed by Congress for technology assessment capabilities has been reliance on the GAO. Beginning in the early 2000s, GAO undertook efforts to develop and improve its technology assessment capabilities. Some of these efforts were initiated by GAO itself, other efforts were initiated at Congress's direction.

Congress has not given GAO statutory authority to conduct technology assessments. Rather, Congress provided GAO guidance with respect to its technology assessments and related activities in the form of reports accompanying annual Legislative Branch Appropriations bills since at least 2001.

In 2000, five years after Congress defunded OTA, GAO established the Center for Technology and Engineering in its Applied Research and Methods team. This center, led by GAO's Chief Technologist, later became GAO's Center for Science, Technology, and Engineering.

Shortly thereafter, Congress began to task GAO with technology assessment activities. In 2001, conferees on the Legislative Branch Appropriations Act, 2002 directed in report language that up to $500,000 of GAO's appropriation be obligated to conduct a technology assessment pilot project and that the results be reported to the Senate by June 15, 2002.[103]

The conference report did not authorize an assessment topic, but three Senators requested GAO to assess technologies for U.S. border control together with a review of the technology assessment process. At the same time, six House Members wrote to GAO supporting the pilot technology assessment project. After consulting congressional staff, GAO agreed to assess biometric technologies. It used its regular audit processes and also its standing contract with The National Academies to convene two meetings that resulted in advice from 35 external experts on the use of biometric technologies and their implications on privacy and civil liberties. The resulting report was issued in November 2002 as *Technology Assessment: Using Biometrics for Border Security* (GAO-03-174).[104]

The FY2003 Senate legislative branch appropriations report noted the utility of GAO's work and said that it was providing $1 million for three GAO studies in order to maintain an assessment capability in the legislative branch and to evaluate the GAO pilot process. However, this language was not included in the Senate bill (S. 2720, 107th Congress); the House bill (H.R. 5121, 107th Congress) or the accompanying report; or in P.L. 108-7, which included as Title H, the Legislative Branch Appropriations Act, 2003. Although funds were not provided for a study,

[102] Peter D. Blair, "After the Fall: Post OTA Efforts to Fill the Gap," in *Congress's Own Think Tank: Learning from the Legacy of the Office of Technology Assessment (1972-1995)*, ed. Albert N. Link (Palgrave Macmillan, 2003), p. 76.

[103] H.Rept. 107-259, the conference report accompanying H.R. 2647, the Legislative Branch Appropriations Act, 2002 (P.L. 107-68).

[104] CRS Report RS21586, *Technology Assessment in Congress: History and Legislative Options*, by Genevieve J. Knezo, May 20, 2005 (out of print; available to Congressional clients upon request); GAO, *Technology Assessment: Using Biometrics for Border Security*, GAO-03-174, November 15, 2002, https://www.gao.gov/products/GAO-03-174.

GAO conducted a technology assessment that was published in May 2004 as *Cybersecurity for Critical Infrastructure Protection*.[105]

For FY2004, the Senate Committee on Appropriations recommended $1 million for two or three technology assessments by GAO, but directed the agency only to conduct this technology assessment work if it was consistent with GAO's mission.[106] The conference report for the Legislative Appropriations Branch, 2004 (P.L. 108-83) noted that

> For the past two years the General Accounting Office (GAO) has been conducting an evaluation of the need for a technology assessment capability in the Legislative Branch. The results of that evaluation have generally concluded that such a capability would enhance the ability of key congressional committees to address complex technical issues in a more timely and effective manner.[107]

Further, the conferees directed GAO to report by December 15, 2003, to the House and Senate Committees on Appropriations "the impact that assuming a technology assessment role would have on [GAO's] current mission and resources."[108]

In 2004, a bill was introduced in the Senate (S. 2556, 108th Congress) to establish a technology assessment capability within GAO. The bill would have authorized the Comptroller General to initiate technology assessment studies or to do so at the request of the House, Senate, or any committee; to establish procedures to govern the conduct of assessments; to have studies peer reviewed; to avoid duplication of effort with other entities; to establish a five-member technology assessment advisory panel; and to have contracting authority to conduct assessments. In addition, the bill would have authorized $2 million annually to GAO to conduct assessments. The bill was referred to the Committee on Governmental Affairs and no further action was taken. A similar bill was introduced in the House (H.R. 4670, 108th Congress) and referred to the House Committee on Science; no further action was taken.

For FY2005, GAO requested $545,000 in appropriations for four new full-time equivalent (FTE) positions and contract support to establish a baseline technology assessment capability that would allow the agency to conduct one assessment per year. In its report, the House Appropriations Committee did not address funding for GAO for technology assessment, but encouraged GAO to "... retain its core competency to undertake additional technology assessment studies as might be directed by Congress."[109] An amendment to add $30 million to GAO's FY2005 appropriations for the purpose of establishing a Center for Science and Technology Assessment was rejected by the House.

The Senate Committee on Appropriations report on the Legislative Branch Appropriations Act, 2005 (S. 2666, 108th Congress) provided additional guidance to GAO with respect to its technology assessment activities, limiting future technology assessments to those having the support of leadership of both houses of Congress and to technology assessments that "are intended to address significant issues of national scope and concern." In addition, the report

[105] GAO, *Technology Assessment: Cybersecurity for Critical Infrastructure Protection*, GAO-04-321, May 28, 2004, https://www.gao.gov/products/GAO-04-321.

[106] S.Rept. 108-88, accompanying S. 1383 (108th Congress), the Legislative Branch Appropriations Act, 2004.

[107] H.Rept. 108-279, the conference report accompanying H.R. 2657 (108th Congress), the Legislative Branch Appropriations Act, 2004 (P.L. 108-83), pp. 51-52.

[108] Ibid, p. 52.

[109] H.Rept. 108-577, accompanying H.R. 4755 (108th Congress), the Legislative Branch Appropriations Act, 2005, p. 27.

directed the GAO Comptroller General to consult with the committee "concerning the development of definitions and procedures to be used for technology assessments by GAO."[110]

In 2007, the House Committee on Appropriations recommended $2.5 million for GAO for technology assessments in FY2008, stating that

> as technology continues to change and expand rapidly it is essential that the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems. The Committee believes it is necessary for the Congress to equip itself with effective means for securing competent, timely and unbiased information concerning the effects of scientific and technical developments and use the information in the legislative assessment of matters pending before the Congress.[111]

That same year, the Senate committee report on the Legislative Branch Appropriations Act, 2008 (S. 1686, 110th Congress) recommended $750,000 and four FTE employees to establish a permanent technology assessment function in the GAO. The report also stated that the committee had "decided not to establish a separate entity to provide independent technology assessment for the legislative branch owing to budget constraints." Further, it asserted that GAO's focus on "producing quality reports that are professional, objective, fact-based, fair, balanced, and nonpartisan is consistent with the needs of an independent legislative branch technology assessment function." In addition, the committee directed GAO "to define an operational concept for this line of work, adapted from current tested processes and protocols," and to report to Congress on the concept.[112]

Conferees on the Consolidated Appropriations Act, 2008 (H.R. 2764, 110th Congress; P.L. 110-161) agreed to provide $2.5 million for GAO for technology assessments in FY2008, asserted the importance of technology assessment to Congress's public policy deliberations, and directed the Comptroller General to ensure that "GAO is able to provide effective means for securing competent, timely and unbiased information to Congress regarding the effects of scientific and technical developments."[113]

For FY2009, conferees continued funding for GAO's technology assessment and reminded the agency that "for the assessments to be of benefit to the Congress, GAO must reach out and work with both bodies of Congress regarding these studies."[114]

For FY2010, the House Committee on Appropriations recommended continuing GAO technology assessment funding at the FY2009 level.[115] The conference report on Legislative Branch Appropriations Act, 2010, endorsed the chamber reports.

No direction was given by Congress to GAO in House, Senate, or conference appropriations reports regarding technology assessment for FY2011, FY2012, FY2013, or FY2014.

In its report on the Legislative Branch Appropriations Act, 2015 (H.R. 4487, 113th Congress), the Senate Committee on Appropriations commended GAO for the technology assessment advice it provided to Congress for a decade, but asserted that the scale and scope of that work has been

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[110] S.Rept. 108-307, accompanying the Legislative Branch Appropriations Act, 2005 (S. 2666).

[111] H.Rept. 110-198, accompanying the Legislative Branch Appropriations Act, 2008 (H.R. 2771), p. 30.

[112] S.Rept. 110-89, accompanying the Legislative Branch Appropriations Act, 2008, (S. 1686), pp. 42-43.

[113] U.S. Congress, House Committee on Appropriations, *Consolidated Appropriations Act, 2008*, Division H (H.R. 2764, P.L. 110-161), committee print, 110th Cong., 1st sess., January 2008, 110-39564, p. 1878.

[114] U.S. Congress, House Committee on Appropriations, *Omnibus Appropriations Act, 2009*, Division G (H.R. 1150, P.L. 111-8), committee print, 111th Cong., 1st sess., March 2009, 111-47494, p. 1771.

[115] H.Rept. 111-160, accompanying the Legislative Branch Appropriations Act, 2010 (H.R. 2918), p. 29.

limited due to budget constraints. The committee recommended an increase in GAO funding to enhance the agency's technology assessment capabilities and directed GAO to submit a strategic plan for its technology assessment program. The strategic plan was to include proposed solutions to challenges constraining the GAO's technology assessment capabilities, approaches to increase responsiveness to congressional needs and priorities, and strategies to improve technology assessment procedures and methodologies, as well as identify additional authorities and resources that may be needed.[116]

In its report on the Legislative Branch Appropriations Act, 2016 (H.R. 2250, 114th Congress), the Senate Committee on Appropriations commended GAO for implementing a new strategic plan for its technology assessment program that expanded the scale and scope of its assessment analysis. Additionally, the committee encouraged GAO to focus hiring efforts on increasing technology assessment staff capacity.[117]

Conferees on the Consolidated Appropriations Act, 2017 (H.R. 244, 114th Congress) lauded GAO's technology assessment work and encouraged GAO to increase its scientific and technical capacity as its work portfolio requires:

> GAO's work is recognized in the area of technology assessment, since being tasked with this responsibility in 2002. GAO has produced highly technical and scientific reports in response to Congressional requests and statutory requirements. These reports have included technology assessments (TA), and other reports to Congress that incorporate analysis of scientific, technological and engineering issues in their evaluations of federal programs. GAO has also produced best practice guides for use across government on the topics of lifecycle cost estimating, project scheduling, and technology readiness assessment. GAO's work in these areas is led by GAO's Center for Science, Technology, and Engineering (CSTE). GAO's CSTE provides wide-ranging technical expertise across all of GAO's areas of work, including support to various studies of federal programs with science and technology elements, such as cybersecurity, nuclear and environmental issues, and major technical systems acquisitions, among others. Also noted is the work of CSTE's e-Security laboratory and Cost Engineering Sciences groups which conduct computer and network security evaluations and advanced operations research analyses (including cost, schedule, and technical performance), respectively. GAO has provided direct support to the Congress via congressional testimony, review of draft legislation, and the adoption of various report recommendations by Executive Branch agencies. GAO is commended for providing key direct technical support to various congressional committees on technology-focused topics such as the U.S. Capitol Police radio systems acquisition. It is noted that GAO is using rigorous methods in its technical reports, including engaging key external technical experts via group meetings conducted in partnership with the National Academies, cost-benefit analysis, risk analysis, technology maturity assessment, and scenario-based trend identification. Given the persistent and growing demand for this technical work, the Comptroller General is commended for his strategic initiative to build the scientific and technical capacity within GAO and encouraging further growth as the work portfolio requires. GAO is encouraged to continue a communication effort with Congress to ensure lawmakers are aware of these services.[118]

No direction was given by Congress to GAO in FY2018 appropriations report language regarding technology assessment.

[116] S.Rept. 113-196, accompanying the Legislative Branch Appropriations Act, 2015 (H.R. 4487), p. 44.

[117] S.Rept. 114-64, accompanying the Legislative Branch Appropriations Act, 2016 (H.R. 2250), p. 44.

[118] Explanatory statement to Division I (Legislative Branch Appropriations Act) of the Consolidated Appropriations Act, 2017 (H.R. 244, 114th Congress), as published in the *Congressional Record*, vol. 163 (May 3, 2017), p. H4034.

Conferees on the Energy and Water, Legislative Branch, and Military Construction and Veterans Affairs Appropriations Act, 2019, directed GAO to expand its technology assessment capacity by reorganizing its S&T function and to create a more prominent office for this purpose within GAO. Congress directed GAO to provide, within 180 days, a plan and timetable for how the new office could expand and enhance GAO's capabilities in scientific and technological assessments:

> *Technology Assessment*: There is general support in Congress to bolster capacity of and enhance access to quality, independent science and technological expertise. Since 2002, GAO has provided direct support to Congress in the area of technology assessment through objective, rigorous, and timely assessments of emerging science and technologies. The Center for Science, Technology, and Engineering (CSTE) within GAO has developed such a capacity, providing wide-ranging technical expertise across all of GAO's areas of work. However, because the scope of technological complexities continues to grow significantly, the conferees seek opportunities to expand technology assessment capacity within the Legislative Branch.
>
> The conferees encourage GAO to reorganize its technology and science function by creating a new more prominent office within GAO. GAO is directed to provide the Committees a detailed plan and timeline describing how this new office can expand and enhance GAO's capabilities in scientific and technological assessments. This plan should be developed in consultation with internal stakeholders of the Legislative Branch such as congressional staff and Members of Congress in addition to external stakeholders, including nonprofit organizations and subject matter experts knowledgeable in the field of emerging and current technologies. Further, such a plan should include a description of the revised organizational structure within GAO, provide potential cost estimates as necessary, and analyze the following issues: the appropriate scope of work and depth of analysis; the optimum size and staff skillset needed to fulfill its mission; the opportunity and utility of shared efficiencies within GAO; and the opportunities to increase GAO's engagement and support with Congress. GAO is directed to submit this report to the Committees within 180 days of enactment.[119]

In January 2019, GAO announced plans to double the size of its current combined science and technology workforce. It also announced the establishment of a new Science, Technology Assessment, and Analytics (STAA) team focused on technology assessments and technical services for the Congress; auditing federal science and technology programs; compiling and utilizing best practices in the engineering sciences; and establishing an audit innovation lab to explore, pilot, and deploy new advanced analytic capabilities, information assurance auditing, and emerging technologies expected to affect auditing practices.[120]

In April 2019, GAO issued its expansion and enhancement plan, *GAO Science, Technology Assessment, and Analytics Team: Initial Plan and Considerations Moving Forward.* According to the plan, the new GAO STAA office would perform the agency's existing science- and technology-focused work, as well as its new technology assessment activities. The GAO plan states that the number of STAA staff will increase from 49 to 70 by the end of FY2019 under the plan. STAA staff would eventually grow to as many as 100-140, depending on congressional requests for technology assessments and technical assistance. Functions to be performed by STAA include providing technology assessments and technical assistance to Congress; evaluation of S&T programs within the federal government; best practices guides in the engineering

[119] H.Rept. 115-929, conference report accompanying H.R. 5895 (115th Congress), the Energy and Water, Legislative Branch, and Military Construction and Veterans Affairs Appropriations Act, 2019 (P.L. 115-244).

[120] GAO, "GAO Deepens Science and Technology Capabilities," press release, January 29, 2019, https://www.gao.gov/about/press-center/press-releases/gao_deepens_science_tech.html.

sciences, including cost, schedule, and technology readiness assessments; and an audit innovation lab.[121]

From 2002 through April 14, 2020, GAO published 16 technology assessment reports, including two in 2019. **Appendix D** provides a complete list of GAO technology assessments.

National Academy for Public Administration Study on Congress's Need for Additional Science and Technology Advice and Technology Assessment

In 2018, conferees on the Energy and Water, Legislative Branch, and Military Construction and Veterans Affairs Appropriations Act, 2019 (H.R. 5895, P.L. 115-244) noted recent testimony and requests for restoring funding for OTA and the need for Congress to have "deep technical advice necessary to understand and tackle the growing number of science and technology policy challenges."

Congress's Charge to NAPA

In this regard, Congress directed CRS to contract with the National Academy of Public Administration (NAPA) or a similar external entity to

> produce a report detailing the current resources available to Members of Congress within the Legislative Branch regarding science and technology policy, including the GAO. This study should also assess the potential need within the Legislative Branch to create a separate entity charged with the mission of providing nonpartisan advice on issues of science and technology. Furthermore, the study should also address if the creation of such entity duplicates services already available to Members of Congress. CRS should work with the Committees in developing the parameters of the study and once complete, the study should be made available to relevant oversight Committees.[122]

In 2018, CRS engaged NAPA to conduct the study and produce a report. In October 2019, NAPA published its report, *Science and Technology Policy Assessment: A Congressionally Directed Review*.

NAPA articulated its mission in addressing the congressional direction as threefold:

- to detail the current resources available to Members of Congress within the legislative branch regarding science and technology policy, including GAO;
- to assess the potential need within the legislative branch to create a separate entity charged with the mission of providing nonpartisan advice on issues of science and technology, such as the former Office of Technology Assessment; and

[121] Government Accountability Office, *GAO Science, Technology Assessment, and Analytics Team: Initial Plan and Considerations Moving Forward*, April 10, 2019, pp. 16-18, https://www.gao.gov/pdfs/about/GAOScienceTechPlan-2019-04-10.pdf.

[122] H.Rept. 115-929, conference report accompanying H.R. 5895 (115th Congress), the Energy and Water, Legislative Branch, and Military Construction and Veterans Affairs Appropriations Act, 2019 (P.L. 115-244).

- to address whether the creation of a separate legislative branch entity would duplicate services already available to Members of Congress.[123]

Assessment of Congressional Need for Additional Science and Technology Advice and Resources Available

In evaluating Congress's need for additional S&T advice, the NAPA study found that "The range, speed, and impact of technical developments suggest a greater congressional need for internal expertise on S&T related issues," but that "nearly every indictor of congressional capacity is moving the wrong way."[124]

The report identified three types of congressional clients that need such information: Members of Congress, personal office staff, and committee staff. Broadly, NAPA found that most Members are reliant on staff and legislative support agencies (e.g., CRS, GAO) for science and technology policy support, but that the number of committee and personal office staff available for S&T policy work has decreased. NAPA also noted reductions in the number of CRS and GAO staff over 35 years.

Members of Congress

The report noted that Members typically do not have professional backgrounds in science and technology and states that Members "often do not have the subject matter expertise to understand fast-moving, complex S&T issues." Therefore, Members without S&T backgrounds, "rely on expert advisors like personal and committee staff and on legislative branch support agencies like the CRS and the GAO to help them understand technical policy issues." The report also cites a 2016 survey of senior congressional staff by the Congressional Management Foundation that found that "Senators and Representatives lack the time and resources they need to understand, consider, and deliberate public policy and legislation."[125]

Committee Staff

NAPA found that committee staff are a critical source of policy expertise, but that the number of committee staff fell by 38% between 1981 and 2015, and by even more in some committees engaged in S&T policy matters. The report also noted the number of hearings—which NAPA describes as an opportunity to "build subject matter expertise"—fell by 63% between the 96th Congress and 114th Congress.[126]

Personal Staff

NAPA found that congressional offices are "overwhelmed by constituent communication" due to growth in digital communications and increases in population, and noted a finding by the Congressional Management Foundation that "Congressional offices are devoting more resources

[123] NAPA. *Science and Technology Policy Assessment: A Congressionally Directed Review*, October 2019, p. viii, https://www.napawash.org/uploads/Academy_Studies/NAPA_FinalReport_forCRS_110119.pdf.

[124] Ibid., p. 7.

[125] Ibid., p. 8.

[126] Ibid., p. 9.

to managing the growing volume of constituent communications."[127] NAPA asserts that this trend, combined with fixed budgets, means that fewer staff are available for policy work.[128]

In its report, NAPA concluded that "as the Nation experiences accelerated S&T developments, certain indicators of Congress' ability to absorb, understand, analyze, and deal with the developments have declined."[129]

Options Identified by NAPA

The report posited three options that it considered to address the gaps it had identified:

Option 1. Enhance Existing Entities
Enhance the capabilities of existing Legislative Branch support agencies, including GAO and CRS, including potential changes to current models;

Option 2. Create a New Agency
Create a separate agency to fill any existing gaps, with attention given to avoiding duplication of effort; and

Option 3. Enhance Existing Entities and Create an Advisory Office
Both enhance existing entities and create an S&T advisory office, led by a Congressional S&T Advisor, which focuses on strengthening the capacity of Congress to absorb and utilize science and technology policy information provided by GAO, CRS, and other sources.[130]

NAPA Recommendations

The NAPA report recommended option 3 with the following elements:

- GAO should further develop the capability of its Science, Technology Assessment, and Analytics mission team to meet some of the supply gaps identified in the NAPA report, including the need for technology assessments, and make appropriate changes in its organization and operating policies to accommodate the distinctive features of technology assessments and other foresight products.
- CRS should enhance and expand its quick-turnaround and consultative services in S&T-related policy issues.
- Congress should create an Office of the Congressional S&T Advisor (OCSTA), which would focus on efforts to build the absorptive capacity[131] of Congress, to include supporting the recruitment and hiring of S&T advisors for House and

[127] Congressional Management Foundation, *How Capitol Hill Is Coping with the Survey in Citizen Advocacy*, 2005. The Congressional Management Foundation is a nonpartisan, nonprofit education and research organization that works with Members of Congress and staff to improve congressional operations and interactions with constituents.

[128] NAPA, Science and Technology Policy Assessment: A Congressionally Directed Review, October 2019, p. 9. The NAPA report also cites Zach Graves and Daniel Schuman, *The Decline of Congressional Expertise Explained in 10 Charts*, October 18, 2018, https://www.techdirt.com/articles/20181018/10204640869/decline-congressional-expertiseexplained-10-charts.shtml.

[129] Ibid., p. 13.

[130] Ibid., p. x.

[131] NAPA identified the wide range of scientific and technical resources and analysis available from the GAO, CRS, the National Academics, and nongovernmental organizations, and states that Congress needs help in making use of this information. In this regard, NAPA asserted the need for a new organization and staff to help Members and staff "absorb and utilize the S&T policy information provided by" these agencies and organizations.

Senate committees with major S&T oversight responsibilities. OCSTA would also be responsible for horizon scanning.

- Congress should create a Coordinating Council to be led by the Advisor and that includes representatives from CRS and GAO's STAA, and a National Academies ex officio member with the objective to limit duplication and coordinate available resources to most benefit the Congress.[132]

Technology Assessment and Horizon Scanning

In its report, NAPA differentiates between technology assessments and "horizon scans." NAPA states that horizon scans are reports 20-60 pages in length that seek to identify S&T issues that might arise in the future, including broad developments and important innovations, as well as estimating the timeframes for such developments. NAPA asserts that such information would allow Congress to know whether it is positioned to be successful in responding to such issues in terms of its structure, activities, and agenda. NAPA also states that horizon scanning can serve as an effective early warning system. While the NAPA report asserts that "no agency expressly claims responsibility for preparing horizon scanning reports as distinct products for Congress," it later offers several examples of horizon scanning efforts undertaken by GAO and argues that these efforts "provide a foundation to further expand capacity in this area."

NAPA Evaluation of Whether to Reestablish OTA

Following release of the report, NAPA panel members stated that it did not evaluate the need for reestablishing the Office of Technology Assessment. In this regard, NAPA asserted that it believed Congress had made clear its intent over the last two decades for technology assessment to be a mission of GAO.

In testimony, panel member Michael McCord asserted that the inability of Congress to reach a consensus about reestablishing OTA for more than two decades shaped the panel's perspective on considering the option. He further asserted that the absence of a consensus in this regard could undermine a reestablished OTA's ability to fulfill the mission its advocates seek. In response to a Member's question as to why the NAPA report did not recommend reinstating OTA or something similar, McCord responded

> We did not recommend [reestablishing OTA]. [However,] it would be, I think, incorrect to say that [NAPA] would think it's a terrible idea if Congress did that. But you can't help but notice that for 25 years Congress has chosen not to do that. So the question whether the support is there to go that route and sustain it, that's a serious question for us, the viability of doing something that you consistently have chosen not to do…. You could go that route eventually.[133]

[132] NAPA, *Science and Technology Policy Assessment: A Congressionally Directed Review*, October 2019, pp. x-xi.

[133] U.S. Congress, House Committee on Science, Space, and Technology, *Experts Needed: Options for Improved Science and Technology Advice for Congress*, 116th Cong., 1st sess., December 5, 2019, https://science.house.gov/hearings/experts-needed-options-for-improved-science-and-technology-advice-for-congress.

Other Perspectives and Recommendations on OTA and the Adequacy of S&T Advice to Congress

In addition to NAPA, other organizations have produced reports on the value of reestablishing OTA and the broader question of the adequacy of S&T advice to Congress.

In 2018, the R Street Institute (R Street), a nonprofit, nonpartisan, public policy research organization, proposed reestablishment of OTA in its report *Bring in the Nerds: Reviving the Office of Technology Assessment*. The report identifies and addresses a number of rationales that have been put forth by others as to why OTA should not be reestablished, including cost, political loss of face, perception by some of an ideological bias in OTA's work, providing a foundation for encouraging additional government intervention, and adding another governmental expert bureaucracy. The report concludes that "Congress can most easily bolster its technology policy knowledge by reviving the OTA."[134]

In September 2019, the Belfer Center for Science and International Affairs of Harvard's Kennedy School published a report, *Building a 21st Century Congress: Improving Congress's Science and Technology Expertise*, focused on providing an overview of Congress's S&T-relevant needs and resources identifying potential actions to address what it perceives as gaps in meeting Congress's needs.

The Belfer Center report asserted that "Congress is one of the most advised bodies in the world." In this regard, Belfer identifies internal resources available to Members—including GAO, CRS, and personal and committee staff—as well as external resources, such as executive branch agencies, think tanks, universities, civil society and nonprofit organizations, lobbyists, industry associations, and the National Academies.[135]

Yet, even though Congress is provided with such advice and resources, Belfer asserted that

> significant gaps remain that hinder Congress's ability to produce timely, thoughtful, and comprehensive legislation on S&T issues. This results in a multitude of negative and many times public outcomes, such as ineffective or absent S&T legislation.[136]

The report concluded that "the core of the problem is a divide between what Congress can absorb and what information it receives."[137] This finding is similar to that asserted by NAPA in its October 2019 report, *Science and Technology Policy Assessment: A Congressionally Directed Review*, on the need for improving the "absorptive capacity of Congress" (discussed in the previous section).

To address these gaps, the Belfer Center report proposed four actions: (1) Congress should create a legislative support body focused on S&T issues; (2) Congress should hire additional S&T talent in personal offices and committees; (3) Congress should provide committee and support agencies

[134] Zach Graves and Kevin Kosar, R Street Institute, *Bring in the Nerds: Reviving the Office of Technology Assessment, R Street Policy Study No. 128*, p. 11, January 2018, https://www.rstreet.org/wp-content/uploads/2018/01/Final-128-1.pdf. The R Street Institute is a nonprofit, nonpartisan, public policy research organization that describes its mission as engaging in "policy research and outreach to promote free markets and limited, effective government."

[135] Mike Miesen, Laura Manley, Maeve Campbell, Chris Kuang, Emily Roseman, Belfer Center for Science and International Affairs, Harvard Kennedy School, *Building a 21st Century Congress: Improving Congress's Science and Technology Expertise*, September 2019, pp. 4-6, https://www.belfercenter.org/sites/default/files/2019-09/ST/Building21stCenturyCongress.pdf.

[136] Ibid., p. 7.

[137] Ibid., p. 8.

with increased funding to allow them to hire additional staff and pay a more competitive salary; and (4) external information providers should produce information in formats that are useful to Congress, generally products that are short, concise, customized for the audience, consistently offered, and timely.[138]

An earlier report by the Belfer Center describes a "widening gap between responsive lawmaking in Congress and the deepening complexity of advancements in science and technology" and that "certain weakened capabilities have atrophied the organization's *absorptive capacity*, or the ways by which it recognizes the value of, assimilates, and makes use of knowledge outside of itself."[139] The report called for the establishment of a Congressional Futures Office that it describes as "a new and deeply embedded internal support body" that would gradually strengthen its "capabilities through open-ended product-service design and dispersed global networks of expertise."

A 2019 report, *Evaluating the 2019 NAPA Report on S&T Policy Assessment and Resources for Congress,* by the Lincoln Network and Demand Progress lauded the NAPA report for recognizing that Congress's S&T capacity gap is broader than just technology assessment and recognizing Congress's need for a mechanism to increase what NAPA referred to as Congress's absorptive capacity. The report agreed with NAPA with respect to its praise of GAO's outreach and transparency in its technology assessments activities. However, the report questioned "whether GAO's culture will be able to adapt to effectively cover the full range of OTA's work (particularly that part concerning non-technical values and horizon scanning)."[140]

In addition, the Lincoln Network and Demand Progress report was critical of the absence of details on key features of NAPA's recommendation for an Office of the Congressional S&T Advisor (OCSTA). In particular, the report questioned how OCSTA would pick topics; how it would integrate new resources into committees; how it would engage in horizon scanning; issues related to OCSTA's oversight, statutory powers, and mechanism for coordinating with other legislative support agencies; and whether OCSTA is the right organization for the horizon scanning function.[141]

The Lincoln Network and Demand Progress also recommended additional analysis on reviving and modernizing OTA, and on evaluating political considerations related to the feasibility of building congressional S&T capacity and the viability of maintaining it. Further, the report noted that NAPA recommended "beefing up CRS in several areas," but noted that NAPA did "not assess CRS's current capacity for S&T work versus the volume and type of congressional demands." The report cited assertions by one former CRS employee that CRS is risk-averse and increasingly politicized, leading to a loss of talent, and by another former CRS employee who asserted that CRS has moved from a policy of nonpartisan advice to one of neutrality which, in his view, has undermined CRS's analytical capabilities. The report recommended additional analysis of any CRS institutional challenges prior to making significant new investments in CRS.[142]

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[138] Ibid., pp. 9-15.

[139] Justin Warner and Grant Tudor, Belfer Center for Science and International Affairs, Harvard Kennedy School, *The Congressional Futures Office*, p. 9, May 2019, https://www.belfercenter.org/sites/default/files/2019-06/PAE/CongressionalFuturesOffice.pdf.

[140] Zach Graves, Lincoln Network; and Daniel Schuman, Demand Progress, *Evaluating the 2019 NAPA Report on S&T Policy Assessment and Resources for Congress*, p. 5, December 3, 2019, https://lincolnpolicy.org/wp-content/uploads/2019/12/Evaluating-the-NAPA-Report.pdf. The Lincoln Network is a nonprofit research organization focused on technology and innovation issues. Demand Progress Education Fund is a nonprofit technology policy research and advocacy organization.

[141] Ibid., pp. 10-11.

[142] Ibid, p. 8.

Options for Congress

Since 1995, several Members of Congress have undertaken numerous legislative efforts to restore funding for OTA or to affirm the need for an OTA-like technology assessment function. **Appendix C**, "OTA/Technology Assessment-Related Legislation in the 107th-116th Congresses," describes each of these efforts.

Options for Congress, if it chooses to reestablish an organizational capability with statutory authorization for conducting technology assessments, include

- reestablishing OTA without any changes to its statute,
- reestablishing OTA with changes to its statute,
- charging an existing legislative branch agency with new or expanded technology assessment authority and duties, or
- seeking technology assessments on a contractual basis from a nongovernmental organization such as the National Academies of Science, Engineering, and Medicine (National Academies).

Alternatively, Congress could choose to rely on existing sources of scientific and technological analysis and technology assessment. Such sources include, but are not limited to, CRS, GAO federal executive branch agencies, federally chartered advisory committees, federally funded research and development centers, the National Academies, academic researchers, industry and trade associations, professional organizations, businesses, not-for-profit organizations, advocacy groups, think tanks, and labor organizations.

This section analyzes these options and their purported advantages and disadvantages.

Option: Reestablish OTA Without Changes to Its Statute

Though OTA was defunded, its statutory authorities remain law. If Congress opts to reestablish OTA without changes to its statutory authority, it may be able to do so solely by appropriating funds to the agency. However, given past report language about closure and abolition, Congress might choose to provide an explicit statement of its intent to reestablish OTA and/or guidance on its reestablishment.

Since 1995, some Members of Congress have undertaken a variety of legislative efforts seeking to reestablish OTA by authorizing or appropriating funding for OTA or to express a "sense of the House" or a "sense of the Senate" that OTA should be reestablished. Most recently, in the 116th Congress, the House approved appropriations of $6 million for OTA in the Legislative Branch Appropriations Act, 2020 (H.R. 2779); these funds were not included in the final legislative branch appropriations act for FY2020 (P.L. 116-94).

While OTA's statutory authorities remain in law, the appropriations act in which it was defunded referred to the "orderly closure" of OTA and the "abolition of the Office of Technology Assessment," and provided for the disposition of "all records and property of the Office (including the Unix system, all computer hardware and software, all library collections and research materials, and all photocopying equipment)"[143] If Congress intends to rely on the existing statute to reestablish OTA, then in addition to providing funds for its establishment and operations it might wish to reaffirm that it intends for the office to operate in accordance with the statute as it existed prior to the enactment of P.L. 104-53. Also, because OTA and certain entities

[143] P.L. 104-53.

currently exist only in statute, the organization would need to be reestablished as provided for in the statute. For example, Congress would face the need to reestablish and appoint members of the TAB. The TAB would need to appoint an OTA Director. The OTA Director would need to hire OTA analysts and support staff, and possibly contract for additional analytical work. In addition, the newly formed organization would need to obtain office space, acquire assets such as furniture and equipment, and secure information and communications services, among other things.

A chief advantage of this approach is simplicity, as it would simply require an appropriation and possibly a statement of Congress' intent to restart the agency and guidance regarding aspects of the restarting of the agency. Another potential advantage of this approach is that it might make the agency operational more quickly by avoiding lengthy and possibly contentious debate regarding new or revised authorities or other topics.

Disadvantages of this approach include reliance on the original design of OTA, including its structure, management, and performance, without taking efforts to address past and contemporary analyses and criticisms of the agency. An OTA reestablished without addressing these critiques might be subject to criticism from congressional and external skeptics about the need for such an agency and its ability to effectively fulfill its statutory duties. Fiscal constraints may also continue to be a concern to some Members of Congress. Reestablishing OTA at a size comparable to the time of its defunding would require annual appropriations of tens of millions of dollars; OTA funding in FY1995 was $33.4 million in FY2018 dollars.

OTA could be established over time with initial funding provided for office space, equipment, management, operational costs, and a small staff of analysts. Congress could gradually provide additional resources to grow the agency's analytical capabilities (e.g., additional analysts, management, contractors) as necessary to meet congressional demand for technology assessment products. For example, Congress defunded the Administrative Conference of the United States (ACUS), like OTA, in 1995.[144] ACUS was reestablished in 2009 through an appropriation of $1.5 million.[145] In FY2019, Congress appropriated $3.1 million for ACUS. Congress could provide funding for the reestablishment of OTA through several mechanisms, for example by allocating additional budget authority to Legislative Branch Appropriations that could be appropriated to OTA or by reallocating funding in the budget and appropriations process from one or more executive branch or legislative branch agency to OTA.

Option: Reestablish OTA with Changes to Its Statute

A second option for Congress is to reestablish OTA by providing funding while also reauthorizing the agency with amendments to its organic statute to address past or contemporary criticisms ("Observations on OTA's Design and Operations"). In such an undertaking, Congress might consider statutory changes that address past criticisms of OTA by helping to ensure that, for example

- OTA provides a unique function, differentiated from similar functions performed by other agencies;
- OTA delivers information, analysis, and options in a timely manner, consistent with the pace of legislative decisionmaking;

[144] Administrative Conference of the United States, "History," https://www.acus.gov/history.

[145] CRS Report RL34523, *Financial Services and General Government (FSGG): FY2009 Appropriations*, coordinated by Garrett Hatch.

- OTA's technology assessments are relevant to the development and consideration of legislation;
- OTA's technology assessments are authoritative, thorough, and of high quality;
- the agency's composition of career civil servants, temporary staff, and contractors aligns with the needs of OTA over the short term and longer term;
- the public has appropriate opportunity for input; and
- OTA selects topics and conducts technology assessments in an objective manner, free from potential ideological, political, or other bias.

Congress may wish to consider the merits of changes in the following areas:

- **The definition of technology assessment.** A topic of intense discussion and debate in the period prior to OTA's establishment, the definition of technology assessment—in general and specifically with regard to advice for policymakers—remains a topic of discussion today. Congress might take into consideration past and current dialogue and analysis on this topic and whether there is a need to clarify the definition of the term in the context of the work to be performed by OTA. **Appendix A** provides a sampling of historical congressional and public discussion of the meaning of technology assessment.
- **Internal organizational structure.** A number of the criticisms of OTA were, in part, related to structural issues. For example, as mentioned earlier, some have criticized OTA's focus on meeting the objectives of the TAB as greatly narrowing the agency's constituency. Others have noted that long-term, one-party control of both houses of Congress, regardless of which party is in control, can result in members of the minority party feeling that OTA's work favors the party in power. Congress may wish to consider structural changes that provide for broader input from outside the TAB or mechanisms for bipartisan approval of decisions on reports to be undertaken. Also, the current statute provides for a Director to be appointed by the TAB, and a Deputy Director to be appointed by the Director with TAB approval. Congress may wish to consider whether the positions, appointment processes, and powers of each are appropriate and adequate for accomplishing the mission of OTA. OTA conducted technology assessments on a wide range of topics, making it cost prohibitive to have permanent staff with deep expertise on each topic. OTA met its needs for specialized expertise for particular assessments through the use of contractors with specialized expertise.[146] (**Figure 3** provides a quantitative window into the balance of staff effort and contractor effort at OTA for FY1992-FY1995.) Congress might opt to provide additional guidance to OTA on the composition of the agency's staff (full-time and part-time), the use of contractors (individuals and organizations), and approaches to managing the conduct of technology assessments.
- **External structure.** The current statute establishes the TAB, composed of equal numbers of House and Senate members from each party, to formulate and promulgate OTA policies. Congress may wish to consider whether the TAB is the best approach for this function or whether it might be performed by existing committees or subcommittees of Congress, by House and Senate leadership, by agency management, or through another mechanism. The current statute also

[146] Jon M. Peha, "Science and Technology Advice for Congress: Past, Present, and Future," *Renewable Resources Journal*, vol. 24, no. 2, pp. 19-23, summer 2006.

establishes a TAAC to provide OTA access to external scientific, technical, and management expertise. Congress might consider whether the TAAC was effective in this role, other roles the TAAC might play (e.g., in reviewing proposed technology assessments), and the potential use of other mechanisms to obtain external expertise.

- **Public participation.** Some have suggested that OTA lacked a strong public input mechanism and have asserted that modern information and communication technology could be used to facilitate a much broader range of public input than was possible in 1995.[147] The Wilson Center's report, *Reinventing Technology Assessment: A 21st Century Model,* suggested that a reestablished U.S. technology assessment agency employ an approach used by a number of parliamentary technology assessment agencies in Europe known as participatory technology assessment (pTA):

  > Participatory technology assessment (pTA) enables laypeople, who are otherwise minimally represented in the politics of science and technology, to develop and express informed judgments concerning complex topics. In the process, pTA deepens the social and ethical analysis of technology, complementing the expert-analytic and stakeholder-advised approaches to [technology assessment] used by the former OTA.[148]

- **Initiation of technology assessments.** The current statute authorizes the following officials and organizations to initiate a technology assessment: the chair of any standing, special, or select committee of either chamber of Congress, or of any joint committee of the Congress, acting on their own behalf or at the request of either the ranking minority member or a majority of the committee members; the TAB; or the Director, in consultation with the TAB. Congress might opt to expand this list to include any Member of Congress or at the request of a certain number of Members of Congress; reduce the list to include only some or one of those currently authorized; or to authorize the OTA Director to initiate assessments without any additional approval. Congress might also provide guidance to the OTA Director on prioritization of requests for technology assessment.
- **Administrative provisions.** The statute currently provides a variety of administrative authorities in areas such as personnel; contracting; real and personal property acquisition; recordkeeping; cooperation with executive and legislative branch agencies; and a proscription on operating laboratories, pilot plants, and test facilities. Congress may wish to review the existing authorities with respect to possible modifications, eliminations, or additions to these provisions.

Potential advantages of this approach include the opportunity to address previously identified OTA issues, to improve agency performance, and to address concerns during debate on reestablishment.

One disadvantage to this approach may be an inability to achieve a consensus on how the OTA statute should be revised, reducing the likelihood of the agency's reestablishment. For those who

[147] Peter D. Blair, "After the Fall: Post OTA Efforts to Fill the Gap," in *Congress's Own Think Tank: Learning from the Legacy of the Office of Technology Assessment (1972-1995)*, ed. Albert N. Link (Palgrave Macmillan, 2003), p. 8.

[148] Richard Sclove, *Reinventing Technology Assessment: A 21st Century Model*, Woodrow Wilson International Center for Scholars, Science and Technology Innovation Program, April 2010, p. vii.

see an immediate need for OTA-type analyses, a second disadvantage is that the agency's reestablishment could be delayed by hearings or studies on proposed changes, as well as consideration of amendments that might be offered to the revisions.

Option: Charge an Existing Agency or Agencies with New or Expanded Technology Assessment Authorities and Duties

At the time OTA was defunded, some Members of Congress anticipated that one or more government agencies might expand their capabilities to meet Congress's need for technology assessments.[149] This section describes options for establishing technology assessment functions within two legislative agencies, GAO and CRS.

Expand the Government Accountability Office's Technology Assessment Function

In FY2002, at the direction of Congress, GAO began developing a technology assessment capability, publishing reports intended to "explain the consequences that certain technology will have on the federal government—and on society as a whole."[150] Congress might leverage or authorize these efforts.

One advantage of this approach is that it would build on an existing capability within the legislative branch. At Congress's direction, GAO has produced technology assessments since 2002 and has recently established a new STAA team with a growing staff of science and technology experts. Another advantage would be GAO's reputation for high quality analytical work.

One potential disadvantage is that, unlike the singular focus of OTA on technology assessment, this would be only one of several functions of GAO. A *Washington Post* editorial in 2018 noted that GAO has an institutional culture centered on audits and investigations, and asserted that it lacks "a larger permanent staff of subject experts with whom legislators can build relationships, as well as the independence to better compete for resources."[151]

An analysis of technology assessment options for Congress written by the American Action Forum, a not-for-profit organization, identified other potential weaknesses. The analysis asserted that GAO reports do not feature many policy options, unlike OTA reports; GAO lacks the in-house expertise OTA had, limiting its ability to counsel Members of Congress; and GAO's consultancy services—"arguably the most important part of any technology assessment program, given the fast pace of technology policy"—need reform. The analysis suggested, however, that GAO could potentially address these shortcomings with additional congressional direction and resources.[152]

[149] Peter D. Blair, "After the Fall: Post OTA Efforts to Fill the Gap," in *Congress's Own Think Tank: Learning from the Legacy of the Office of Technology Assessment (1972-1995)*, ed. Albert N. Link (Palgrave Macmillan, 2003), p. 76.

[150] GAO, website, "Technology & Science, Technology Assessment," https://www.gao.gov/technology_and_science, accessed July 19, 2019. A link to each of GAO's technology assessment reports can be found at https://www.gao.gov/technology_and_science#t=1.

[151] Editorial Board, "Legislators Struggle with Tech. That's Why We Need the Office of Technology Assessment," *Washington Post*, September 17, 2018, https://www.washingtonpost.com/opinions/legislators-struggle-with-tech-thats-why-we-need-the-office-of-technology-assessment/2018/09/17/bb7c30c6-b860-11e8-a7b5-adaaa5b2a57f_story.html.

[152] Will Rinehart, *Should Congress Revive the Office of Technology Assessment?*, American Action Forum, October 29, 2018, https://www.americanactionforum.org/insight/should-congress-revive-the-office-of-technology-assessment/.

Create a Technology Assessment Function in the Congressional Research Service

The Congressional Research Service, a service unit of the Library of Congress, provides comprehensive research and analysis on all legislative and oversight issues of interest to Congress. CRS has a staff of about 600, including approximately 320 analysts and attorneys and 100 information professionals. CRS has expertise in a variety of policy fields, including many fields of science, engineering, and technology as well as S&T policy.

Much of CRS's work is provided in the form of consultancy in response to inquiries from Members of Congress, their personal staff, and congressional committee staff.

Most of the analytical work of CRS experts is short-term in nature—measured in hours, days, or weeks—and conducted to meet specific requests of staff working on legislative or oversight issues. Some of CRS's longer and more analytically complex reports may take several months to produce. In contrast, OTA reports generally took 18 months or longer to produce.

CRS does not have a statutory mission to perform technology assessments, nor has CRS otherwise received direction from Congress to conduct technology assessments. CRS has a statutory mission to prepare and provide information, research, and reference materials and services to Congress—to include House and Senate committees, joint committees of Congress, and Members of the Senate and House of Representatives. CRS serves Congress and not the public.

At the time Congress defunded OTA, some Members of Congress, including those on the House Appropriations Committee, anticipated that the Congressional Research Service might undertake some of the work performed by OTA. In 1999, CRS reorganized its operational structure and embedded science and technology analysts in CRS units in which science and technology issues were an important part of broader issue areas (e.g., energy, environment, health, defense). A smaller cadre of analysts in a discrete science and technology unit focused primarily on science and technology policy issues writ-large (e.g., policies associated with research and development funding and activities, technology transfer, innovation). Some have asserted that this change diminished CRS's ability to fill the gap left by OTA's closure. In his book, *Congress's Own Think Tank*, Peter Blair asserted that

> The unintended result was a significant dilution of CRS's capability to cover science and technology policy issues. It was never realistic to presume that CRS was in a position to fill the void left by OTA's closure.

Alternatively, CRS management and some policy analysts believed that the reorganization improved CRS's ability to provide more comprehensive analysis to Congress.

Potential advantages of using CRS to conduct technology assessments might include CRS's reputation for providing Congress with authoritative, confidential, objective, timely, and nonpartisan analysis in support of congressional legislative and oversight activities, as well as CRS's current cadre of experts in science, engineering, technology, and S&T policy.

Disadvantages include CRS's lack of experience and expertise in conducting in-depth technology assessments of the type historically performed by OTA. While CRS could potentially acquire such experience and expertise, this approach would require a departure from CRS's current work and organizational culture. It might also require additional financial resources, expanded facilities, the hiring of additional management and staff, and potentially the establishment of a new organizational unit within CRS devoted to technology assessment. While current staff with science, engineering, and technology expertise could contribute to the establishment of such a

unit within CRS, that might detract from their ability to provide the analyses and services the agency currently provides to Congress.

Option: Use the National Academies for Technology Assessment

Since its founding under a congressional charter in 1863, the National Academies have been an authoritative source of high-quality expertise on science, engineering, and health matters for Congress and the nation. The National Academies produces analyses in seven major program areas: Behavioral and Social Sciences and Education, Earth and Life Studies, Engineering and Physical Sciences, Gulf Research, Health and Medicine, Policy and Global Affairs, and Transportation Research.[153]

Members of each component of the National Academies—the National Academy of Sciences, National Academy of Engineering, and National Academy of Medicine—elect new members based on outstanding and continuing achievements in their fields. Academy members, together with other experts, serve pro bono on committees conducting National Academies studies and reports:

> Each year more than 6,000 of the world's foremost scientists, engineers, and health professionals volunteer their time to address some of society's toughest challenges by serving on the hundreds of study committees that are convened to answer specific sets of questions. Our peer-reviewed reports present the evidence-based consensus of these committees of experts.[154]

At the time of OTA's defunding, some policymakers and analysts postulated that the National Academies (as well as other nongovernmental organizations such as universities) might undertake technology assessments. Representative Jack Kingston, chairman of the Subcommittee on Legislative Branch Appropriations, reiterated this perspective in House floor debate on FY2005 legislative branch appropriations:

> In 1995 on a bipartisan level, we eliminated [OTA], and the belief at that time was that there were other committees that we could turn to to get technology studies and technology assessment. Some of these, for example, are the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council. All of them have hundreds of people who are technically educated.[155]

However, according to author Peter Blair, while the National Academies saw a short-term increase in congressional requests for reports following the closure of OTA, demand returned to its previous levels shortly thereafter:

> The increased use of the [National Academies], however, was short-lived, lasting only one year—the number of congressionally mandated or requested [National Academies] reports doubled in the 105th Congress (1997-1998) to 59, up from the historical average of about 22 studies (e.g., in the 104th Congress [1995-1996] as OTA was closing down), but interestingly then dropped back to the historical average by the 107th Congress (2001-2002).[156]

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[153] National Academies, "What We Do," http://www.nationalacademies.org/about/whatwedo/.

[154] Ibid.

[155] Representative Jack Kingston, *Congressional Record*, vol. 150, part 95 (July 12, 2004), p. H5488, https://www.congress.gov/congressional-record/2004/07/12/house-section/article/H5488-2.

[156] Peter D. Blair, "After the Fall: Post OTA Efforts to Fill the Gap," in *Congress's Own Think Tank: Learning from the Legacy of the Office of Technology Assessment (1972-1995)*, ed. Albert N. Link (Palgrave Macmillan, 2003), p. 76.

It is unclear why the number of requests for National Academies fell after the initial increase. Among the possibilities: a decrease in demand for science and technology information and advice; a perception that such reports were not meeting Congress's needs in terms of factors such as relevance, timeliness, or actionability; and increased fiscal constraints.

The National Academies study process is highly structured, methodical, and deliberate. The process includes four major stages: defining the study; committee selection and approval; committee meetings, information gathering, deliberations, and drafting of the report; and report review. This process includes checks and balances "at every step in the study process to protect the integrity of the reports and to maintain public confidence in them."[157] Accordingly, some assert that the National Academies is not structured to respond to congressional needs in a timeframe consistent with the pace of legislative decisionmaking—a criticism also made of OTA.

In 2006, Peter Blair, in his capacity as executive director of the National Academy of Sciences' Division of Engineering and Physical Sciences, testified at a House Science Committee hearing on scientific and technical advice for Congress. In his written statement, Blair cited timeliness and cost as factors that could impede the National Academies' utility to legislative decisionmakers.[158] With respect to timeliness, Blair stated that the average time for completion of a National Research Council (NRC) study was 18 months, but that it can take longer. He attributed this lengthiness to the study process (described above), coordination of the schedules of busy study committee members, and the time required for peer review, editing, production, and release. Blair noted further that, before a study can even begin, each congressionally mandated National Academies study must be defined and funded under negotiated contracts with federal agency sponsors:

> [It] often takes six to nine months [to move] through a government procurement process to initiate an NRC study even after a mandated study has been enacted in law (or included in report language). For those studies mandated by Congress, an additional delay often results from the time needed to enact the relevant legislation.[159]

With respect to cost, Blair noted a widely held perception that the cost of National Academies studies was high, attributing this in part to the negotiation of separate contracts "for each study, unlike the central funding for agency advisory committees."

Further, Blair noted that it is difficult for an organization to serve many different types of needs:

> Like any process designed to serve many needs, the NRC study process is not perfectly tuned to serve all government needs. For example, our process is less well equipped, currently, to go beyond technical analysis, to gauge the broader policy implications of alternative actions, especially those implications that may involve fundamental value judgments or tradeoffs for which it may be difficult or impossible to achieve consensus. [160]

To address some of these perceived shortcomings, Blair suggested the potential utility of establishing a sub-unit of the National Academies that would employ "a study process specifically adapted to congressional needs, adopting more of an OTA-like study model with base support and contracting capability as well as a task-order like funding mechanism." [161]

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[157] National Academies, "Our Study Process," http://www.nationalacademies.org/nasem/na_064188.html/.

[158] Testimony of Peter D. Blair, Executive Director, Division of Engineering and Physical Sciences, National Academy of Sciences, in a hearing on "Scientific and Technical Advice for the U.S. Congress," before the House Committee on Science, Serial No. 109-57, July 25, 2006, pp. 37-46.

[159] Ibid.

[160] Ibid.

[161] Ibid.

Potential advantages of using the National Academies to perform technology assessments include the organization's long-standing credibility and strong reputation for technical expertise and authoritative, objective, high-quality scientific and technical analysis; its congressional charter to help inform public policymakers on matters of science and technology; and its members' depth and breadth of knowledge across the spectrum of science and engineering disciplines.

As discussed above, potential disadvantages of relying on the National Academies to provide technology assessments to Congress include concerns about its cost, timeliness, and ability to assess and advise on implications involving non-scientific, non-technical value judgements and trade-offs.

Ultimately, the National Academies serves Congress as a private, nonprofit corporation negotiating a contract with the government—with all the advantages and disadvantages that process involves—and does not serve as a part of the legislative branch.

Option: Rely on a Broad Range of Existing Organizations for Scientific and Technical Analysis and Technology Assessment

While some identify a need for an organization to produce the types of technology assessments previously produced by OTA, others assert that Congress already has access to all of the scientific and technical advice it needs. Still others assert that the issue is not a lack of S&T information, but rather whether Congress uses existing sources effectively when making policy decisions.

Congress may obtain scientific and technical analysis (and, in some cases, advice and recommendations) from a wide array of entities, including federal executive branch agencies, GAO, CRS, federally chartered advisory committees, federally funded research and development centers, the National Academies, academic researchers, industry and trade associations, professional organizations, businesses, not-for-profit organizations, advocacy groups, think tanks, labor organizations, and others. The types of information and analysis these organizations provide, and their authoritativeness, objectivity, independence, timeliness, and cost, vary widely.

A key advantage of relying on existing agencies is that the infrastructure, people, and processes are currently in place, reducing the time and logistical complexities (e.g., hiring, acquiring space, establishing processes and procedures) associated with establishing new organization. In addition, relying on existing organizations may also reduce legislative hurdles associated with establishing a new organization.

The primary disadvantage of this approach, according to some, is that the information some of these entities currently provide to Congress may lack authoritativeness, objectivity, or independence. A key factor in the creation of OTA in 1972 was a perceived need for Congress to have its own, independent source of scientific and technical expertise, capable of providing in-depth technology assessments, provided by an institution responsive to the needs and timing of the legislative process.[162] Some of the entities identified above, and the analysis they perform, may not embody all these characteristics.

[162] U.S. Congress, Senate Committee on Rules and Administration, *Office of Technology Assessment for the Congress*, A hearing on establishing an Office of Technology Assessment for the Congress as an aid in the identification and consideration of existing and probable impacts of technological application, 92nd Cong., 2nd sess., March 2, 1972, pp. 49-50.

Science and Technology Advice to Congress: Identifying Needs and Avoiding Duplication in Meeting Them

Congress uses information and analysis about science and technology and its implications to inform its deliberations and decisions that affect the U.S. economy, national security, quality of life, standard of living, public health and well-being, and other matters of national policy. A wide range of organizations provide science and technology information and analysis directly and indirectly to Congress. Some of these organizations are public, some private, and some quasi-governmental. Among the public organizations, some are part of the executive branch and others are in the legislative branch (i.e., CBO, CRS, and GAO). Some in Congress believe that there is a need to re-create OTA or an OTA-like organization, or to assign OTA-like responsibilities to an existing organization to meet Congress's unique information needs and produce analysis not currently being provided by existing organizations; others disagree. Some believe that a new organization should be established to handle some or all of the science and technology information and analysis services OTA was authorized to provide.

Duplication of capabilities has been a concern expressed by some within Congress and external observers during debate about the establishment of OTA, during debate about the defunding of OTA, and during subsequent debate and discussions about reestablishing OTA or OTA-like capabilities. Most parties agree on the need to prevent the creation of duplicative organizations or functions, and to eliminate (or at least minimize) duplicative organizations, duplicative functions within organizations, and duplicative work, along with the costs associated with them.

To avoid duplication and meet its information and analysis needs, Congress may wish to further the process of

- identifying the science and technology analysis it needs to support its deliberative processes and decisions;
- determining which federally funded organizations (e.g., federal agencies, quasi-public, and other nonprofit organizations) are currently charged with addressing the identified needs and how effectively the organizations address these needs;
- identifying areas of overlap or duplication of authorities and activities of the organizations and their components;
- identifying areas of need that are not being addressed by these organizations; and
- determining whether such needs can best be met by an existing organization or organizations; whether the identified needs merit the creation of a new organization, organizations, or the extension of the capabilities of an existing organization; or whether the costs of obtaining additional science and technology information and analysis outweighs the need.

Appendix A. An Historical Overview of the Definition of Technology Assessment

The definition of the term *technology assessment* has a long history of discussion and debate. Much of this discussion occurred in the late 1960s and early 1970s during the efforts that ultimately led to the establishment of the Office of Technology Assessment in 1972. This appendix offers a variety of perspectives on the meaning of technology assessment in the context of public policy.

In the House of Representatives, the Committee on Science and Astronautics' Subcommittee on Science, Research, and Development played a leading role in the exploration of technology assessment to assist policymakers. In 1969, Representative Emilio Q. Daddario, chairman of the subcommittee, stated that technology assessment was identified as a major activity of the subcommittee in 1965.[163]

In 1967, Representative Daddario introduced H.R. 6698 (90th Congress) to establish a Technology Assessment Board for the purpose of

> identifying the potentials of applied research and technology and promoting ways and means to accomplish their transfer into practical use, and identifying the undesirable by-products and side-effects of such applied research and technology in advance of their crystallization and informing the public of their potential in order that appropriate steps may be taken to eliminate or minimize them.[164]

That same year, Representative Daddario put forth in a written statement, published as a committee print, the following definition of technology assessment:

> Technology Assessment is a form of policy research which provides a balanced appraisal to the policymaker. Ideally, it is a system to ask the right questions and obtain correct and timely answers. It identifies policy issues, assesses the impact of alternative courses of action and presents findings. It is a method of analysis that systematically appraises the nature, significance, status, and merit of a technological program. The method may well vary from case to case….
>
> Technology Assessment is designed to uncover three types of consequences—desirable, undesirable, and uncertain. The benefits that accrue from technology are naturally the driving force for its application. Economic growth is fostered by more convenient and efficient services or by new and less expensive goods. Society benefits when technology is developed around some value or goal, consistent with democracy. Undesirable consequences, sometimes played down by calling them harmful side effects, can be expected with most innovations. Technology means change—change to the natural environment, change in personal habits and behavior, change in social and economic patterns, and not infrequently, change in the legal and political processes. While many of these changes are beneficial, many are disruptive and dislocative. They change situations more rapidly than the pace at which individuals can adjust. The well-known cultural lag finds its logical beginnings in the phenomena. Assessment of the risks is a necessary concomitant to assessment of the benefits.

[163] U.S. Congress, House Committee on Science and Astronautics, Subcommittee on Science, Research, and Development, *Technical Information for Congress*, committee print, U.S. Government Printing Office, 99-044, prepared by the Science Policy Research Division of the Legislative Reference Service of the Library of Congress, 91st Cong., 1st sess., April 25, 1969, Letter of Transmittal.

[164] H.R. 6698 (90th Congress).

Uncertain consequences are the third type to be identified and assessed. Available information may point out early that an effect will occur and can give no idea of the degree of impact. When the severity of impact is not known further research is often warranted…. In general, experimentation and pilot projects are required to determine what proscriptions might be necessary before the technology is able to successfully diffuse through society.

If assessment is a method of policy research that identifies the amount and type of change for alternative course of action and provides a balanced appraisal of each alternative, then what is the scope of technology assessment? What will it try to measure? What timeframe will it consider? What yardsticks will be used? How does assessment differ from other methods of analysis?

Answers to these questions will more concisely define Technology Assessment and more closely show its relationship to the policymaking process.

Technology Assessment for the Congress will deal for the most part with applications in the United States. It is worth noting though, that the entire world, and even outer space, is the system with which we are concerned…. The international aspects of Technology Assessment will become more important as the power and ubiquity of man-made forces continue to increase….

To assess technology one has to establish cause and effect relationships from the action or project source to the locale of consequences.

A direct or immediate effect is easy to spot and assess. The direct effects, in turn, will cause other consequences—indirect or derivative effects. As the scope of assessment moves outward in time the derivative effects become the result of many causes and not of one specific technological change….

The function of technology assessment is to identify all of these [impacts and trends]—both short-term and long range. The emphasis though will be on the short-term impacts that can be measured by natural science parameters. That is, the focus of Technology Assessment will be on those consequences that can be predicted with a useful degree of probability. Possible changes in values, attitudes, or motivations are important but not easily predicted. These changes are usually long term and fall beyond the primary focus of Technology Assessment. Therefore, because of their slow evolution, present human values and political motivations will serve as the frame of reference for purposes of measurement and appraisal.

Assessment is a form of policy research and is not technological forecasting or program planning. It is a balanced analysis of how a technological program could proceed with the benefits and risks of each policy alternative carefully described. It incorporates prediction and planning, but only to expose the potential consequences of the program.

Assessment is an aid to, and not a substitute for, judgment. Technology Assessment provides the decision maker with a list of future courses of action backed up by systematic analysis of the consequences. In this sense it is an analytical study that could be prepared by anyone. Its utility would be enhanced if it was undertaken for a particular policymaking group that could sketch in the nature of the problem for the study team beforehand. In a broader sense, assessment is part of the legislative process. Our subcommittee will gather and assess information before we can make any judgments. Part of this information will be actual assessment studies prepared for the subcommittee by scientific community and the Science Policy Research Division [of the Legislative Research Service, later renamed the Congressional Research Service]. When viewed as either a method of research or a part of

> the legislative process, Technology Assessment serves to provide information tailored to the constraints and needs of the policymaking process.[165]

Shortly after assuming office in 1969, President Richard Nixon established the National Goals Research Staff, "a small, highly technical staff, made up of experts in the collection, correlation and processing of data relating to social needs, and in the projection of social trends."[166] The announcement of its formation offers a perspective on the Nixon Administration's view of the importance and role of technology assessment:

> We can no longer afford to approach the long-term future haphazardly. As the pace of change accelerates, the processes of change become more complex. Yet at the same time, an extraordinary array of tools and techniques has been developed by which it becomes increasingly possible to project future trends—and thus to make the kind of informed choices which are necessary if we are to establish mastery over the process of change.
>
> The functions of the National Goals Research Staff will include
>
> - forecasting future developments, and assessing the long-range consequences of present social trends;
> - measuring the probable future impacts of alternative courses of action, including measuring the degree to which changes in one area would likely affect another;
> - estimating the actual range of social choice—that is, what alternative sets of goals might be attainable, in light of the availability of resources and possible rates of progress;
> - developing and monitoring social indicators that can reflect the present and future quality of American life, and the direction and rate of its change; and
> - summarizing, integrating, and correlating the results of related research activities being carried on within the various Federal agencies, and by State and local governments and private organizations.

The National Goals Research Staff was directed to produce a report by July 4, 1970, "to help illuminate a possible range of national goals for [the U.S. Bicentennial]." In July 1970, the organization released its first (and only) report, *Towards Balanced Growth: Quantity with Quality*, describing technology assessment:

> Advanced technology of all sorts produces unexpected and often unwanted indirect consequences. A movement called "technology assessment" now advocates a more pervasive and systematic assessment of the social costs and benefits of both new and existing technology. The main issues are: To what extent should the use of new and old technology be restricted because of adverse side effects? What institutional mechanisms might assess and regulate technology? What effect would such a policy have on economic growth and on the size and nature of our technological and scientific establishments?…
>
> In short, what is meant by technology assessment is nothing more than a systematic planning or forecasting process that delineates options and costs, encompassing economic,

[165] U.S. Congress, House Committee on Science and Astronautics, Subcommittee on Science, Research, and Development, *Technology Assessment. Statement of Emilio Q. Daddario*, CMP-1967-SAH-0015, committee print, 90th Cong., 1st sess., July 3, 1967, pp. 12-14.

[166] The White House, *FG6-13 (National Goals Research Staff) (White House Central Files: Subject Files)*, https://www.nixonlibrary.gov/finding-aids/fg-6-13-national-goals-research-staff-white-house-central-files-subject-files.

> environmental, and social considerations (both external and internal) and with special focus on technology-related "bad," as well as "good," effects.[167]

In moving toward the establishment of the Office of Technology Assessment, Congress sought and received input from a number of sources about technology assessment in the context of public policy.

At the request of the House Committee on Science and Astronautics, reports on technology assessment were delivered by the National Academy of Sciences (NAS) and the National Academy of Engineering (NAE) in 1969, and the National Academy of Public Administration (NAPA) in 1970.

The National Academy of Sciences' report, *Technology: Processes of Assessment and Choice*, emphasizes the absence of a unitary concept of technology assessment and emphasizes that different views vary with the interests and perspectives of the proponent:

> The choice … is between technological advance that proceeds without adequate consideration of its consequences and technological change that is influenced by a deeper concern for the interaction between man's tools and the human environment in which they do their work.
>
> For those who hold this more balanced view, the expression "technology assessment" may acceptably describe what occurs when the likely consequences of a technological development are explored and evaluated. Their objective is to improve the quality of such efforts at exploration and evaluation of our technological order. But the concept of improved technology assessment is by no means a unitary one; it suggests different things to different people. The contents and focus of the notion vary with the vital interests and perspectives of its many proponents.
>
> To some, concerned primarily with the *preservation and enhancement of environmental quality*, technology assessment suggests evaluation of technical changes or applications from the perspective of their likely impact on various environmental goals and resources—or the exploration of how particular environmental objectives might be affected, beneficially or adversely, by the growth and speed of various technologies….
>
> To others, concerned with the *measurement of social change* as a step toward the achievement of broad national goals, technology assessment connotes the use of new tools to monitor the impacts on society of technical changes (among others) and to improve the quality of feedback from social effects to technological (and other) developments….
>
> Yet another group is concerned broadly with the need for *greater foresight and planning* to guide technological change with more timely and comprehensive balancing of total costs against total benefits. To this group, technology assessment means an attempt to project the likely growth and probable impacts of specific technologies.…
>
> Another group, concerned with *improving the allocation of public resources*, views technology assessment as a means of identifying and measuring the possible uses of technologies generated by federally supported research and development activities. Of special concern to this group is the supposed transfer of space and defense technology and management techniques to the civilian sector, particularly for the solution of major social problems related to urbanization, such as housing, crime, transportation, and municipal services.
>
> And to still others, whose concerns lie with *better program and policy evaluation* and who do not restrict their attention to resource allocation, technology assessment represents one component of planning-programming-budgeting (PPB). Their emphasis is upon

[167] The White House, National Goals Research Staff, *Towards Balanced Growth: Quantity With Quality*, July 4, 1970, pp. 28 and 118.

> developing more precise definitions of program objectives as they related to national goals and priorities; more specific and unbiased criteria for assessing program potentiality and performance in cost-benefit terms; and more successful ways of modifying old programs or proposing new programs with the help of such analytic devices.[168]

The National Academy of Engineering's report, *A Study of Technology Assessment*, states that one of its underlying concerns entering the study—a concern expressed by a number of technology assessment skeptics—was that the outcome of such assessments would primarily be to impede technology commercialization. Nevertheless, the NAE report concluded that technology assessment could prove a useful tool for legislators:

> When the Committee on Public Engineering Policy first undertook its assignment to explore the concept of technology assessment, we were concerned about the concept's utility and practicality. Prior to our feasibility studies, we felt—perhaps as others may have—that results from such assessments might become primarily impediments to the uses of technology. We can now reflect on the collective experience of nearly 50 participants in this work, which is summarized in this report.
>
> First of all, we now feel that useful methodologies are available for technology assessment and that more adequate ones can be developed through practice. Second, our experiences show that task forces of experts specifically constituted for particular technology assessments can accumulate data and develop insight on the potential impacts of technology on society. Third, our preliminary work shows that such task forces can propose a variety of national strategies for modulating the effects of technology or society, thereby providing the legislator with a better base for his judgments on the role of government in influencing technology.[169]

The National Academy of Public Administration's report, *A Technology Assessment System for the Executive Branch*, noted that assessment at that time had only dealt with narrow first-order effects within the assessing agency's scope of interest, and only technical and economic second-order effects. The report advocates a wider, systemic, and more complex perspective approach to technology assessments:

> Simply stated, technology assessment is the evaluation of the impacts of new, developing, or established technologies, including, but not limited to, those which the Federal Government may support or regulate…. Most assessments of the consequences of introducing a technology are incomplete, if not superficial. Commonly, they include few first-order consequences outside the assessing agency's program interests or statutory responsibility, and only technical and economic analyses of second-order consequences. Good assessments should consider the interactions of population, environment, technology, society, and the economy.[170]

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[168] National Academy of Sciences, Panel on Technology Assessment, *Technology: Processes of Assessment and Choice*, prepared for the Committee on Science and Astronautics, U.S. House of Representatives, July 1969, pp. 3-6. According to the report, "In December 1963 the Committee on Science and Astronautics concluded a formal agreement with the National Academy of Sciences. The purpose of the agreement, which evolved into the first series of contracts between Congress and the Academy, was the production of study and pilot programs designed to isolate and describe some of the critical policy issues which government must consider in its decisions to regulate, support or otherwise foster research in the United States." Note: Italics used in the text of the quote are the emphasis of the author, not CRS.

[169] National Academy of Engineering, Committee on Public Engineering Policy, *A Study of Technology Assessment,* prepared for the Committee on Science and Astronautics, U.S. House of Representatives, July 1969, p. vi. According to the report, "Early in 1968, the Committee on Science and Astronautics concluded a formal agreement with the National Academy of Engineering calling for a special study of possible techniques to be applied in areas of Technology Assessment. This was the first contractual arrangement entered into by the Congress and the Academy."

[170] National Academy of Public Administration, *A Technology Assessment System for the Executive Branch*, prepared for the Committee of Science and Astronautics, U.S. House of Representatives, July 1970, p. 1.

The House Subcommittee on Science, Research, and Development also requested a report from the Legislative Reference Service (LRS, later the Congressional Research Service) of the Library of Congress, which was delivered in 1971. The report, *Technical Information for Congress,* included the following description of technology assessment:

> Before, during, and after the building of a technological system, it is necessary to identify and study the consequences of its operation. The objective is to improve the management of the total technological society, including the minimizing of consequences which are unintended, unanticipated, and unwanted. Assessment includes forecasting and prediction, retroactive evaluation, and current monitoring and analysis. Measurements involve non-economic, subjective values as well as direct, tangible quantifications. Above all, assessment requires that catastrophic consequences of each proposed new technology be foreseen and avoided before the new technology becomes entrenched in the socioeconomic complex of human organization.[171]

During this period, other organizations offered their views of technology assessment. In December 1971, *The Futurist,* a bi-monthly magazine with articles on technological, societal, and public policy trends, offered this definition:

> [Technology assessment is] a reasoned response to the stress that a rapidly changing and expanding technology puts on our complex and increasingly industrialized, urbanized, and densely populated society. It attempts to make the process of coping with technological development more systematic and rational. Technology assessment can be viewed as a mixture of early warning signals and visions of opportunity. Or as a device for protecting man from his own technological creativity. Or as a formal mechanism for allocating scientific resources, setting technological priorities, and seeking more benign alternatives for technologies already in use. Or as an attempt to control and direct emerging technologies so as to maximize the public benefits while minimizing public risks.[172]

In the act establishing OTA in 1972 (P.L. 92-484), Congress implicitly defined technology assessment in its findings and declaration of purpose for the agency:

> As technology continues to change and expand rapidly, its applications are large and growing in scale and increasingly extensive, pervasive, and critical in their impact, beneficial and adverse, on the natural and social environment. Therefore, it is essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems....
>
> [I]t is necessary for Congress to equip itself with new and effective means for securing competent, unbiased information concerning the physical, biological, economic, social, and political effects of such applications; and utilize this information, whenever appropriate, as one factor in the legislative assessment of matters pending before the Congress, particularly in those instances where the Federal Government may be called upon to consider support for, or management or regulation of, technological applications.

In 1973, the Congressional Research Service, in response to a request from the House Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, prepared *Science Policy: A Working Glossary.* This glossary, published as a committee print, included the following definition for technology assessment:

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[171] U.S. Congress, House Committee on Science and Astronautics, Subcommittee on Science, Research, and Development, *Technical Information for Congress*, committee print, House Document No. 91-137, prepared by the Science Policy Research Division of the Legislative Reference Service of the Library of Congress, 91st Cong., 1st sess., June 1971, p. 481.

[172] David M. Kiefer, "Assessing Technology Assessment," *The Futurist*, December 1971, p. 234.

> A generalized process for the generation of reliable, comprehensive information about the chain of technical, social, economic, environmental, and political consequences of the substantial use of a technology, to enable its effective social management by decisionmakers. Initially advanced as an instrument to provide advice to political decisionmakers, the concept has been increasingly accepted as a policy service within corporate management of private businesses.[173]

In one of its first reports, *Requirements for Fulfilling a National Materials Policy*, published in August 1974, the Office of Technology Assessment stated its mandate as being directed to

> provide early indication of the probable benefits and adverse impacts of technology and to develop other coordinate information which assists the Congress. Among other specific functions the OTA is charged with identifying impacts of technology, ascertaining cause and effect relationships, identifying alternate technological methods, identifying alternate programs, comparing the impacts of alternate programs, presenting analysis to appropriate legislative bodies, and identifying areas where additional research or data collection is required.[174]

In 1975, the American Bar Association's Section of Science and Technology held a program on "Technology Assessment—Legal and Policy Implications" at the organization's annual meeting. In his opening statement, the chair of the section, Ronald A. May, relied on the definition of technology assessment used in a survey conducted on behalf of the National Science Foundation:

> Technology Assessment is "the process of identifying actual or potential secondary effects of a technological development (or of a set of interrelated technological developments) on social, political, economic, and/or environmental values or institutions."[175]

In his remarks, May posed the question: What does technology assessment mean for lawyers? In response to this question, May noted that

> Ten times as many [technology assessments] that were studied in this survey were "problem initiated" as opposed to "technology initiated." In other words, only one out of ten [technology assessments] had been done because somebody developed a new technology and decided they wanted to assess its impact. Stated conversely, in nine out of ten [technology assessments] there was a problem, and the technology was studied on that account. Lawyers are problem solvers, so this is significant.[176]

May also observed that while technology assessments were performed for the purpose of influencing executive decisions in corporations and to influence agency and legislative decisionmakers, "very little [technology assessment] was done to influence judicial decision-making."[177]

In 1995, during the period in which Congress was considering whether to discontinue funding for OTA, one critic reflected back to the time leading up to the establishment of OTA, noting concerns held by some that technology assessments would become a tool to stifle innovation and technological commercialization. Alan Porter, director of the Georgia Tech Technology Policy

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[173] U.S. Congress, House Committee on Science and Astronautics, Subcommittee on Science, Research, and Development, *Science Policy: A Working Glossary*, committee print, prepared by Congressional Research Service, 93rd Cong., 1st sess., July 1973, p 72.

[174] Office of Technology Assessment, Reinventing Technology Assessment: A 21st Century Model, August 1974, https://www.princeton.edu/~ota/disk3/1974/7402_n.html.

[175] Ronald A. May, Michael S. Baram, and Joseph Coates, et al., "Proceedings of and Papers Presented at American Bar Association Section of Science and Technology Program Held at the ABA Annual Meeting in Montreal, Quebec on August 11, 1975," *Jurimetrics Journal*, vol. 16, no. 3 (Spring 1976), p. 158, https://www.jstor.org/stable/29761535.

[176] Ibid., p. 159.

[177] Ibid., p. 159.

and Assessment Center, noted both the ambiguity of the term *technology assessment* and those concerns:

> It should not shock us that two general, widely used, and ambiguous terms—'technology' and 'assessment'—when combined, do not yield a singular meaning. Nonetheless, we can track and even, perhaps, make sense of the usage of 'technology assessment'. The initiation of [technology assessment] in the late 1960s in the USA engendered lively discussion along two distinct streams. The more direct sought to devise an effective policy analysis mechanism to help the U.S. Congress better cope with executive branch proposals. The other, philosophical in bent, concerned the broad roles of technology in society, seeking to help society better manage technology. Both streams struck fear in those committed to technology-based free enterprise, as expressed in charges that TA meant 'technology arrestment.' [178]

In a 1970 House Subcommittee on Science, Research, and Development field hearing to explore the relationship between technology assessment and environmental problems, one academic critic asserted that technology assessment as proposed by subcommittee chairman Representative Emilio Daddario was "conceptually impossible" and that instead market forces should be used to guide and control technology:

> I feel I cannot let pass unchallenged the assumption that technology assessment of the type described [by the chairman] is a useful or even a harmless exercise, or is, indeed, possible…. I am not suggesting a less ambitious role for Congress because I think the impact of technology on society is unimportant, but precisely because I think it is extremely important—so important in fact that it should be not left to the Congress of the United States to assess and control technology.…
>
> The first problem confronting anyone who attempts technology assessment is that it can't be done. It is conceptually and practically impossible to determine what the impact of any particular technological gadget will be, let alone evaluate these effects and find benefit/cost or benefit/risk ratios. Even if our foresight were as good as our hindsight it would be impossible…. The world, and especially human societies, are just too complex and interrelated for anyone, or any committee, to determine the direct and derivative effects of technology, even in the past…. Everybody knows, of course, that technology assessment is at best a very difficult task; I am suggesting it is more than difficult, it is conceptually impossible….
>
> [However,] technology can be and has been guided and controlled, by social institutions which encourage its development and application in socially desirable ways. The primary social institution which has guided technology has been the market…. On the whole, this system has worked very well, without the need for any official body to assess all the long-term effects of each new technological process as it appeared.[179]

More recent definitions of technology assessment are also varied and echo the same themes present in the definitions from the 1960s and 1970s.

[178] Alan L. Porter, "Technology Assessment," *Impact Assessment*, 1995, 13-2, p. 135, https://www.tandfonline.com/doi/pdf/10.1080/07349165.1995.9726087.

[179] Testimony of Larry E. Ruff, professor of economics, University of California at San Diego, before the U.S. Congress, House Science and Astronautics, Science, Research, and Development, *Hearing on H.R. 17046*, 91st Cong., 1st sess., March 13, 1970, 46-927, pp. 360-364.

Appendix B. Selected Trends and Factors That May Contribute to a Perceived Need for Technology Assessment

A variety of reports published in 2019, together with proposals by some Members of Congress and others outside of Congress, have asserted that Congress needs a bolstered technology assessment capability to inform its policy decisions. This section describes selected trends and factors that may contribute to this perspective, including the rapid pace of technological change, the globalization of R&D, the role of science and technology (S&T) in the U.S. economy, the role of S&T in national security, the increasing complexity of technology, the advent of new information and communications technologies, and the role of S&T in other aspects of public policy. The role of new and powerful technologies in industry, national security, society, and the global balance of power may have important implications for congressional policy decisions, including policies related to their development and application, as well as in preventing, mitigating, and remediating potential adverse effects.

Rapid Pace of Technological Change

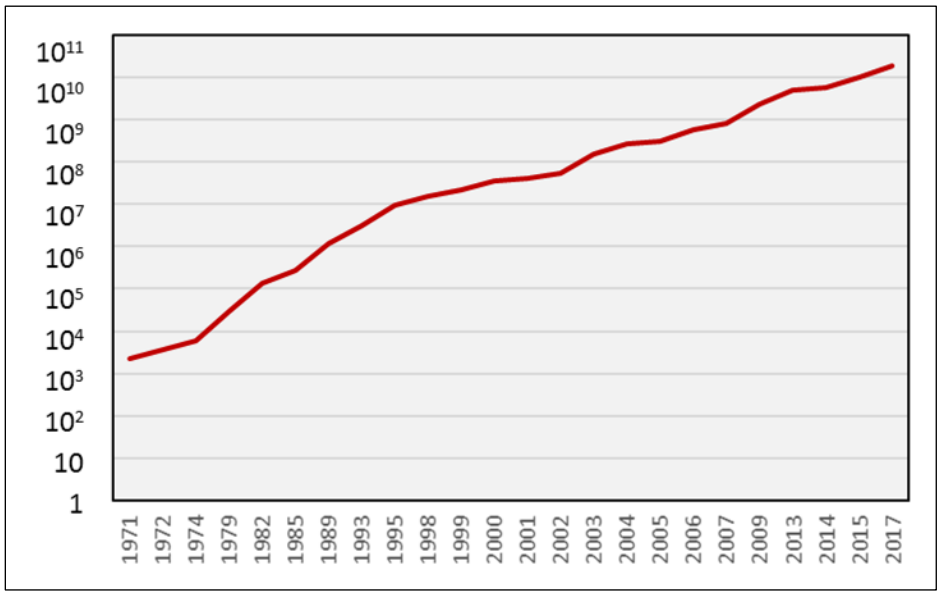
Technology—the application of scientific and other knowledge for practical purposes—is advancing rapidly, and by some measures it is growing at an accelerating pace. This growth is fueled, in part, by increased public and private investments in R&D. A variety of technologies have seen rapid growth—magnetic data storage, DNA sequencing, wired and wireless data transmission technologies—some continuing this growth over multiple decades.[180] For example, as illustrated in **Figure B-1**, the number of transistors on a microchip since 2001 has grown exponentially.[181] While this chart only shows data since 1971, the rapid growth can be traced back to the invention of the integrated circuit. Similarly, **Figure B-2** shows rapid growth in the number of human genome base pairs that can be sequenced per dollar. (Note: **Figure B-1** and **Figure B-2** show growth on a logarithmic scale where each increment on the y-axis represents a 10-fold increase. A logarithmic scale is often used when analyzing a large range of data.)

[180] Ray Kurzweil, *The Singularity Is Near* (New York: Viking, 2005), as cited on the website SingularityHub, https://singularityhub.com/2016/03/22/technology-feels-like-its-accelerating-because-it-actually-is/.

[181] Some refer to the rapid growth in the number of transistors on a microchip as "Moore's Law." Moore's Law is not a law of science, but rather an empirical observation made by Fairchild Semiconductor founder and former Intel Corporation chairman and chief executive officer Gordon Moore about the trend over time. Moore observed that the number of components in integrated circuits had doubled on a regular time interval (in 1965 he posited the doubling occurred every year; in 1975 he revised that to approximately every two years) and predicted that this trend would continue.

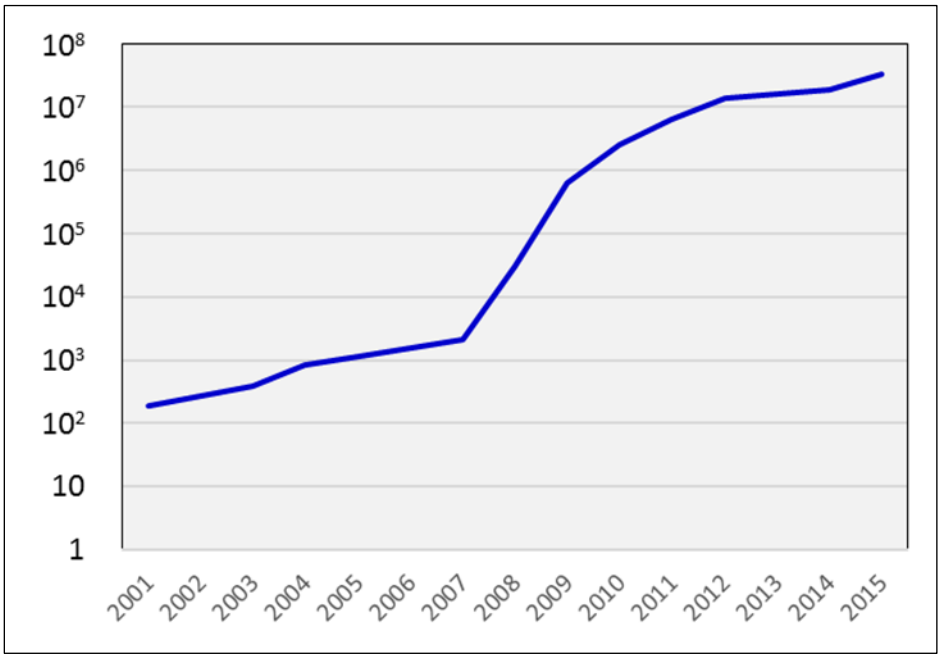
Figure B-1. Number of Transistors on a Microchip

1971-2017



Source: CRS, using data from Our World in Data, "Moore's Law—Exponential Increase of the Number of Transistors on Integrated Circuits," https://ourworldindata.org/technological-progress, based on Karl Rupp, "40 Years of Microprocessor Trend Data," https://www.karlrupp.net/2015/06/40-years-of-microprocessor-trend-data/.

Figure B-2. Number of Human Genome Base Pairs Sequenced per Dollar



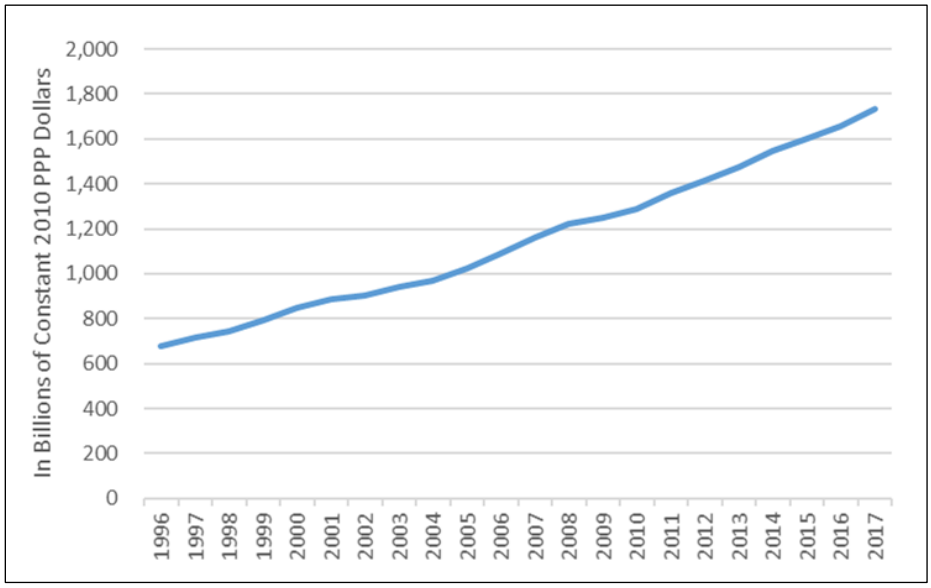
Source: CRS analysis of data from Our World in Data, "Moore's Law—Exponential Increase of the Number of Transistors on Integrated Circuits," https://ourworldindata.org/technological-progress, based on Kris A. Wetterstrand, "DNA Sequencing Costs: Data," National Institutes of Health, National Human Genome Research Institute, Genome Sequencing Program, http://www.genome.gov/sequencingcostsdata.

Countries are aggressively pursuing R&D directed at goals such as innovation, competitiveness, economic growth, wealth creation, productivity improvements, national security, and quality of life. Companies are pursing R&D for innovations that yield new and better products and processes, market advantage, and cost reductions, enabling them to serve new and existing markets and increase their profitability. Since OTA was defunded, total global gross expenditures on research and development (GERD) have grown rapidly.[182] In 2017 total GERD was $1.9 trillion, more than 3.9 times its level in 1996 ($504 billion), measured in current purchasing power parity dollars. Measured in constant dollars, the real purchasing power of global R&D increased more than 150% between 1996 and 2017. (See **Figure B-3**.)[183]

These growing global investments in R&D are delivering new technologies, products, and services with potentially substantial societal implications. Some of these advances are evolutionary—offering incremental improvements on the technologies, products, and services already in use—while other advances are revolutionary with the potential, according to some analysts, to disrupt markets, companies, industries, occupations, and the balance of economic and military power.

Figure B-3. Total Global Gross Expenditures on Research and Development, 1996-2017

In constant 2010 purchasing power parity dollars



Source: CRS analysis of Organisation for Economic Development and Cooperation, OECD.Stat database, https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB.

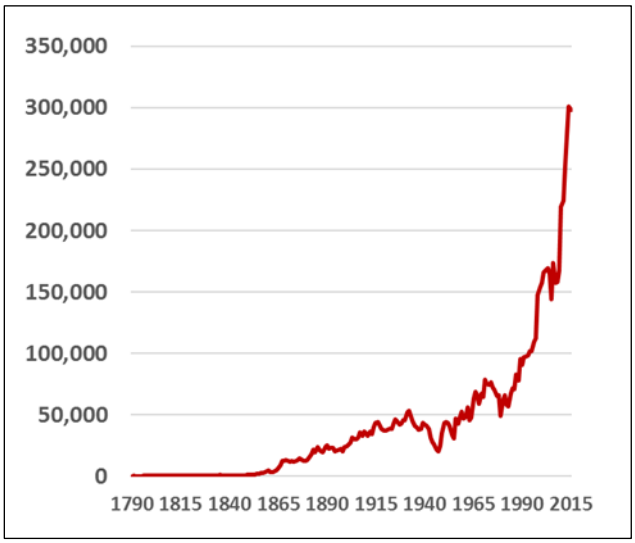
Notes: Global R&D includes the expenditures of the OECD countries, plus Argentina, China, Romania, Russia, Singapore, South Africa, and Taiwan. PPP = Purchasing Power Parity. PPP is used to determine the relative value of different currencies and to adjust data from different countries to a common currency, allowing direct comparisons among them. CRS estimated GERD for some non-OECD countries for years that they did not report GERD by interpolating values between reported years.

[182] The Organization of Economic Cooperation and Development's (OECD's) Frascati Manual, an internationally recognized methodology for harmonizing the collection and use R&D data, defines Gross Expenditures on Research and Development, or GERD, as the total intramural expenditure on research and development performed in a country during a specified period.

[183] CRS analysis of Organisation for Economic Development and Cooperation, OECD Stat database, https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB.

Figure B-4 shows the number of utility patents ("patents for inventions") granted by the U.S. Patent and Trademark Office each year from its establishment in 1790 to 2015, another metric illustrating rapid growth in the development of new technology. It took more than 200 years for USPTO to issue its 5 millionth patent; 27 years later, on June 19, 2018, the USPTO issued its 10 millionth patent.

Figure B-4. Annual Utility Patents Granted by U.S. Patent and Trademark Office
1790-2015



Source: CRS analysis of data from the U.S. Patent and Trademark Office, "U.S. Patent Activity, Calendar Years 1790 to the Present," https://www.uspto.gov/web/offices/ac/ido/oeip/taf/h_counts.htm.

While there is consensus on the rapid growth in technology, not all agree that the pace of technological change is accelerating. For example, considering technological change through the lens of technology adoption, one information technology expert notes that

> The time it takes for a new technology to be used in 50 percent of U.S. homes has long been used as a comparative adoption benchmark. By this standard, both radio and television were accepted faster than personal computers or mobile phones. More importantly, most Internet of Things (IoT) technologies—Fitbits, smart watches, 3D printers—are being adopted even more slowly.[184]

Globalization of Research and Development

The United States' share of global R&D expenditures fell from 69% in 1960 to 28% in 2017 as other countries increased their R&D investments, both public and private, some quite substantially. In recent years, China has accounted for a large share of global R&D growth. Between 1996 and 2016, China increased its investments from $14.2 billion to $451.2 billion (measured in current PPP dollars), an increase of more than 3,000%, to become the world's second largest funder of R&D, behind only the United States. (See **Table B-1**.) During the same period, U.S. R&D grew 158%. In constant 2010 PPP dollars, between 1996 and 2017 China's

[184] David Moschella, Leading Edge Forum, *The Myths and Realities of Digital Disruption,* August 2015, p. 4, https://leadingedgeforum.com/media/1328/the_myths_and_realities_of_digital_disruption_-_an_executives_guide_executive_summary.pdf.

R&D investment grew by 2,279% while investment by the U.S. in R&D measured in constant 2010 PPP dollars grew by 86%.[185]

In addition to developing new technologies, nations around the world are adopting and deploying these technologies to meet their economic, social, and military objectives. This development, adoption, and deployment may have significant implications for not only their own countries, but for the United States as well. On the one hand, for example, the adoption of these technologies could increase the prosperity of other countries, creating potential new markets for American products and services. On the other hand, the indigenous development of technological capabilities in countries other than the United States and its allies may limit the United States' ability to control access to military technologies and may reduce the influence of the United States in the establishment of standards for the ethical and safe use of new technologies. The United States might also lose its technology leadership in key fields, long considered a key component in the strength of the U.S. economy.

Table B-1. Share of Total Global R&D, by Country, 2017

Measured in purchasing power parity dollars

Country	Share
United States	27.7%
China	25.3%
Japan	8.7%
Germany	6.7%
South Korea	4.6%
France	3.3%
United Kingdom	2.5%
Russia	2.1%
Taiwan	2.0%
Italy	1.7%
Others	15.4%

Source: CRS analysis of Organisation for Economic Development and Cooperation, OECD.Stat database.

Notes: For purposes of calculating global R&D, CRS included the expenditures of the OECD countries, plus Argentina, China, Romania, Russia, Singapore, South Africa, and Taiwan. For additional information, see CRS Report R44283, *Global Research and Development Expenditures: Fact Sheet*, by Emily G. Blevins.

Role of Science and Technology in the U.S. Economy

Economists have long maintained that advances in science and technology play an important role in U.S. and global economic growth, productivity, job creation, and standard of living. These benefits flow from factors such as new and improved products, improvements in manufacturing technologies, the reorganization of work, and enabling and improving services. For example, S&T discovery has played an important role in extracting and exploiting America's energy resources—through the advancement of fracking, horizontal drilling, and sonic imaging technologies used in oil and gas production—and in reducing the cost and improving the performance of alternative energy sources such as solar and wind.

[185] CRS analysis of OECD Government Domestic Expenditure on Research and Development (GERD) data measured in purchasing power parity dollars, current and constant, https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB.

Role of Science and Technology in National Security

Science and technology have played a central role in U.S. national security and military strength—from the weapons systems developed during World War II (e.g., nuclear weapons, radar, sonar, microelectronics) to those developed during the Cold War period and after (e.g., advanced nuclear weapons, intercontinental ballistic missiles (ICBMs), multiple independently targetable reentry vehicles (MIRVs), satellites, stealth fighter and bomber aircraft, nuclear-powered naval vessels, precision targeting, and information- and network-centric systems for intelligence, surveillance, and reconnaissance). Military strategists and analysts anticipate future U.S. defense capabilities are likely to rely heavily on advances in leading-edge technologies such as artificial intelligence, autonomy, nanotechnology, advanced computing and communications, augmented reality, and hypersonics.

Increasing Complexity of Technology

Innovation has become increasingly multidisciplinary. Some of the most promising fields involve the intersection of two or more powerful technologies, such as artificial intelligence and autonomy (e.g., driverless cars, package delivery by drones); high-speed computing, big data, and biotechnology (e.g., personalized medicine, synthetic biology, epidemiology, identifying the relationships between genes and particular diseases); and sensors and the internet (e.g., supply chain management and optimization, health self-monitoring, persistent scientific observation). The marriage of disparate technologies may lead to powerful and unanticipated new technologies with widespread societal implications.

Role of Science and Technology in Other Aspects of Public Policy

Science and technology also play key roles in many other aspects of public policy. For example, biomedical R&D contributes to the development of new drugs and treatments for illness, disease, and other medical issues. Advances in science and technology in the biomedical field may contribute to human longevity, healthiness, and quality of life. Consequently, they may have implications for a wide array of federal programs.

Similarly, advances in science and technology in a variety of fields may contribute to meeting a wide range of public policy objectives:

- in agriculture, advances could contribute to ensuring national and global food and nutrition needs are met;
- in transportation, advances may help to save lives and reduce the environmental impacts of automobiles, trucks, trains and other modes of transportation;
- in energy, advances may help to make energy sources less costly and more abundant, to cost-efficiently tap renewable sources of energy, and to reduce the environmental impacts of its use;
- advances in understanding weather and climate may help reduce the loss of lives, the cost of property damage, and the time required for recovery;
- in criminal justice, advances may help to quickly and more accurately identify criminals and to prevent the prosecution of the innocent; and
- in industrial applications, advances may contribute to economic growth and job creation.

At the same time, advances in science and technology can also raise complex societal, ethical, and legal challenges with which legislators grapple.

Appendix C. OTA/Technology Assessment-Related Legislation in the 107th-116th Congresses

116th Congress

The House Select Committee on the Modernization of Congress voted out recommendations that included "reestablishing and restructuring an improved Office of Technology Assessment." This specific recommendation was not included in the recommendations included in the Moving Our Democracy and Congressional Operations Towards Modernization Resolution (H.Res. 756) which was passed by the House on March 10, 2020.

The Legislative Branch Appropriations Act, 2020 (H.R. 2779) would have provided $6.0 million in initial funding to reestablish the Office of Technology Assessment. The House Committee on Appropriations reported the bill on May 16, 2019, accompanied by H.Rept. 116-64, which states

> As requested by a number of Members of Congress, the Committee bill includes $6,000,000 in initial funding to reestablish the Office of Technology Assessment (OTA). This Legislative Branch agency was created in 1972 and operated until funding was discontinued in 1995.
>
> To do its job in this modern era, Congress needs to understand and address the issues and risks resulting from a wide range of rapid technological developments such as cryptocurrencies, autonomous vehicles, gene editing, artificial intelligence, and the ever-expanding use of social media platforms, to give just a few examples. A re-opened OTA will play an important role in providing accurate, professional, and unbiased information about technological developments and policy options for addressing the issues those developments raise. In that role, OTA will complement the work of the Government Accountability Office in the area of science and technology.

P.L. 116-94, the Further Consolidated Appropriations Act, 2020, which included the Legislative Branch Appropriations Act, 2020, as Division E, was enacted December 20, 2019. The act did not include an appropriation for reestablishing OTA.

On September 19, 2019, Representative Mark Takano introduced H.R. 4426, the Office of Technology Assessment Improvement and Enhancement Act. On the same day, Senator Thom Tillis introduced S. 2509, a nearly identical bill with the same title. Both bills bill would amend OTA's statute in a variety of ways, including

- renaming OTA as the Congressional Office of Technology (the office);
- directing that the work of the office "be provided as expeditiously, effectively, and efficiently as possible while maintaining a forward-looking, holistic, and rigorous approach to the assessment of the impacts of technology";
- expanding office reporting to Congress from "completed analysis" to "completed analyses, as well as preliminary findings of ongoing analyses";
- adding three additional duties of the office: "provide information to Members and committees of Congress in the form of briefings, informal conversations, documents, and similar formats which may be provided expeditiously on the basis of existing research and staff expertise without the need for review by the Board; provide technical assistance to Members of Congress on legislation related to science and technology which may be provided expeditiously on the basis of existing research and staff expertise without the need for review by the

Board; and, when requested, provide objective policy options to Members on how Members may achieve goals with respect to science and technology policy";

- expanding the list of who may initiate assessment activities to include any Member of Congress, including a Delegate or Resident Commissioner, and providing the office the authority to determine whether to undertake an assessment according to a number of specified criteria;
- requiring completed analyses be made available to the public, subject to certain restrictions;
- authorizing the director of the office to make limited term or temporary appointments scientists, engineers, and other technical and professional personnel on leave of absence from academic, industrial, or research institutions to work for the office;
- requiring the office to coordinate with CRS and GAO to avoid unnecessary duplication or overlapping of research activities;
- changing the authority for House and Senate appointments to the Technology Assessment Board to be made jointly by leaders of the majority and minority parties in each body; and
- requiring the TAB to hold at least one meeting each year at which Members of Congress may appear and present information to the TAB about any technology assessment activities the Members would like the TAB to undertake, and requiring an annual report by the TAB to the Subcommittees on the Legislative Branch of the Committees on Appropriations of the House of Representatives and Senate on the activities of the office during the year, including a description of the technology assessment activities undertaken during the year.

H.R. 4426 was referred to the House Committee on House Administration; no further action had been taken at the time of this report. S. 2509 was referred to the Senate Committee on Rules and Administration; no further action had been taken at the time of this report.

115th Congress

In September 2018, H.Rept. 115-929, accompanying the Energy and Water, Legislative Branch, and Military Construction and Veterans Affairs Appropriations Act, 2019 (P.L. 115-244), provided direction to both CRS and GAO on matters related to providing science and technology policy support and technology assessment to Congress.

In the report, Congress directed CRS to engage with the National Academy of Public Administration (NAPA) or another external organization to produce a report that identifies resources available to Congress on science and technology policy; assesses the need for a separate entity to provide nonpartisan advice on issues of science and technology to Congress; determines whether such an organization would duplicate services already available to Members.

In H.Rept. 115-929, Congress also expressed its interest in GAO growing its current capabilities to provide expanded technology assessment capacity by reorganizing its technology and science function by creating a new more prominent office within GAO. Congress directed GAO to

provide within 180 days a plan and timetable for how the new office could expand and enhance GAO's capabilities in scientific and technological assessments.[186]

Other amendments and resolutions introduced in the 115th Congress also sought to provide funding to reestablish OTA or to affirm the need for its reestablishment:

- Representative Mark Takano introduced H.Amdt. 219 to H.R. 3219, the Defense, Military Construction, Veterans Affairs, Legislative Branch, and Energy and Water Development National Security Appropriations Act, 2018, on July 26, 2017. The amendment would have provided $2.5 million to reinstitute OTA, offset by funds from the Architect of the Capitol's Capital Construction and Operations Account. The amendment was not agreed to.
- Representative Mark Takano introduced H.Amdt. 761 to H.R. 5895, the Energy and Water, Legislative Branch, and Military Construction and Veterans Affairs Appropriations Act, 2019, to reinstitute OTA, offset by funds from an administrative account within the Architect of the Capitol. The amendment was not agreed to.

Representative Bill Foster introduced H.Res. 849, a resolution "expressing the sense of the House of Representatives that the Office of Technology Assessment should be reestablished," on April 26, 2018, with 21 cosponsors. The resolution would have expressed the sense of the House of Representatives that "the legislative process would greatly benefit from once again having an office dedicated to giving nonpartisan, technical advice to Congress; the Office of Technology Assessment represents a cost-effective improvement to the governance of the United States; and funding should be restored for the Office of Technology Assessment." The resolution was referred to the House Committee on Administration. No further action was taken.

Earlier Congresses

In the 107th-114th Congresses, there were a number of efforts to reestablish OTA by authorizing or appropriating funding. Other legislative efforts have sought to express a "sense of the House" or "sense of the Senate" that OTA should be reestablished. A summary of each of these efforts is provided below, in reverse chronological order:

- In the 114th Congress, Representative Mark Takano introduced H.Amdt. 117 to H.R. 5325, the Continuing Appropriations and Military Construction, Veterans Affairs, and Related Agencies Appropriations Act, 2017, and Zika Response and Preparedness Act, on June 10, 2016. The amendment would have provided $2.5 million to reinstitute OTA, offset by funds from the Architect of the Capitol's Capital Construction and Operations Account. The amendment was not agreed to by the House, by a vote of 179-223.

In the 114th Congress, Representative Bill Foster introduced H.Res. 605, a resolution "expressing the sense of the House of Representatives that the Office of Technology Assessment should be reestablished," on February 4, 2016, with 14 cosponsors. The resolution would have expressed the sense of the House of Representatives that "the legislative process would greatly benefit from once again having an office dedicated to giving nonpartisan, technical advice to Congress; the Office of Technology Assessment represents a cost-effective improvement to the governance of

[186] GAO produced a report, *GAO Science, Technology Assessment, and Analytics Team: Initial Plan and Considerations Moving Forward*, to meet this requirement in April 2019. This GAO report can be accessed at https://www.gao.gov/pdfs/about/GAOScienceTechPlan-2019-04-10.pdf.

our country; and funding should be restored to the Office of Technology Assessment." The resolution was referred to the House Committee on Administration. No further action was taken.

- In the 113th Congress, Representative Rush Holt introduced H.Amdt. 649 to H.R. 4487, the Legislative Branch Appropriations Act, 2015, on May 1, 2014. The amendment would have provided $2.5 million to reinstitute OTA, offset by funds from the House Historic Buildings Revitalization Trust Fund. The amendment was not agreed to.
- In the 112th Congress, Representative Rush Holt introduced H.Amdt. 711 to H.R. 2551, the Legislative Branch Appropriations Act, 2012, on July 22, 2011. The amendment would have provided $2.5 million to reinstitute OTA, offset by funds from the House Historic Buildings Revitalization Trust Fund. The amendment was not agreed to.
- In the 110th Congress, S. 1602, the Clean, Reliable, Efficient and Secure Energy Act of 2007, was introduced by Senator Chuck Hagel on June 12, 2007. Title V, Subtitle C of the bill would have renamed the Technology Assessment Act of 1972 as the Office of Technology Assessment Reestablishment Act of 2007, and would have authorized appropriations of $25 million per year for OTA for FY2008 through FY2013. The bill was referred to the Senate Committee on Energy and Natural Resources. No further action was taken.
- In the 108th Congress, H.R. 125, a bill "to reestablish the Office of Technology Assessment," was introduced by Representative Rush Holt on January 7, 2003, with 65 cosponsors. The bill would have renamed the Technology Assessment Act of 1972 as the Office of Technology Assessment Reestablishment Act of 2003, and would have authorized appropriations of $20 million per year for OTA for FY2004 through FY2009. The bill was referred to the House Committee on Science's Subcommittee on Space and Aeronautics. No further action was taken.
- In the 107th Congress, H.R. 2148, a bill "to reestablish the Office of Technology Assessment," was introduced by Representative Rush Holt on June 13, 2001, with 87 cosponsors. The bill would have renamed the Technology Assessment Act of 1972 as the Office of Technology Assessment Reestablishment Act of 2001, and would have authorized appropriations of $20 million per year for OTA for FY2002 through FY2007. The bill was referred to the House Committee on Science's Subcommittee on Space and Aeronautics. No further action was taken.

A CRS search of Congress.gov identified no legislation seeking to reestablish OTA during either the 105th Congress or 106th Congress.

Appendix D. GAO Technology Assessments[187]

2019/2020

Artificial Intelligence in Health Care: Benefits and Challenges of Machine Learning in Drug Development, GAO-20-215SP, December 20, 2019. (This product was reissued with revisions on January 31, 2020.)

Irrigated Agriculture: Technologies, Practices, and Implications for Water Scarcity, GAO-20-128SP, November 12, 2019.

2018

Critical Infrastructure Protection: Protecting the Electric Grid from Geomagnetic Disturbances, GAO-19-98, December 19, 2018.

Technology Assessment: Artificial Intelligence: Emerging Opportunities, Challenges, and Implications, GAO-18-142SP, March 28, 2018.

Chemical Innovation: Technologies to Make Processes and Products More Sustainable, GAO-18-307, February 8, 2018.

2017

Medical Devices: Capabilities and Challenges of Technologies to Enable Rapid Diagnoses of Infectious Diseases, GAO-17-347, August 14, 2017.

Internet of Things: Status and Implications of an Increasingly Connected World, GAO-17-75, May 15, 2017.

2016

Technology Assessment: Municipal Freshwater Scarcity: Using Technology to Improve Distribution System Efficiency and Tap Nontraditional Water Sources, GAO-16-474, April 29, 2016.

2015

Technology Assessment: Water in the Energy Sector: Reducing Freshwater Use in Hydraulic Fracturing and Thermoelectric Power Plant Cooling, GAO-15-545, August 7, 2015.

Technology Assessment: Nuclear Reactors: Status and Challenges in Development and Deployment of New Commercial Concepts, GAO-15-652, July 28, 2015.

2011

Technology Assessment: Neutron Detectors: Alternatives to Using Helium-3, GAO-11-753, September 29, 2011.

Technology Assessment: Climate Engineering: Technical Status, Future Directions, and Potential Responses, GAO-11-71, July 28, 2011.

2010

Technology Assessment: Explosives Detection Technologies to Protect Passenger Rail, GAO-10-898, July 28, 2010.

[187] As listed at GAO, "Technology Assessments," accessed March 4, 2019, https://www.gao.gov/technology_and_science#forums&t=1.

2005

Technology Assessment: Protecting Structures and Improving Communications During Wildland Fires, GAO-05-380, April 26, 2005.

2004

Technology Assessment: Cybersecurity for Critical Infrastructure Protection, GAO-04-321, May 28, 2004.

2002

Technology Assessment: Using Biometrics for Border Security, GAO-03-174, November 15, 2002.

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