Effective Science and Technology Advice for Congress: Comparing Options

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For science and technology policy advice for Congress to be effective, it must be both credible and suitable to congressional needs. As measures of credibility, from the perspective of those who will use the advice, it must be (1) authoritative, (2) objective, and (3) independent. As measures of suitability, again from the perspective of those who will use it, it must be (4) relevant, (5) useful, and (6) timely.

Congress draws on many sources for science and technology (S&T) advice, but four stand out as having been used most frequently over the years: the National Research Council (NRC), the operating arm of the National Academies of Sciences, Engineering, and Medicine; the Congressional Research Service (CRS); the Government Accountability Office (GAO); and the former Office of Technology Assessment (OTA).

In the wake of OTA's closure in 1995, the NRC, CRS, and the GAO each assumed some of the former OTA's function—but only to a modest degree:

- Following OTA's closure, congressional requests for NRC studies doubled but then fell back to the historical trend, perhaps because NRC studies typically are carried out at a different level of policy context than the kinds of efforts that Congress traditionally commissioned to the former OTA.
- CRS's delivery of timely "off-the-shelf" S&T information remains an excellent resource for Congress, improved considerably over the years with new technology and experience, but did not fill the analysis gap left by OTA's closure.
- In 2002, the GAO began to develop a technology assessment (TA) capacity, but the agency has yet to adopt key features for providing the most effective TA for Congress.

To elaborate on the last point, over OTA's 23-year history the office delivered hundreds of technology assessments that drew extensively and broadly on the nation's authoritative S&T expertise through its advisory panels, its use of contractors and consultants, and its participation in rigorous external review of its products. OTA relied on experienced and highly qualified staff expertise recruited specifically for the technical and policy needs of the assessments undertaken. And OTA focused on topics relevant to clearly articulated needs of congressional committees of jurisdiction as judged by the Technology Assessment Board—the bipartisan group of senators and representatives that oversaw OTA's work—and informed by the Technology Assessment Advisory Council of external experts.

By comparison, during the 18 years that the GAO's TA function has been active so far (2002–2020), the GAO issued 16 efforts listed as technology assessments, and developing a TA capability with commensurate OTA-like features has progressed very slowly. The GAO's early TA efforts (2002–2010) rarely involved external expert groups at all and, even in more recent efforts (2011–2020), onetime National Academies–organized expert meetings have provided the only degree of formal access to external expertise. In most of the GAO's TA projects, expert review was limited solely to internal agency mechanisms—and, even recently, the only movement toward comprehensive external review has been inviting some of the National

Academies technical expert meeting participants to provide comments on draft reports. And in only one instance did the GAO complete a TA that had been initiated with bipartisan requests from the relevant committees of jurisdiction in both chambers of Congress. Most of the GAO's TA efforts carried no request formally expressed by the committees of jurisdiction.

Each of the three remaining standout sources of S&T policy advice for Congress could adapt to better meet today's congressional needs. Indeed, the plans for the GAO's new Science, Technology Assessment, and Analytics (STAA) team include features tuned to today's context—although the STAA has much to do to rise to the standard set by OTA. And the NRC's internal transformation process may yield new ways of providing S&T advice to Congress.

Reconstructing an OTA with many of the original agency's features remains a viable option—even a preferable one, considering the slowness of progress toward replicating those features elsewhere. But bringing back OTA could take many years to accomplish, and the revived OTA could take years to mature. Whatever route is taken—renewing OTA, strengthening another existing option, or even creating an entirely new agency—future efforts to provide Congress with S&T policy advice would need to include new features such as: a broader portfolio of activities and products than offered today, including some related to shorter-term needs of individual members of Congress as opposed to just committees; closer connections with other organizations to more efficiently gather the most recent information; enhanced electronic communications for considerably expanded and timelier information-gathering and delivery of information to Congress and the public; and collaboration across congressional support agencies—the GAO, CRS, and the Congressional Budget Office (CBO)—where topical areas overlap and strengths are complementary.

To illustrate this last feature, even with a restored OTA, the GAO's STAA team would likely be better suited than a new OTA to evaluate the management performance of programs in the nation's massive federal S&T enterprise. The GAO's traditional approach to performance audits but with more attention to S&T would be a better fit for that task than would the TA approach used by OTA. Better to build on each office's strengths than to try to re-create those strengths in every one of them.

The Various Roles of Government in the U.S. S&T Enterprise

Federal, state, and local governments are all increasingly involved in the nation's S&T enterprise in different ways. At the highest level of abstraction, key among these government roles are:

- carrying out research directly and sponsoring it in other organizations;
- regulating the fruits of research through patents, copyrights, and antitrust law;
- regulating key aspects of S&T-intensive industries such as health care, national security, energy, telecommunications, and transportation;
- consuming the products of R&D and of technology in carrying out government missions; and
- influencing the education of scientists and engineers and the general public about S&T through sponsoring of research and other means.

At the risk of overgeneralizing, until the 1970s, the legislative branch tended to delegate government authority over S&T issues to the executive branch. With a growing recognition of the role of science and technology in major social and political issues—including the environment, national security, and international economic competitiveness—Congress in the

1970s increasingly began to address S&T matters. A recent Harvard University study concluded that

> Congress is driven to address S&T issues by several broad forces, including the pace of technological advancement, which creates new opportunities and concerns; catastrophic events, which cause Congress to react; national security, which drives demand for S&T research and development; and national economic competition, which, among other things, compels Congress to allocate funding to federal research and development. Other broad forces include pressure from the news media, lobbyists, and advocacy organizations, and American attitudes towards technology.
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> Additionally, there are several localized forces that act on individual members of Congress. Members seek S&T information when constituents pressure them for information or to recommend they act on an issue, when committee work or floor legislation centers on an S&T topic, or when they are simply personally interested in an S&T topic.[1]

The scale and scope of S&T issues facing Congress are growing, as are their complexity and impact on the economy. That is, S&T dimensions are becoming more significant across the agenda of Congress, not only directly (as in the prominent forces identified in the Harvard study) but also indirectly (in areas where S&T may not be the dominant concern but is often a very significant one that, if misunderstood, could lead to poor legislative and oversight decisions).

A present-day example: Congress is considering the conditions under which the new fifth-generation digital cellular network, known as 5G, will be deployed in the United States. 5G is expected to transform wireless data communications, enabling many new features such as a greatly expanded "Internet of things." However, the deployment of 5G touches on many complicated technical issues. For example, the portions of the electromagnetic spectrum planned for use by various 5G proposals will be very near portions used by passive remote sensing technology for weather and Earth-observation satellites, particularly for measuring atmospheric water vapor concentrations. Without effective controls, the interference caused by 5G deployment could be significant. As currently proposed, 5G out-of-band emissions could produce a 30 percent reduction in weather-forecast accuracy, a degradation in weather-forecasting model performance that would have (for instance) resulted in a failure to predict the track and thus the impact of Superstorm Sandy in 2012.[2] In short, this is a very complicated and possibly very consequential technical debate—but Congress is poorly prepared to address it.

To compound these concerns, some characteristics of the U.S. political and economic systems can make it more difficult for Congress to address challenges presented by the growing role of S&T in society. Among the more important of such characteristics are:

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[1] Mike Miesen, Maeve Campbell, Chris Kuang, Laura Manley, and Emily Roseman, "Building a 21st Century Congress: Improving Congress's Science and Technology Expertise," paper, Harvard Kennedy School, Belfer Center for Science and International Affairs, Technology and Public Purpose Project (September 2019), https://www.belfercenter.org/publication/building-21st-century-congress-improving-congresss-science-and-technology-expertise.

[2] "The Future of Forecasting: Building a Stronger U.S. Weather Enterprise," hearing before the Committee on Space, Science and Technology, Subcommittee on Environment, U.S. House of Representatives, 116th Cong. (May 16, 2019) (testimony of Neil Jacobs, Acting Undersecretary of Commerce for Oceans and Atmosphere, National Oceanic and Atmospheric Administration).

- *Short time horizon*. Both our political and economic systems focus on the short term—the next congressional election or the next quarter's earnings report. Often subordinated or neglected entirely are the long-term policy considerations, including those often associated with S&T.
- *Political-system inertia*. The U.S. political system, operating under a very conservative constitution with many checks and balances, favors the status quo. Such a system requires consensus building that can be difficult in a large country with so many competing values and interests.
- *Disagreement over the role of government*. The major political parties as well as other powerful constituencies disagree about the degree to which government should be activist in technology policy, resulting in oscillations: from activist policies in the 1970s, to a laissez-faire approach in the 1980s, to more moderate policies in the early 1990s, to the Republican Revolution of the mid-1990s, and so on.
- *Poorly informed public*. As noted earlier, issues in S&T are often complex, and the public often has a weak knowledge base upon which to base views about policy choices.
- *Fractured political parties*. On many technology-related issues, rather than speaking with a single voice, the major political parties are splintered by regional or special-interest concerns.
- *Government organization*. Congress distributes jurisdiction over S&T issues among many committees and subcommittees. Similarly, the executive branch diffuses authority for developing and implementing S&T-related development and policy across many departments and agencies.

These features and the dynamic context of S&T across the congressional agenda heighten the sense of urgency for expanding Congress's capacity to deal with the S&T dimensions of the issues it faces. Developing or restoring that capacity is long overdue.

Science and Technology Advice to Congress: The Historical Experience

For S&T advice, Congress today draws on the knowledge of its committee and personal staffs, supplemented with external expertise from universities, industry, executive agencies, constituents, and many other sources. Among the many other kinds of S&T-related organizations that provide advice and advocacy are expert groups convened directly by government agencies that operate under policies and procedures of the Federal Advisory Committee Act (such as the President's Council of Advisors on Science and Technology);[3] federally funded research and development centers (FFRDCs), typically commissioned by federal agencies (such as the Jet Propulsion Laboratory and the National Center for Atmospheric Research);[4] the national

[3] The Federal Advisory Committee Act (FACA), Pub. L. No. 92-463, was enacted October 6, 1972 to govern the behavior of federal advisory committees, defined as "any committee, board, commission, council, conference, panel, task force, or other similar group" (organized by the executive branch) that dispenses "advice or recommendations" to the president of the United States. FACA committees today include 972 active committees across the executive branch (FACADatabase.gov, https://www.facadatabase.gov/FACA/apex/FACAPublicTotals?fy=2019). See also Wendy R. Ginsberg, U.S. Congressional Research Service, R40520, *Federal Advisory Committees: An Overview* (Library of Congress, April 16, 2009).

[4] The current federal inventory of FFRDCs includes 43 organizations across the departments of Defense, Transportation, Treasury, Energy, Homeland Security, Health and Human Resources, and Commerce, as well as federal agencies, NASA and NSF, and the U.S. Courts. See National Science Foundation, "Master Government List

laboratories; independent commissions created by Congress, the president, or federal agencies (such as the commission that investigated the *Challenger* space shuttle accident); university-based think tanks and university consortia; independent S&T think tanks (such as the RAND Corporation); policy think tanks whose work occasionally includes S&T-related advice; science and engineering professional societies that often organize activities producing S&T advice for policymakers (such as the Institute for Electrical and Electronic Engineers, the American Nuclear Society, and the American Association for the Advancement of Science); and policy advocacy groups that regularly address S&T issues (such as the Federation of American Scientists, the Union of Concerned Scientists, the Environmental Defense Fund, and the National Center for Science Education).

But, as mentioned above, the four sources of S&T advice used most frequently by Congress are the National Research Council, the Congressional Research Service, the former Office of Technology Assessment, and the Government Accountability Office. The balance of this paper analyzes the roles as well as relative strengths and weaknesses of these four organizations.

National Research Council

The National Research Council (NRC) is the principal operating arm of the National Academies of Sciences, Engineering, and Medicine, which is a private, independent, nongovernmental organization operating under the 1863 congressional charter that created the National Academy of Sciences to "investigate, examine, experiment, and report upon any subject of science whenever called upon to do so by any department of the government."[5]

As the United States prepared to enter World War I in 1916, the National Academy of Sciences (NAS) fashioned a proposal to expand its significant but relatively modest historical role in technology development for military preparedness by creating the NRC.[6] In the proposal, the NAS defined the NRC's purpose as the following:

> To bring into cooperation existing governmental, educational, industrial, and other research organizations with the object of encouraging the investigation of natural phenomena, the 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.[7]

Pursuant to an executive order issued by President Woodrow Wilson in that same year, the NAS established the NRC under its original 1863 congressional charter. The NRC included the new feature of broadening the community of experts involved in the provision of advice to

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of Federally Funded R&D Centers (FFRDCs)—April 2019," National Center for Science and Engineering Statistics (2019), https://www.nsf.gov/statistics/ffrdclist/.

[5] U.S. Congress, An Act to Incorporate the National Academy of Sciences, 37th Cong., Sess. III (March 3, 1863). The National Academy of Engineering was formed in 1964 and the National Academy of Medicine was created in 1970, originally as the Institute of Medicine. The NRC functions today as the operating arm of all three academies, all under the collective name "The National Academies of Sciences, Engineering, and Medicine."

[6] For more detail on this history, see Peter D. Blair, "The Evolving Role of the US National Academies of Sciences, Engineering, and Medicine in Providing Science and Technology Policy Advice to the US Government," *Palgrave Communications* vol. 2, article no. 16030 (June 2016), https://doi.org/10.1057/palcomms.2016.30; or Rexmond Cochrane, *The National Academy of Sciences: The First 100 Years, 1863–1963* (Washington, D.C.: National Academy of Sciences, 1978).

[7] Cochrane, *The National Academy of Sciences*, op. cit., p. 209.

the government to include not only elected members of the academy, but also other experts from across the nation's much larger science and technology communities.

Following World War I, the scale and scope of the NRC's activities in advising the federal government grew steadily, albeit slowly, for several decades. Today, the NRC model for providing advice is widely viewed as particularly influential because of several key strengths, which include:

- *credibility*—a long record of independence as reflected in its distinctive if not unique congressional charter;
- *convening power*—a long-established tradition of being able to involve widely recognized experts contributing their efforts pro bono to the work of the NRC, which enhances the authority of its products; and
- *study process*—a transparent and accountable study process, including independent external review and other features to minimize potential bias and conflicts of interest of those participating in the effort.[8]

The NRC today issues around 200 reports annually to federal agencies and other interests addressing the full spectrum of S&T-related topics from basic science research to technology applications across the economy and the government. Congress requests on average 25 reports per year. The NRC employs about 1,000 staff and draws on 7,000 appointed committee members, as well as an additional 3,000 appointed reviewers of draft reports who serve pro bono in support of the NRC's mission of providing S&T advice to the government.

In the year after OTA's suspension of operations (1996)—described below—the number of congressional requests for NRC studies doubled, but it fell back to its historical trend the following year, perhaps because the nature of NRC studies did not match the level of policy abstraction and context that Congress had expected of OTA reports.

Congressional Research Service

In 1914, Congress created the Legislative Reference Service as a separate department within the Library of Congress; it was renamed the Congressional Research Service (CRS) in 1970. Its mandate is "to serve Congress and, in particular, individual members of Congress, throughout the legislative process by providing broad-ranging legislative research and analysis."[9]

Today, CRS employs about 400 policy analysts, attorneys, and information professionals (600 employees overall) across a variety of disciplines. The expertise of the staff ranges from law, economics, and foreign affairs to defense and homeland security, public administration, education, health care, immigration, energy, environmental protection, science, and technology.[10] The number of staff devoted to S&T issues has remained relatively stable over the years,

[8] For elaboration on these strengths, and how they evolved, see Blair, "The Evolving Role of the US National Academies of Sciences, Engineering, and Medicine in Providing Science and Technology Policy Advice to the US Government," op. cit.

[9] U.S. Congress, An Act to Improve the Operation of the Legislative Branch of the Federal Government, and for Other Purposes, 91st Cong., Sess. I (October 26, 1970).

[10] For additional detail, see Library of Congress, "About CRS" (accessed August 23, 2019), https://www.loc.gov/crsinfo/about/.

although the agency's reorganization in 1996 resulted in merging the agency's former Science Policy Research Division, which focused on S&T issues, with several other units.[11]

CRS prepares reports in three major categories: (1) congressionally distributed products providing research and analysis on legislative issues; (2) responses to individual members and committees; and (3) legislative summaries, digests, and compilations. Individual CRS analysts respond to 200–300 congressional requests annually.[12] CRS remains a key and highly valued source of off-the-shelf S&T information and advice to members of Congress. For example, the agency conducts bicameral seminars for congressional staff on the annual federal research and development budget to acquaint staff with the S&T context of appropriations for the federal government's science mission agencies.[13]

Office of Technology Assessment

In 1972, Congress established the Office of Technology Assessment (OTA) as a small analytical agency to better inform the legislature about the implications of new and emerging technologies. The Technology Assessment Act of 1972 defined the agency's mission as assisting Congress "in the identification and consideration of existing and probable impacts of technological application" to ensure that "the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems."[14]

The agency's architects intended the reports and associated information that OTA produced—written by experienced professionals with the involvement of widely recognized experts in science and technology—to be attuned to the language and context of Congress. OTA's principal products, known as *technology assessments*, were designed to inform congressional deliberations and debates about issues that involved S&T dimensions but without recommending specific policy actions. The organizing statute concluded as the legislation's "declaration of purpose" in establishing OTA that it is necessary for Congress to "(1) equip itself with new and effective means for securing competent, unbiased information concerning the physical, biological, economic, social, and political effects of such [technology] applications; and (2) 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."[15]

In its final years of operation, OTA employed 143 staff in permanent positions, 50–60 additional rotational staff recruited for the specific assessments commissioned by Congress, and additional in-house contractors as necessary to help provide the needed technical expertise for the agency's work portfolio. OTA also contracted for outside services as needed. The agency

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[11] For organization charts before and after the 1996 reorganization, see Library of Congress, *Annual Report of the Congressional Research Service of the Library of Congress for Fiscal Year 1996 to U.S. Congress, Joint Committee on the Library* (June 1997) and *Annual Report of the Congressional Research Service of the Library of Congress for Fiscal Year 1997 to U.S. Congress, Joint Committee on the Library* (March 1998).

[12] See Ida A. Brudnick, U.S. Congressional Research Service, RS33471, *The Congressional Research Service and the American Legislative Process* (Washington, D.C.: Library of Congress, 2008), http://digitalcommons.ilr.cornell.edu/key_workplace/511/.

[13] Library of Congress, *Annual Report, Congressional Research Service, Library of Congress, Fiscal Year 2018, to the Joint Committee on the Library, United States Congress* (January 2019), https://www.loc.gov/crsinfo/about/crs18_annrpt.pdf.

[14] Office of Technology Assessment Act, Pub. L. No. 92-484, 92nd Cong. (October 13, 1972).

[15] Ibid.

convened advisory panels of external experts that became integral to the technology assessment process. The organizing statute specified OTA's governance as a Technology Assessment Board (TAB) composed of House and Senate members, with equal membership between majority and minority parties. The TAB helped ensure that the issues the agency addressed were tightly aligned with the congressional agenda and that assessments undertaken by the agency proceeded with partisan and other stakeholder bias minimized.

Over a span of 23 years (1972–1995), OTA delivered over 750 reports to Congress on a wide range of topics, including health, energy, defense, space, information technology, the environment, and many others; the vast majority of these reports were also made available to the public.[16] The agency developed a well-established and respected process for providing science and technology policy analysis useful to Congress.[17] S&T issues have continued to grow across the congressional agenda in the 25 years since Congress suspended OTA's operations by eliminating its funding, so there have been various attempts to restart the agency's operations—since the statute that created the agency remains on the books.

Government Accountability Office

The General Accounting Office was created by Congress in 1921 as an independent auditing agency for Congress to "investigate . . . matters relating to the receipt, disbursement, and application of public funds, and [to] make to the President . . . and to Congress . . . reports [and] recommendations looking to greater economy or efficiency in public expenditures."[18] Renamed the Government Accountability Office (GAO) in 2004, the agency today defines its mission as "to serve the Congress and the American people by collecting, analyzing, and reporting on information about federal programs and services" through 15 "teams" of analysts, financial auditors, and specialists who work on reports and other products that help achieve that mission.[19]

Congress commissions the GAO's work principally at the request of congressional committees and the agency has a well-established protocol for delivering the bulk of its work products in the form of so-called *performance audits*, mainly related to management of federal agency programs. The agency produces approximately 900 reports of this type annually, employing around 3,000 staff to complete them.[20]

In 2002, several years after OTA suspended operations, the GAO initiated a technology assessment (TA) pilot program in an attempt to fill some of the gap left by OTA's closure, although the GAO's conception of TA was much narrower than OTA's, as evidenced by the four reports completed in the GAO's pilot TA program between 2002 and 2006 (discussed more

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[16] OTA was created in 1972 but began producing a significant number of assessment reports in 1974. The complete catalog of OTA reports is available in various repositories, such as: U.S. Congress, Office of Technology Assessment, *The OTA Legacy: 1972–1995* (Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office, 1996). This is a CD-ROM collection, which is also accessible online at https://www.princeton.edu/~ota/ or https://ota.fas.org/technology_assessment_and_congress/.

[17] For a more complete description of OTA, see Peter D. Blair, *Congress's Own Think Tank: Learning from the Legacy of the Office of Technology Assessment (1972–1995)* (New York: Palgrave Macmillan, 2013).

[18] Budget and Accounting Act, Pub. L. No. 67-13, 67th Cong. (June 10, 1921).

[19] For more detail, see U.S. Government Accountability Office, "About GAO" (accessed August 23, 2019), https://www.gao.gov/about/careers/our-teams/.

[20] U.S. Government Accountability Office, *Performance and Accountability Report, Fiscal Year 2018*, GAO-19-1SP (November 2018), pp. 13 and 90, https://www.gao.gov/assets/700/695501.pdf.

later).[21] As of this writing, the pilot program has been in operation for 17 years and produced 16 reports classified by the agency as technology assessments, despite significant differences from OTA assessments in many respects (discussed below).[22]

In January 2019, the GAO launched a new organizational unit to house the agency's TA activities—the Science, Technology Assessment, and Analytics (STAA) team, mentioned earlier in this paper. In addition to producing the GAO's technology assessments, the STAA team will audit federal S&T programs and have several other S&T-related responsibilities.[23]

Measuring Effectiveness of S&T Advice to Congress: Six Tests

To return to the measures discussed in the introduction, for S&T advice to Congress to be effective it should meet six tests—it must be (1) authoritative, (2) objective, (3) independent, (4) relevant, (5) useful, and (6) timely. The first three tests relate to the overall *credibility* and *quality* of the advice provided from the perspective of those who will use it. The remaining three tests characterize the *suitability* of the advice to the context and the sometimes highly specific needs of Congress.

The following sections examine each of the six tests and discuss in detail how the four entities just described—the NRC, CRS, OTA, and the GAO—measure up. (Table 1 summarizes this discussion.)

Test 1: Is the S&T advice provided to Congress *authoritative* and widely perceived to be?

An obvious goal is to involve, directly and significantly, the most knowledgeable expertise available in the subject under study, in terms of both the external experts involved or consulted and the professional staff engaged in formulating the advice. The expertise involved in the effort should be aligned as closely as possible to the topic under study. Involvement of widely respected external experts in and of itself demonstrates authority, although how exactly even the most respected experts are involved in the effort is also important.

Engaging External Expertise

NRC. Among the four defined options, the NRC is most widely recognized as impaneling consensus study committees with highly prestigious memberships and deep expertise in a carefully circumscribed scope of work. The NAS president, who serves ex officio as the chair of the NRC, presides over an elaborate process to appoint study committees. Appointment to and pro bono service on an NRC committee is widely considered an honor. When study committees convene, they also invite experts with even more specialized expertise to present perspectives. In an external review process administered by the Academies' independent Report Review Committee, additional expert panels are appointed to review draft reports and an independent monitor ensures that the study committee responds sufficiently to external reviews before the study report is released for transmittal to the sponsor and subsequently the public.

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[21] It is worth noting that just as OTA was closed, the GAO itself was downsized significantly—from over 5,000 staff eventually to 3,500 staff. See Brookings Institution, *Vital Statistics on Congress* (2013), www.brookings.edu/vitalstats.

[22] U.S. Government Accountability Office, "Technology & Science: An Overview of GAO's Wide-Ranging Technology and Science Work" (2019), https://www.gao.gov/technology_and_science#t=1.

[23] U.S. Government Accountability Office, "Our New Science, Technology Assessment, and Analytics Team," *GAO WatchBlog* (January 29, 2019), https://blog.gao.gov/2019/01/29/our-new-science-technology-assessment-and-analytics-team/.

OTA. The former OTA engaged recognized external experts through prestigious advisory panels, but usually with broad interdisciplinary memberships reflecting important policy perspectives and stakeholder interests. Additional experts were engaged in assessment workshops, as consultants, and to perform contracted research. Still others were invited to serve as reviewers of draft reports, including approval of a "response to review" memorandum in similar fashion to the NRC process. Finally, OTA's organizing statute also specified a Technology Assessment Advisory Council of external experts to perform essentially as a standing visiting committee advising the agency's governing board regarding OTA's organization, operations, and capacity to anticipate major issues likely to be faced.

GAO. The GAO's STAA, in the preliminary design of its TA study process, seeks to acquire relevant expertise by commissioning the NRC to identify experts to participate in a onetime expert meeting as part of the GAO's assessment process. The plan is then for the GAO to ask at least some of those experts to review draft assessment reports, joined by "views from relevant third parties, if applicable, and request comments from relevant federal agencies, as appropriate."[24] Some of the GAO's recent assessments have employed this approach, but the process for accountability to the external review is so far unspecified. The degree of involvement of authoritative external expertise to underscore the credibility of TA activities is one of the most important differences between the GAO and the NRC or OTA approaches, and is among the most substantial shortfalls of the GAO approach to date.

CRS. CRS seldom draws on external experts in any formal way for its analysis and reports, but it does so informally quite frequently in the course of its work, and at times it also convenes workshops, symposia, and other events involving external experts.

Expertise of Professional Staff

NRC. The NRC professional staff generally plays a supporting role, facilitating the study committee's work, although, depending upon the subject of the study, the staff on occasion takes on a substantive role in authoring the report and in collecting the evidence base used in the report. The most effective staff are subject-matter experts and participate to varying degrees in drafting the study committee report and managing the report through the rigorous external review process. The staff also play a dominant role in building relationships with federal agencies and, to a lesser degree, congressional committees that commission the NRC's work and in supporting the NRC's standing boards, which provide oversight for the overall NRC portfolio of work.[25]

OTA. In many ways, the former OTA's approach to studies or assessments was like the NRC's approach, except for a reversal in the roles of the external committee and the professional staff. That is, the OTA approach used an authoritative committee of volunteers as an advisory panel rather than in the role of assuming authorship of the study report itself. OTA's professional staff produced and were responsible for the assessment report, which was then subject to extensive external review by the advisory committee and many other external reviewers. On one hand, this approach permitted easier regulation of the role of the external group of expert advisors, particularly if either achieving a consensus in a broad controversial area among

[24] U.S. Government Accountability Office, GAO-20-246G, *Technology Assessment Design Handbook* (December 2019), p. 3, Table 1, https://www.gao.gov/products/GAO-20-246G.

[25] The NRC is currently organized into seven program divisions (Engineering and Physical Sciences; Earth and Life Studies; Health and Medicine; Behavioral and Social Sciences and Education; Transportation Research; Policy and Global Affairs; and the Gulf Research Program), further subdivided into standing boards, such as the Board on Energy and Environmental Systems, the Space Studies Board, and the Board on Chemical Sciences and Toxicology.

differing ideological perspectives or acquiring the necessary technical expertise without conflicts of interest was unlikely from the outset. On the other hand, such a practice sacrificed the authoritativeness of the "best and brightest" volunteer experts identified specifically as authors of the report, which is an important feature of the NRC process. As a result, the traditional NRC process is less well suited than the OTA process for producing studies or assessments involving the broad social, political, economic, and other policy issues associated with the area under study.[26]

The OTA staffing model also differed from other congressional support agencies in several significant ways. First, OTA employed a core "permanent" staff (ultimately the 143 formally authorized positions), divided into substantive program areas. Temporary or rotational staff, consultants, "in-house" contractors, and external contracted experts were recruited as necessary to meet the needs of current assessments. Both permanent and rotational staff groups included professionals from many disciplines, over half with PhDs not only in the physical and biological sciences, but also in the social sciences, law, and medicine.[27]

GAO. The role of the staff in the GAO's TA approach has evolved slowly since the function began at the agency in 2002, but recruitment of internal staff subject-matter expertise relevant to the TA efforts undertaken has been particularly slow. Since the formal role of external expertise to date has been minimal as well, relative to the NRC and OTA experiences, the burden of expertise rests largely on the staff carrying out the assessment. As a result, while the GAO is beginning to explore ways to tune staff expertise to the needs of current assessments, much remains to be done to ensure a robust and responsive mechanism for recruiting the necessary subject-matter expertise in the GAO staff itself, at least relative to the OTA approach, in addition to securing access to authoritative external expertise, relative, again, to the NRC and OTA approaches.

CRS. In the CRS approach, the professional staff plays a different role, responding mostly to requests from individual House and Senate members in specifically designated areas allocated by organizational design. The agency has assembled a corps of staff dedicated to assigned subject areas where members of Congress commonly request analysis and the resulting analysis is expected to be completed quickly, using off-the-shelf resources. The current CRS staff includes experts in many S&T areas, but they are focused on providing useful, current, and relevant information rather than serving as independent authoritative experts.

Test 2: Is the advice produced *objective* as well as perceived to be?

The process for assembling effective advice to Congress should include a balanced use of all the most important perspectives and accurate representation of those interests.

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[26] At this writing the Academies are engaged in a broad internal "NRC Transformation" aimed in part at broadening the portfolio of options for NRC work in meeting study sponsor needs. See Marcia McNutt, C. Dan Mote Jr., and Victor J. Dzau, open letter to the National Academies Members and Appointed Groups (February 2018), with excerpts from: National Academy of Public Administration, *Improving the National Research Council's Study and Administrative Processes: An Independent Review* (December 2017; not publicly available in full).

[27] As an example, in 1985 OTA was organized into three program divisions with three standing boards in each division: (1) Energy, Materials, and International Security Division (Energy and Materials Program, International Security and Commerce Program, and Industry, Technology, and Employment Program); (2) Health and Life Sciences Division (Food and Renewable Resources Program, Health Program, and Biological Applications Program); and (3) Science, Information and Natural Resources Division (Communications and Information Technologies Program, Oceans and Environment Program, and Science, Transportation, and Innovation Program). See Blair, *Congress's Own Think Tank*, op. cit.

OTA designed panels to capture diverse and divergent perspectives. As noted above, the OTA statute prevented the agency from providing formal recommendations, which was arguably quite sensible since the policy directions often hinged on considerations beyond the scope of OTA's analysis, which, broad though it was by design, still did not encompass the full range of considerations for congressional action. The goal was to inform the debate rather than decide it.

The NRC, by contrast, assembles committees to come to consensus, which for many subjects may be quite appropriate, particularly for highly technical areas with fewer subjective policy complications and perspectives (often the case with requests related to the needs of executive-branch agencies). Such a format, however, often proves difficult when deep ideological differences exist in policy areas, or when the committee does not encompass the full range of expertise and perspectives relevant to the congressional actions. This is one of the fundamental differences between the OTA and NRC processes.

In both the OTA and NRC cases there are extensive information-gathering meetings, workshops, and other mechanisms for acquiring the most up-to-date and relevant information. In addition, in both cases, extensive and independently accountable external review identifies gaps and weaknesses in analysis as well as ensures conformance with high standards of evidence and documentation in the written reports. Such mechanisms have not developed so far in the evolving GAO approach, at least to the standard of the NRC or OTA cases. For example, in earlier GAO technology assessments produced starting in 2002, review of draft reports was limited solely to internal agency mechanisms. More recently, the GAO has invited some of the NRC expert-meeting participants to review draft reports and, as noted earlier, the STAA design mentions unspecified plans to involve other external experts. Pending these prospective developments, the lack of an extensive, transparent, and accountable external-review mechanism will severely limit the credibility of the GAO's developing TA enterprise.

Since CRS relies principally on off-the-shelf information to facilitate generating reports quickly, the necessity for extensive external review is less urgent, although mechanisms to ensure accuracy will become more important as many additional sources accumulate in its information-gathering.

Test 3: Is the advice provided *independent*, i.e., free from influence of vested interests?

When Congress requests independent and objective S&T advice,[28] its expectation is that the advice will be developed with controls on the influence of organizations and individuals with vested interests in the outcome, and that any study produced should be transparently informed by all of those interests. In addition, there is an expectation of some mechanism for verifying the accuracy and strength of the provided evidence, such as a rigorous independent external review.

Congress funded OTA assessments via annual appropriations to the agency rather than directing funding from a specific sponsor. This insulated the agency from concerns about sponsorship conflicts of interest. As noted earlier, the Technology Assessment Board decided which assessments to undertake and fund from resources appropriated to the agency. The TAB based its decisions mostly on formal requests from the congressional committees of jurisdiction, which helped ensure high-priority relevance to the congressional agenda. The GAO funds its assessments similarly, except for the lack of a direct governance mechanism like the TAB to determine priorities, relying instead on the authority of the comptroller general to render such decisions (along with and competing with decisions involving all other GAO activities beyond

[28] In many cases, such as most hearings, Congress openly seeks the points of view of individuals or organizations with vested interests, but it expects independent advice from congressional support agencies and congressionally chartered organizations such as the NRC.

TA, the negative consequences of which are addressed in Test 4). Congressional studies commissioned to the NRC typically require legislation passed by both houses of Congress and signed by the president and a contract to a federal agency to provide the funding, although sometimes agencies provide resources to support letters of request from congressional committees.

In both the NRC and OTA models, extensive external review helps ensure all relevant perspectives are considered. Since in the NRC case the study committee authors the report, the NRC administers elaborate policies regarding conflicts of interest (COI) and committee composition and balance to help minimize bias. In the OTA approach, the expert group is advisory so the COI issues are less relevant; the challenge, rather, is to include, as a high priority, all the relevant important perspectives in the panel composition, including those with conflicts. This requirement also often resulted in external review involving a hundred or more reviewers to ensure capture of the full range of relevant stakeholder interests. Finally, OTA reports focused on articulating the implications of policy options rather than producing consensus recommendations, so consensus was unnecessary, but a clear and extensive understanding of the policy context, especially the role of Congress, was essential.

CRS attempts to respond to all requests from members of Congress, and it is funded as part of the annual appropriation to the Library of Congress. As an agency manual states, "CRS works exclusively for Congress, providing the legislature with an independent source of information and assisting the Congress in its ability to oversee the executive branch in a system characterized by separation of powers."[29] Like OTA, CRS makes no legislative or other policy recommendations to Congress and the agency maintains staff requirements "for confidentiality, timeliness, accuracy, objectivity, balance, and nonpartisanship."[30] As noted earlier, CRS assembles mostly off-the-shelf information in response to congressional requests, seldom utilizing external expertise, at least formally.

Earlier GAO TA efforts (2002–2010) involved no external expert groups. In the more recent GAO efforts and in the developing design of the STAA TA process, onetime NRC-organized expert meetings provide some degree of access to external expertise, but since that expertise is advisory, COI considerations are not relevant, as with all NRC-organized expert meetings. As noted earlier, some of the expert meeting participants are invited to review the draft GAO report. This means that, pending the development of the extensive external review process noted earlier, the GAO approach has no mechanism for ensuring the independence of the views set forth in its reports other than its existing internal agency review process, which does not distinguish between TA and the balance of the agency's activities and does not include the subject-matter expertise to sufficiently judge the relative independence of the views expressed in its draft TA reports.

Test 4: Is the S&T advice provided *relevant* to the congressional agenda?

Congressional committees and/or individual members expect S&T advice tuned specifically to the congressional context, language, scope, and scale of the issues under consideration. In the cases of OTA, the GAO, and CRS, all are located organizationally inside Congress and accountable only to Congress; that alone goes a long way to ensuring relevance to the congressional context. The NRC case is more challenging since by far the bulk of NRC work is carried out for executive-branch agencies with often quite different needs and levels of policy

[29] U.S. Congressional Research Service, RL30240, *Congressional Oversight Manual* (January 16, 2020), p. 80.
[30] Ibid.

abstraction. The GAO case is somewhat complicated as well since the preponderance of its work for Congress is devoted to auditing government programs, so only a very small fraction of the agency's work portfolio relates directly to S&T.

As noted earlier, congressionally commissioned studies to the NRC usually require enacting legislation and allocating resources under contract for the effort. Since the NRC is outside of Congress, specifications of the work generally must appear in legislation—passed by both houses and signed by the president—and then contracts written by agencies underwriting the cost and defining the scope, which have to then be reconciled with congressional intent. It is a lengthy process but usually definitive in demonstrating a substantial degree of relevance to congressional priorities since so many levels of approval within Congress itself are required to commission the study.

In the OTA case, as noted earlier, the TAB considered all requests of the agency to carry out assessments and placed a higher priority on those submitted by committees of jurisdiction from both chambers and with support from both majority and minority committee leadership. With requests received from many committees, the TAB played a crucial role in shaping the agency's priorities and ensuring a match with congressional priorities.

Early GAO TA efforts lacked any such filters. For example, the 2002 GAO TA *Using Biometrics for Border Security* was requested by the chair and ranking member of the Senate Legislative Branch Appropriations Subcommittee, and the 2010 assessment *Explosives Detection Technologies to Protect Passenger Rail* was requested by the chairs and ranking members of the Senate and House Legislative Branch Appropriations Committees. None of the requesting committees has any formal jurisdiction for such topics in either chamber.

In the 17 years between when the GAO began producing what it called technology assessments and the creation of its STAA team (2002–2019), it produced 14 documents it classifies as TAs—and only one was initiated with bipartisan requests from the relevant committees of jurisdiction in both chambers. Five TAs resulted from bipartisan requests from one committee of jurisdiction in one chamber. Six TAs resulted from requests by only ranking minority members (including one that was not really a TA at all, even by the GAO's definition, but rather a summary of an expert meeting).[31] The remaining two, as noted above, resulted from requests from the legislative branch appropriations subcommittees, which had no legislative jurisdiction for the studies undertaken. This illustrates one significant weakness in the GAO approach—some mechanism to match the work undertaken with the congressional agenda, including especially aligning the work with the committees of jurisdiction over the subject areas addressed by assessments undertaken. It remains to be seen whether this aspect of the approach will change under the new STAA, but some more effective mechanism for tuning the GAO's TA work portfolio to congressional needs as expressed directly by the working committees of jurisdiction is essential.

CRS continues to explore ways to become more relevant to congressional needs, including addition of new products that provide background on pending issues, realignment of its organizational structure as congressional priorities change, and communication with members and staff through a variety of mechanisms to provide the information it assembles in as timely a manner as possible.

[31] GAO, "Technology & Science: An Overview of GAO's Wide-Ranging Technology and Science Work," op. cit.

Test 5: Is the advice provided *useful* for congressional decision-making?

In order to be effective, S&T advice delivered to Congress must be in a form matched to policy decisions to inform the policy debate productively. The scope of work should also match the policy context. OTA was, as noted earlier, an agency of Congress and accountable only to Congress, so its process was designed specifically to meet Congress's needs in terms of context, relative priority, scope, language, level of abstraction, and scale of effort suitable to congressional deliberation. As noted earlier, the TAB provided the principal mechanism for setting priorities among assessments requested by congressional committees or other groups within Congress.

Similarly, the GAO is an agency of Congress, so it too designs its process specifically to meet Congress's needs in terms of context, scope, language, level of abstraction, and scale of effort.

CRS is also an agency of Congress, so its process is tuned to congressional needs, but its work portfolio is designed to fill a different need than that provided by the GAO or the former OTA in terms of scale of effort. CRS focuses on a high volume of output that is responsive to individual member requests, and, as noted earlier, is delivered very quickly, principally utilizing off-the-shelf information.

NRC efforts for Congress are typically circumscribed for a very specific need of Congress, but are often less useful for the broader policy context. Since executive agencies commission nearly 90 percent of Academies studies, the NRC staff and committees generally are less familiar with the nuanced context and level of abstraction of advice needed by Congress.

One key generic weakness in the approaches of all the options except CRS is the lack of an effective mechanism for interfacing with the rank-and-file congressional membership (a weakness this paper will discuss later).

Test 6: Is the advice *timely*, i.e., delivered in time to be of use in making decisions?

Early in OTA's history, full-scale TAs, which for many years averaged about 18 months in duration, only intermittently coincided precisely with legislative needs, although as the agency matured, it delivered updated assessments in follow-up or other alternative or interim products delivered more quickly to meet legislative needs in a timelier fashion. The full assessment reports were frequently cited in the legislative process and in broader policy discourse, however, which demonstrated their value in providing a comprehensive and accessible introduction to many technical subject areas for members and staff. The accumulated body of work in key areas also enabled study project directors to work with congressional committees as "shared staff" and often proved invaluable in preserving the applicability of an assessment's findings for many years.[32] At the time of OTA's closure, the agency was developing mechanisms to operate on a shorter life cycle with a broader range of product offerings beyond its classic full-scale TA to respond more flexibly to congressional needs.

Today many criticize the NRC, much like the former OTA, for taking too long to deliver its traditional product, a consensus report. NRC reports are usually completed in around 18 months, although there is a considerable variance by topic—with some "fast-track" efforts delivered within several months and major decadal surveys of basic science areas that take several years or more. A current ongoing internal "NRC Transformation" effort is intended to

[32] Blair, *Congress's Own Think Tank*, op. cit., p. 61.

improve the efficiency of producing traditional NRC reports as well as put forward a wider array of other kinds of products to respond in a more timely and cost-effective way to urgent needs.[33]

The average duration for the GAO technology assessments (from 2002 to 2019) is 21 months, but it is hard to draw strong conclusions due to the small sample size and breadth of topics as opposed to, for example, OTA's hundreds of reports in 23 years, and the NRC's thousands of reports in 150 years. As noted earlier, the GAO is considering how to adapt its TA activities to the changing needs of Congress, including experimenting with a shorter, six-month TA format.[34] Indeed, advances in technology make it possible to improve the timeliness of all the TA approaches and to offer a broader range of products tuned to congressional needs.

CRS mechanisms for delivering timely information continue to evolve as well. In addition to making most of its reports publicly available, beginning in 2019, the agency has also begun preparing "In Focus" products, which are two-page executive-level briefing documents on many of the topics it addresses, and "Insight" products, which provide short-form analysis on fast-moving or more focused issues.[35]

Modernizing Technology Assessment Capabilities

If OTA operated today, significant changes in policies, procedures, and capabilities would be necessary to better meet the needs of Congress as they have evolved in the quarter century since OTA's closure. Congress has changed in many ways, including in considerably expanding the means by which members and staff access information to do their work.

Perhaps the most obvious change involves modern information and communications technology, which affects virtually all aspects of TA: acquisition of information, convening groups of experts, drafting reports and other formats for providing advice, peer or external review, publication, dissemination and outreach, follow-up activities, and more. The availability of such improvements also affects the capacity of organizations to collaborate. For example, one of OTA's weaknesses, as mentioned above, was its inability to interact effectively with rank-and-file members of Congress, particularly when there was a major turnover in congressional membership and leadership. By contrast, this is one of CRS's distinctive strengths. It is easy to imagine collaborations on topic areas where the combined capacity of CRS and OTA would amplify each agency's strengths and compensate for its weaknesses.

The search by most institutions for ways to function while coping with the circumstances surrounding the COVID-19 global pandemic is already accelerating efforts to use electronic communication and convening capabilities more effectively. For example, there has been a longstanding concern about the need to "socialize" an NRC study committee when it is formed—to create a sense of community, mutual trust, and shared mission. The presumption has been that an in-person meeting is essential to "kick off" an NRC study, after which electronic convening and collaboration by various means is likely to be more productive. This has been a presumption, however, not supported by much empirical evidence, and the circumstances surrounding COVID-19 are forcing a real-time experiment of operating nearly all NRC functions electronically.

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[33] McNutt, Mote, and Dzau, open letter and excerpts from NAPA review, op. cit.

[34] U.S. Government Accountability Office, Designing Technology Assessments Experts Forum, background information (September 4, 2019; not publicly available). The forum was held in order to inform the preparation of the GAO's *Technology Assessment Design Handbook*, op. cit.

[35] Carla D. Hayden, "New CRS Content Now Online," *Library of Congress Blog*, Library of Congress, March 8, 2019, https://blogs.loc.gov/loc/2019/03/new-crs-content-now-online/.

The Bottom Line

Providing authoritative, objective, independent, relevant, useful, and timely S&T advice for Congress is challenging and, done well, a distinctive process. The credibility of the analyst delivering advice as a trusted agent along with the transparency and validity of assumptions and methods used in arriving at findings, conclusions, and recommendations as perceived by policymakers and the public frames the credibility of advice received by Congress. The more an agent is perceived as authoritative, disinterested, and independent of bias and the more the assumptions and methods used in crafting the advice are viewed as transparent and valid, the higher the credibility. The pursuit of the goals of independence and transparency is more straightforward, albeit not always easy, when the issues are dominated by technical questions, e.g., as in assessing technology capabilities, cost, and performance. When competing ideologies and values dominate, however, these goals are much more difficult to pursue—the essential challenges of technology assessment.

It is important to recognize this scale of credibility as a continuum. Some observers assert that scientists, for example in regulatory decision-making, are incapable of neutrality and instead conceal their policy preferences beneath a seeming neutrality—cynically rejecting any aspiration to neutrality on the part of scientists as unattainable and characterizing and even dismissing science-based advice as a flawed "technocratic model." That may sometimes and even possibly often be true, particularly for deeply value-based issues, but adding the standard of transparency and independent external review—in the model of the evidence that is subjected to peer review in science—helps reveal bias and makes analysis more useful and credible even in the most value-laden subjects.

The well-developed mechanisms of external review at the NRC and the former OTA prove in both cases to be important if not vital to the credibility of their reports. However, as Vannevar Bush opined, "science is not enough."[36] For example, in the case of environmental regulation, the function of the scientific adviser is rather to engage in dialogue and consensus-building with policymakers on both the policy ends and the scientific means of regulation. Science alone cannot definitively resolve environmental controversies, but it can help to legitimate policy by defining the boundaries of the technically feasible and politically acceptable, or as Bruce Smith of the Brookings Institution puts it in the case of environmental decision-making: "The science adviser walks a fine line between assuming a technocratic, value-neutral stance (which brings with it the danger of being aloof and above the fray) and being a political partisan (which might mean being discredited as simply another partisan voice). . . . The environmental science adviser must partake of the objective aura of science even while being aware of the political realities behind the advice."[37] This is surely the case for all areas of S&T advice—and science plays a part in almost every major issue facing Congress, even if it alone can seldom provide the definitive answers.

Providing broad, comprehensive, nonpartisan, disinterested, timely S&T advice to Congress tuned to congressional needs is difficult with any of the existing options. Creating OTA-like features that would replicate the OTA study process and operate under direct congressional oversight is still possible in existing congressional organizations, such as the GAO or CRS, and it may also be possible to incorporate more OTA-like features in the work of external organizations such as the NRC. In some cases, the NRC is already introducing OTA-like features in its portfolio, perhaps brought about more by circumstance than design, but for broader

[36] Vannevar Bush, *Science Is Not Enough* (New York: Morrow, 1967).
[37] Bruce L. R. Smith, *The Advisers: Scientists in the Policy Process* (Washington, D.C.: The Brookings Institution, 1992), p. 99.

application, many internal and external control issues would have to be resolved to expand such a capability. The GAO's new STAA may put in place some OTA-like features as well.

Another possible and likely preferable option is reconstructing an OTA with many of the agency's original features. But a restarted OTA would need to include new features as well, including: (1) a broader portfolio of activities and products, including some related to shorter-term needs of individual members as opposed to exclusively congressional committees; (2) closer connections with other organizations outside Congress; (3) utilizing more electronic communications for considerably expanded information-gathering and -delivery to Congress and the public; and (4) increasing collaboration with other congressional support agencies—the GAO, CRS, and CBO—where topical areas overlap and strengths are complementary.

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