A Report by a Panel of the

NATIONAL ACADEMY OF PUBLIC ADMINISTRATION

Science and Technology Policy Assessment: A Congressionally Directed Review

NATIONAL ACADEMY OF PUBLIC ADMINISTRATION®

FRONT COVER PHOTO

Donald Giannatti credited for the cover photo, taken on May 19, 2018, as he rode through Socorro, New Mexico. The photo is an online image and entitled, "Very Large Array, Socorro, United States." https://unsplash.com/photos/Wj1D-qiOseE

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NATIONAL ACADEMY OF PUBLIC ADMINISTRATION

October 31, 2019

Science and Technology Policy Assessment: A Congressionally Directed Review

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The views expressed in this report are those of the panel. They do not necessarily reflect the views of the Academy as an institution.

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October 31, 2019
Printed in the United States of America
Academy Project Number: 2236

Foreword

Even the most proficient of experts are challenged by the rapid advances and increasing complexity occurring in science and technology during this century. Faced with this dynamic environment, Members and staff of the United States Congress need responsive access to the best scientific and technical expertise as they make policy, conduct oversight, and interact with constituents. Furthermore, they need to proactively understand how developments in science and technology create social changes that demand a public policy response.

With these challenges in mind, the Fiscal Year 2019 Legislative Branch Appropriations Bill conference report directed the Congressional Research Service (CRS) to contract with the National Academy of Public Administration (the Academy) to detail the current resources within the Legislative Branch regarding science and technology developments and related policy that are available to Members of Congress and their staff. The conference report also directed the Academy recommend options to enhance science and technology resource support to Congress, whether by means of a newly created legislative agency or by those agencies that currently provide such support.

As a congressionally chartered, non-partisan, and non-profit organization with over 900 distinguished Fellows, the Academy has a unique ability to bring nationally-recognized public administration experts together to help agencies address challenges. We are pleased to assist the CRS by conducting this study, and we appreciate the constructive engagement of its employees, as well as many other stakeholders who provided important observations and context to inform this report. I am deeply appreciative of the work of the Panel of five Academy Fellows and the Study Team who provided their valuable insights and expertise throughout the project.

I expect that the Academy Panel's report will guide efforts to enhance the quality and availability of science and technology resources available to Congress. Knowing the criticality and complexity of these topics for the Nation, I trust that this report will be useful to Members of Congress as they consider how to shape and implement changes needed to accomplish their vital mission.

Teresa W. Gerton
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Acronyms and Abbreviations

AAAS	American Association for the Advancement of Science
Academy	National Academy of Public Administration
BS	Bachelor of Science
CRS	Congressional Research Service
DARPA	Defense Advanced Research Projects Agency
EFF	Electronic Frontier Foundation
EPIC	Electronic Privacy Information Center
FFRDC	Federally Funded Research and Development Centers
FTE	Full-time Equivalent
FY	Fiscal Year
GAO	Government Accountability Office
GSA	General Services Administration
IEEE	Institute of Electrical and Electronics Engineers
IIASA	International Institute for Applied Systems Analysis
LIS	Library Information Service
MA	Masters of Arts
MBA	Masters of Business Administration
NAS	National Academy of Science
NASEM	National Academies of Sciences, Engineering, and Medicine
OCSTA	Office of the Congressional Science and Technology Advisor
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy
OTA	Office of Technology Assessment
PCAST	Presidential Council of Science and Technology Advisors
Ph.D.	Postgraduate Doctoral Degree
RSI	Resources, Science, and Industry
TA	Technology Assessment
S&T	Science and Technology
STAA	Science, Technology Assessment, and Analytics
STEM	Science, Technology, Engineering, and Mathematics

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Executive Summary

The exponential rate of change in science and technology in the 21st century brings both enormous prospects and complex challenges for both individual citizens, and for those with responsibility to evaluate how these changes might impact society as a whole. In this context, the Congress needs to improve its capacity to deal with science and technology-related issues.

In the conference report to accompany H.R. 5895, Congress directed the Congressional Research Service (CRS) to contract with the National Academy of Public Administration (the Academy) to conduct a review to include the following.

- Detail the current resources available to Members of Congress within the Legislative Branch regarding science and technology (S&T) policy, including the Government Accountability Office (GAO);
- 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 (OTA); and
- Address whether the creation of a separate Legislative Branch entity would duplicate services already available to Members of Congress.

To undertake this review, the Academy formed a Panel of five distinguished Academy Fellows. The Panel was supported by a professional study team.

The Panel's report provides context for understanding congressional needs, including an overall decline in staff and time devoted to S&T and other policy issues. The report further provides a taxonomy of congressional needs for S&T policy resources and an inventory and analysis of these resources that are available to Congress from agencies within the Legislative Branch. The inventory is assessed against the taxonomy to identify gaps.

The report identifies six types of S&T-related support products and services that Congress requires in order to more effectively conduct its work: quick-turnaround support, networking support, consultative support, and three types of reports: short- to medium-term reports, technology assessments and horizon-scanning reports. These types of products and services are summarized in Table 1 below.

Taxonomy of Congressional Science and Technology Support Needs

Category of Support	Summary of S&T Support Demand From Congress	Approx. Timeframe	Approx. Product Length	Current Providers
Quick Turnaround	Questions that require a prompt response with facts, figures, and descriptions; for example, a legislative correspondent working to respond to a constituent's inquiry or a brief overview of key S&T issues	one hour to three weeks	one to five pages	CRS
Networking	Access to a wide array of outside S&T experts embracing academia, industry, and non-profit segments	on-going	NA	Modest gap
Consultative	Readily available, consistent consulting with experts who provide more personal assistance to Members and staffs who can provide clear recommendations, if requested	on-going	NA	Modest gap CRS, but desire for additional S&T consultation
Report: Short-to Medium-Term	Studies and analyses of S&T trends that can be completed relatively quickly to allow critical issues to be addressed; provide detailed summaries of policy issues with original information gathered from stakeholders in all sectors, including government, nonprofit, industry, and government; these types of reports lay out options to deal with the challenges or leverage the opportunities; they are generally peer-reviewed from outside experts	one to twelve months	three to twenty pages	Modest gap[1] with CRS and GAO seeking to respond
Report: Technology Assessment	Detailed research into the impact of S&T trends and provide avenues to mitigate the challenges and take advantage of opportunities; this type of study has a formal methodology that must be followed and are peer-reviewed by outside experts, going through a high degree of scrutiny before release	twelve to twenty-four months	fifty to 200 Pages	GAO
Report: Horizon Scanning	Identify emerging S&T technology trends and the opportunities and issues that might result from them in future	six to eighteen months	twenty to sixty pages	Gap

Table 1. Taxonomy of Congressional Science and Technology Support Needs

In comparing present supply and demand of S&T resource support for Congress, the Panel finds a modest gap in the areas of networking, consultative support, short- and medium-term S&T-related reports. That is, congressional clients expressed a desire for greater support in these categories.

[1] While the Panel notes a "gap" in this category, it recognizes that both the CRS and the GAO offer medium-term resource support to Congress as requested. Even so, neither agency expressly stresses this segment of resource support as its principal focus, but rather as an ancillary focus in response to occasional demand. Thus, the Panel notes it this way.

Also, the Panel finds a gap in S&T horizon scanning; no agency expressly claims responsibility for preparing horizon scanning reports as distinct products for Congress.

The report presents the following three options for addressing the identified gaps:

1. Enhance Existing Entities: Enhancing the capabilities of existing Legislative Branch support agencies, including GAO and CRS, including potential changes to current models.
2. Create a New Agency: Creating a separate agency to fill any existing gaps, with attention given to avoiding duplication of effort.
3. Enhance Existing Entities and Create an Advisory Office: Both enhancing existing entities and creating 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.

Each option is evaluated and ranked low, medium or high with respect to each of the following criteria:

- Desirability: How well does it meet customer needs?
- Feasibility: How difficult is it to implement?
- Viability: How likely is it to succeed in the long term?

Desirability is given greater weight than feasibility and viability. This weighting reflects the Panel's view that an option that maximizes S&T support resources available to Congress will be more likely to succeed.

Recommendations

Based on its assessment of the options, the Panel recommends Option 3: Enhance Existing Entities and Create an Advisory Office. This option has four key components.

1. CRS enhances and expands its quick-turnaround and consultative services in S&T-related policy issues.
2. GAO further develops the capability of its Science, Technology Assessment, and Analytics (STAA) mission team to meet some of the supply gaps identified in this report (i.e., Technology Assessments, short-to-medium term reports, and networking) and make appropriate changes in its organization and operating policies to accommodate the distinctive features of technology assessments and other foresight products.

3. Congress creates an Office of the Congressional S&T Advisor (OCSTA), which would focus on efforts to build the absorptive capacity of Congress, to include supporting the recruitment and hiring of S&T advisors for House and Senate committees with major S&T oversight responsibilities. OCSTA would also be responsible for horizon scanning.
4. Congress creates a Coordinating Council to be led by the Advisor and includes representatives from GAO's STAA, CRS, and a NASEM *ex officio* member with the objective to limit duplication and coordinate available resources to most benefit the Congress.

The Panel recommends that Congress conduct a thorough independent, nonpartisan, review to evaluate the performance of the option. This review would take place 24 months after implementation. Congress should provide CRS and GAO resources and authority to build the capabilities needed to carry out the roles embodied in the recommended option.

During the course of this study, it became clear that improving the capacity of Legislative Branch entities to provide S&T policy resources is only part of the equation. Success will depend also on the ability of Congress to absorb and utilize the S&T policy information provided by these entities whatever option is chosen. Toward this end, the Panel makes recommendations to strengthen the absorptive capacity of Congress in the following three areas: (1) committee structure and activities; (2) attraction and retention of S&T talent to congressional staff; and (3) proceedings – debate and deliberation.

Finally, the Panel recommends that Congress codify the recommended actions, both to enhance the capabilities of GAO and CRS and to improve its own absorptive capacity. The enhancement of CRS and GAO capabilities can be accomplished within existing statutory authorities and Congress can take the steps to improve its staff capacity without new authorizing legislation. However, the Panel recommends that Congress enact new authorizing legislation not only to codify the recommended actions, but also to provide for a deliberative hearing process and extensive congressional floor debate, which would both educate and engage Members on these vital issues and announce to the public at large its commitment to keep the country on the cutting-edge of S&T issues.

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Chapter 1: Background and Overview

Over the last century, the United States economy has witnessed rapid evolution of a massive research, development, infrastructure across science and technology to power growth, fight disease, extend lifespans, and fight and win the Cold War. The role of government within this ever more complex ecosystem is changing in response to a variety of forces. These forces include accelerating knowledge creation and diffusion; the globalization and integration of economies around the world; the changing structure of the U.S. economy, including the growth of the service, information, and high-tech industries; and changing public and private research and development investment strategies. Scientific and technological changes have been, and continue to be, dramatic. "An analysis of the history of technology shows that technological change is exponential, contrary to the common-sense 'intuitive linear' view. So we won't experience 100 years of progress in the 21st century — it will be more like 20,000 years of progress (at today's rate)."[2]

Profound scientific and technological changes that are accelerating in this century pose ever-greater challenges for the U.S. government to consider how to anticipate issues arising from these advancements, and then fashion a responsive public policy in a timely manner. Congress not only seeks to adequately protect the American people from abuses and downside risks inherent with these changes, but also to consider policies that might harness them in order to enhance safety and prosperity for the Nation's citizens. In recent years, the U.S. Congress has wrestled with numerous challenges resulting from this evolving science and technology landscape, including data breaches, election cyber-security, genetic engineering, drug-resistant superbugs, international competitiveness in emerging technologies, and many more. Today, and in the future, Congress will need to leverage greater scientific and technical expertise to make policy, conduct oversight, and interact with constituents. Furthermore, Congress will need to understand how the social implications of developments in science and technology can be adapted appropriately into public policy.

This is a report of a Panel of five distinguished Fellows of the National Academy of Public Administration (the Academy) that provides independent, non-partisan, and research-driven analysis and recommendations, supported by a five-member professional study team (see Appendix A for biographical information on the Panel and staff). The report responds to a congressional mandate in the FY 2019 Legislative Branch Appropriations bill.

The remainder of this chapter addresses the following: the origin and scope of the need for greater science and technology (S&T) support to Congress; a brief description of the assessment methodology and approach; and an overview of the report's structure.

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[2] Excerpt taken from an essay by Ray Kurzweil entitled *"The Law of Accelerating Returns"* May 7, 2001. https://www.kurzweilai.net/the-law-of-accelerating-returns.

Origin and Scope of the Report

This report was mandated by the Fiscal Year (FY) 2019 Legislative Branch Appropriations bill and is specifically mentioned in the conference report to accompany H.R. 5895.[3] The conference report directed the Congressional Research Service (CRS) to contract with the Academy to conduct a review detailing the current resources within the Legislative Branch that are available to Members of Congress regarding S&T policy.

The conference report language calls for this study to address the following points:

- Produce a report detailing the current resources available to Members of Congress within the Legislative Branch regarding science and technology policy, including the GAO.
- 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 (OTA).
- Address whether the creation of a separate entity would duplicate services already available to Members of Congress.

Study Approach and Methodology

Under the Panel's direction, the study team was guided by four principal research questions, as it organized its research:

1) What S&T support does Congress need?
2) What support from within the Legislative Branch does Congress receive?
3) What is the gap between congressional demand and current supply?
4) How should demand gap(s) be addressed, with simultaneous focus to minimize duplication of efforts?

The study combined direct and indirect approaches to assess congressional needs. The direct approach consisted of interviews with current and recent congressional Members and staff. In these interviews, the study team sought to understand congressional demands for S&T information. A key line of inquiry included clarifying the nature of S&T support that the CRS and the GAO provide, the quality of their S&T support, and what S&T support congressional consumers wished they had but do not receive. The indirect approach to the inquiry looked to information, facts, and developments that indicate congressional needs. Two examples of this manner of research include describing: the overall decline in congressional capacity to deal effectively with S&T issues, and documenting the increasing complexity and prevalence of S&T issues deemed important for the country and the Congress.

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[3] U.S. Congress, House, *Energy and Water Development and Related Agencies for the Fiscal Year Ending September 30, 2019, and for Other Purposes*, Conference Report to Accompany H.R. 5895, 115th Congress, 2nd Session, https://www.congress.gov/115/crpt/hrpt929/CRPT-115hrpt929.pdf

The analysis marries an assessment of congressional needs with research on leading practices in institutional design to develop options for policymakers to enhance S&T support for the Congress.

Several fundamental principles guided our research:

- Adopt demand-driven solutions: Conduct interviews with a wide variety of stakeholders to understand congressional needs, and prioritize input from former and current congressional staff, Members, and former OTA staff members in order to gain clarity from the "consumers" of S&T resource support.
- Create a taxonomy to describe and evaluate the various types of S&T support in demand/supply: Develop a taxonomy to describe, categorize, and analyze congressional demand for S&T resources.
- Consider re-funding an OTA that is structured and tailored to fill current demand gaps: Examine the pros and cons of re-funding OTA within the context of the gaps in S&T resource support revealed by our research, rather than limiting our consideration to re-funding an agency (OTA) so that it might operate as it did in the past.
- Consider how existing providers of S&T support to Congress might enhance and/or expand their support: Conduct extensive interviews with the CRS and the GAO in order to understand how each agency functions to provide S&T resource support to Congress. During those meetings, the study team explored with both organizations whether there was an appetite to broaden their S&T resource support in order to fill identified gaps.
- Apply best practices in institutional design: Conduct interviews and complete documentary research with experts on institutional design, Congress, legislative branch support, technology assessment (TA), and alternative models for TA in order to identify best practices.
- Devise and apply decision-making criteria to evaluate gap-filling options: The Panel uses three general criteria to evaluate options: feasibility, viability, and desirability. Options are evaluated by the performance criteria of high, medium, and low.
- Identify whether actions might be taken by congressional Members and staffs that could enhance their own absorptive capacity: Recognize that the issues connected with providing sound and timely S&T resource support to Congress have two important parties involved – suppliers and consumers. The study team leveraged the insights from our research to provide targeted guidance for enhancing the consumer side of the equation.

Documentary Research and Interviews

Our research methodology utilized documentary and interview-based research to prepare this report. The study team conducted extensive research and analysis of written policies and reviewed technology assessments performed by the OTA and the GAO. In addition, the study team incorporated information from other materials such as media reports and articles, and other analyses of how OTA operated. The study team also examined how other legislative bodies address similar challenges both domestically and internationally.

The study team also conducted interviews with 127 stakeholders (see Appendix B for a full list of interviewees), including the following groups:

- Congressional Members and Staff (Current and Former)
- Government Accountability Office
- Congressional Research Service
- Former OTA staff
- National Academies of Science, Engineering, and Medicine
- Executive branch offices, or former employees
- Various European governments and support systems
- State-level agencies
- Federally funded research and development centers
- Think tanks and other research and development organizations
- Academics
- Advocacy organizations
- Good government groups

Organization of the Report

In addition to this chapter, the report contains five other chapters, as follows:

- Environmental and Congressional Context
- Taxonomy of Congressional Needs
- Inventory and Analysis of Current Resources
- Options and a Recommendation for Enhancing S&T Support to Congress
- Addressing the Absorptive Gap

Chapter 2: Environmental and Congressional Context

In this chapter, context and important background are presented that both shape this report and provide insights into why S&T resource support to Congress is essential in the 21st century.

The Office of Technology Assessment

The *Technology Assessment Act*[4] created the Office of Technology Assessment (OTA) in 1972. The OTA's intention was to provide detailed, comprehensive, technical analysis of the scientific and technology issues confronting the nation and Congress.

From 1972 to 1995 (11 sessions of Congress) it published nearly 750 full technology assessments,[5] background papers, technical memoranda, case studies, and workshop proceedings. These included reports covering myriad S&T issues, including evaluation of the environmental impacts of technology, estimated the economic and social impacts of rapid technological change, and examined cutting edge science in many different fields.[6]

On September 29, 1995, OTA closed its doors after its funding was not renewed as part of House Speaker Newt Gingrich's Contract with America. The shuttering of OTA coincided with a decline in other types of internal congressional policy support capacity.

Over the next 23 years, there were several attempts to enhance congressional capacity for S&T policy guidance. The three major themes of these efforts were: (1) re-funding OTA; (2) establishing a new S&T organization to advise Congress; and (3) expanding S&T capabilities in existing organizations.

The only successful legislative efforts involved expanding S&T capabilities within an existing congressional organization. In 2002, the GAO was directed by legislation to establish a pilot technology assessment program. That program continued over the next decade. In 2019, the

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[4] *Office of Technology Assessment Act*, Public Law 92-484, October 13, 1972, https://www.princeton.edu/~ota/ns20/act_f.html

[5] Generally, technology assessment is a form of policy research that examines short, medium, and long-term consequences of the application of technology. The goal of technology assessment is to provide policy makers with information on policy options. The various forms and applications of technology assessment vary widely. The Office of Technology Assessment was tasked "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."

[6] *Office of Technology Assessment Act*, Public Law 92-484, October 13, 1972, https://www.princeton.edu/~ota/ns20/hough_f.html

conference report accompanying Legislative Branch Appropriations directed the GAO to create an enhanced S&T capability.[7]

In 2018, there were renewed efforts to enhance the Congress' S&T guidance capabilities that arose both from within the Congress and from external advocates. These efforts culminated with the conference report accompanying the 2019 Legislative Branch Appropriations bill that directed this Academy study and encouraged the GAO to create an enhanced S&T capability.[8]

Changes Since 1995

Since 1995, the world has changed significantly. Sectors as disparate as healthcare, manufacturing, entertainment, and finance have been disrupted or impacted by developments in S&T. Just this year, Congress has grappled with the launch of fifth-generation (5G) wireless broadband, troubling increases in opioid-related deaths, sustained expansion of commercial space ventures, commercial use of autonomous flying vehicles, genetic engineering, drug-resistant superbugs, and the continued acceleration of deep fake technologies powered by artificial intelligence and machine learning. This is just a selection of the many important S&T developments today.

Each has immense economic, societal, and political implications for the Nation and, in turn, policymakers in Congress. For example, artificial intelligence algorithms have supported efforts to reduce the cancer burden in the United States through the SEER Program,[9] but will also power increasingly sophisticated "deep fake technologies." Providers of commercial space satellite services are aiming to provide global broadband service from space. However, as low-earth orbit becomes more crowded, the likelihood of accidents increases.[10] The information economy has been revolutionized by the commercialization of the Internet, and now Congress is wrestling with the implications of digital advertising, dominance of online platforms, and digital privacy.

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[7] U.S. Congress, House, *Energy and Water Development and Related Agencies for the Fiscal Year Ending September 30, 2019, and for Other Purposes*, Conference Report to Accompany H.R. 5895, 115th Congress, 2nd Session, https://www.congress.gov/115/crpt/hrpt929/CRPT-115hrpt929.pdf

[8] Ibid.

[9] U.S. Congress, House, Committee on Science, Space, and Technology, *Hearing on Artificial Intelligence: Societal and Ethical Implications*, June 26, 2019, https://science.house.gov/imo/media/doc/Tourassi%20Testimony.pdf

[10] U.S. Congress, House, Committee on Science, Space, and Technology, *The Commercial Space Landscape,* July 25, 2019, https://science.house.gov/imo/media/doc/Christensen%20Testimony.pdf

"Many of the underlying drivers of the digital revolution—massive increases in processing power, exploding storage capacity, steady miniaturization of computing, ubiquitous communications and networking capabilities, the digitization of all data, and more—are beginning to have a profound impact beyond the confines of cyberspace." – *Adam Thierer, author, Permissionless Innovations: The Continuing Case for Comprehensive Technological Freedom*

Today, commonplace technologies have embedded microchips, sensors, microphones, and antennas, which enable an "always-on" fully customizable world, the Internet of Things. These developments are leading to accelerated advances in robotics, autonomous systems, artificial intelligence, and additive manufacturing, but also enable unprecedented surveillance of our citizens.[11]

For many of these emerging technologies, there are different categories of potential congressional involvement, including clarifying the rules and promoting greater market certainty, updating and clarifying how current laws apply to new technologies and their various applications, and creating an environment to enable or curtail the growth of an emerging industry.

Specifically, there has been a recent demand for a congressional dialogue on S&T issues like digital privacy, data security, election security, competition in digital markets, and autonomous vehicles. For example, Congress has recently been grappling with online platforms and their influence. Contentious touch-points include online platforms' relationship with Section 230 of the Communications Decency Act and competition in the digital markets. Congress is similarly beginning to confront larger digital privacy and data security issues that are increasingly prevalent in our digitally monitored, networked, and trafficked world. At the same time, research and development of autonomous vehicles is accelerating and Congress is wrestling with potential regulatory approaches. The profound scientific and technological changes that will continue to accelerate during this century will create ever-greater challenges for Congress.

A Decline in Congressional Capacity

The range, speed, and impact of technical developments suggest a greater congressional need for internal expertise on S&T related issues. Yet, nearly every indicator of congressional capacity is moving the wrong way. A growing electorate and a massive increase in electronic mail to Congress have stretched personal office resources thin. Committee staff levels continue to decline despite increasing oversight demands created by growing executive branch power and post-9/11 responsibilities.[12] Staff pay has stagnated, creating a brain drain as staffers move to more lucrative

[11] Adam Thierer, *Permissionless Innovations: The Continuing Case for Comprehensive Technological Freedom,* (Arlington: Mercatus Center at George Mason University, 2016).

[12] Vital Statistics on Congress, The Brookings Institution

lobbying and think tank jobs.[13] Congress' own think tanks, the legislative branch support agencies, still have not recovered from two decades of staff cuts. As a result, a significant number of senior congressional staffs do not believe Congress has the resources or knowledge available to do its job.[14]

Members

Senators and Representatives are the officials entrusted to represent their constituents, but a 2016 survey of senior congressional staff by the Congressional Management Foundation found that "Senators and Representatives lack the time and resources they need to understand, consider, and deliberate public policy and legislation."[15] This finding is supported by a 2013 survey of 25 Members[16] and the Academy's interviews with current and former Members, and results from a number of changes in chamber rules and practices, as well as other environmental factors. For example, committees and subcommittees are meeting less than at almost any other time, and Congress is relying on committees less to consider and address fast-moving issues like S&T in society.[17]

Members of Congress typically do not come from professional backgrounds in science and technology.[18] Based on a CRS review of the membership of the 116th Congress, 17 of the 535 Members had a professional background in a field related to science and technology policy (this does not include physicians and other medical professionals).[19] These professional backgrounds included 11 engineers, 4 venture capitalists, 1 physicist, and 1 chemist. The rest 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. As a result, Members rarely have the time and resources to tackle issues connected with public policy and legislation, and they often do not have the subject matter expertise to understand fast-moving, complex S&T issues.

Committee Staffing and Activity

A critical source of policy expertise in Congress lies within congressional committees. Yet committee-staffing levels have declined significantly over time. From 1981 to 2015, the number of full-time standing committee staff has shrunk by 38 percent – a loss of 1,361 positions, reflected in Figure 1 below. Key committees for technology policy reflect a similar trend. For instance, from 1981 to 2015 (note: 1979 data for House committees were unavailable), the House Energy and

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[13] Megan Wilson, *Brain Drain in Congress as Staffers bolt for K St.,* July 28, 2014, https://thehill.com/business-a-lobbying/lobbying-hires/213534-brain-drain-in-congress-as-staffers-bolt-for-lobby-jobs

[14] Congressional Management Foundation. *State of the Congress: Staff Perspectives on Institutional Capacity in the House and Senate.* (Washington, D.C.: Congressional Management Foundation, 2017).

[15] Ibid

[16] *Life in Congress: The Member Perspective, a Joint Research Report by CMF-SHRM*, 2013.

[17] Congressional Management Foundation. *State of the Congress: Staff Perspectives on Institutional Capacity in the House and Senate.* (Washington, D.C.: Congressional Management Foundation, 2017).

[18] Congressional Research Service. *Membership of the 116th Congress: A Profile*. (Washington, D.C.: Congressional Research Service, 2019). Link: https://crsreports.congress.gov/product/pdf/R/R45583

[19] Ibid.

Commerce Committee full-time staff declined by 45 percent. From 1979 to 2015, staff of its Senate counterpart, the Committee on Commerce, Science, and Transportation, declined by 33 percent. Similarly, from 1981 to 2015, House Judiciary Committee full-time staff declined by 19 percent. From 1979 to 2015, staff of its Senate counterpart declined by 59 percent.

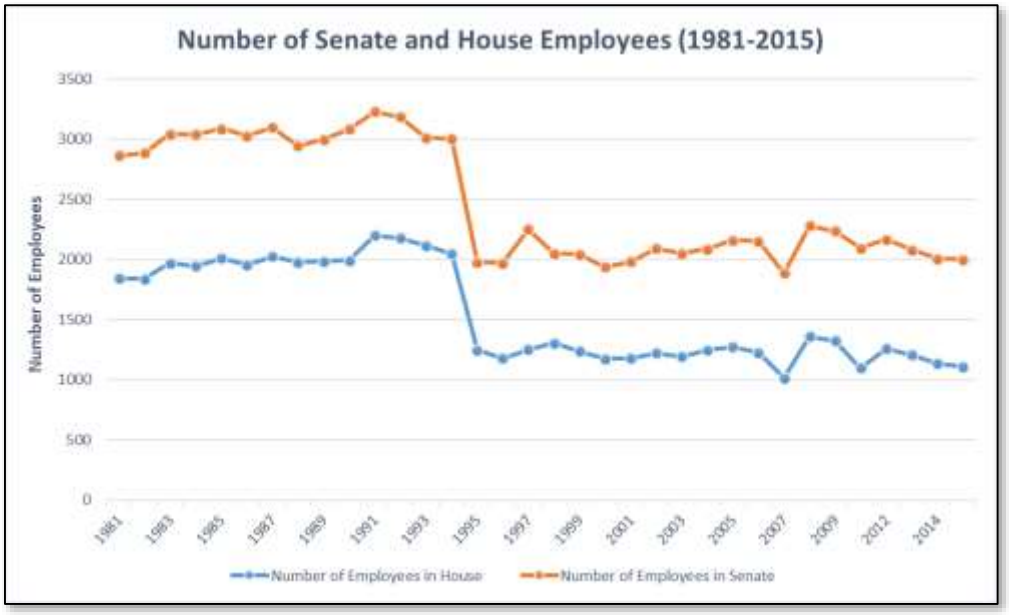

Figure 1 - House and Senate Committee Staff 1981-2015 (Source: Vital Statistics on Congress, The Brookings Institution. [Table 5-5])

Also, committees and subcommittees have spent significantly less time conducting hearings and official meetings, in which they would deliberate on policy, and develop legislation. This reduces the time that Members have to build subject matter expertise on the issues in their committee jurisdictions. From the 96th Congress (1981-1980) to the 114th Congress (2015-2016), the aggregate number of committee and subcommittee meetings across both chambers decreased by 63 percent.[20]

Personal Office Staffing and Resources

With the explosion of digital communication and U.S. population growth, congressional offices are overwhelmed by constituent communication. In response, "Congressional offices are devoting more resources to managing the growing volume of constituent communications."[21] Given the fixed budgets of offices, this shift in resource allocation has real effects on the policy capabilities of personal offices. One indicator of this shift in resource allocation between constituent communications and policy is the growing percentage of personal office staff based in district and

[20] The Brookings Institution. 2019. Vital Statistics on Congress [Table 6-1 and 6-2].

[21] Congressional Management Foundation. *How Capitol Hill is Coping with the Survey in Citizen Advocacy.* (Washington D.C.: 2005).

state offices. "Since overall legislative branch staffing and budgets have declined over this period, this trend means fewer resources for retaining policy experts."[22]

From 1979 to 2016, the percentage of Senate personal office staff in state offices has increased from 24 percent to 43 percent, reflected in Figure 2 below.[23] The House ratio has shifted similarly.[24]

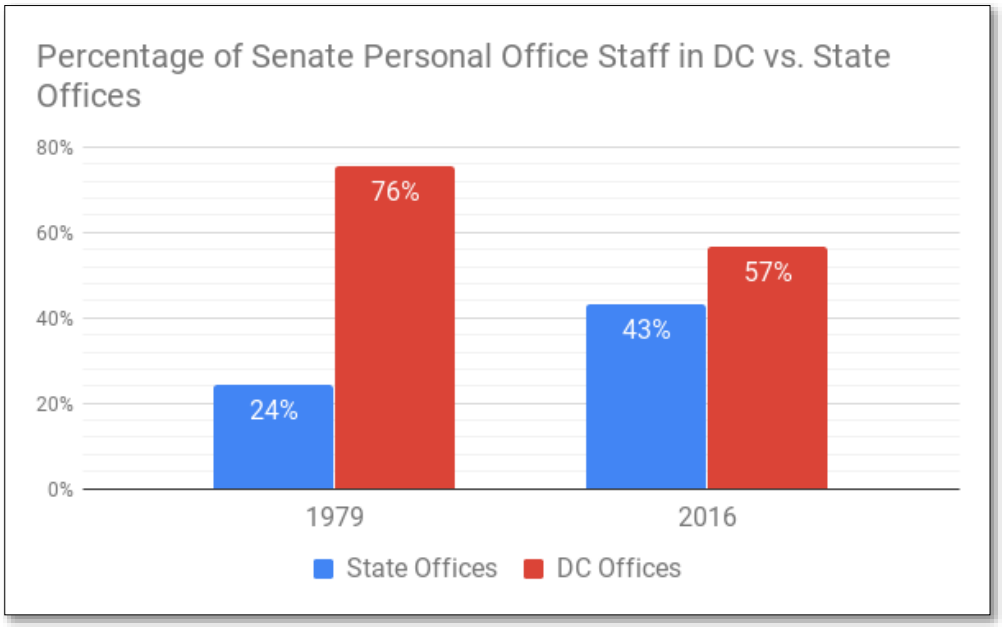

Figure 2 - (Source: Vital Statistics on Congress, The Brookings Institution. [Table 5-4])

Legislative Branch Compensation

One of the biggest drivers of Congress' capacity challenge is compensation, which is a political problem and a problem experienced in the Executive Branch as well. Members vote annually to deny themselves and their staff a salary increase. Also, the Member's Representational Allowance, which is the House appropriation that pays for personal office staff, is lower than it was 20 years ago (in real dollars).[25] The Senate is in a similar situation. Committee staff funding shows similar trends. [26]

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[22] Graves, Zach and Daniel Schuman, *The Decline of Congressional Expertise Explained in 10 Charts*, October 18, 2018, https://www.techdirt.com/articles/20181018/10204640869/decline-congressional-expertise-explained-10-charts.shtml

[23] The Brookings Institution. 2019. Vital Statistics on Congress [Table 5-4].

[24] The Brookings Institution. 2019. Vital Statistics on Congress [Table 5-3].

[25] Congressional Research Service. *Members' Representational Allowance: History and Usage*. (Washington, D.C.: Congressional Research Service, September 2019.) Link: https://crsreports.congress.gov/product/pdf/R/R40962

[26] Congressional Research Service. *House Committee Funding: Description of Process and Analysis of Disbursements*. (Washington D.C.: Congressional Research Service, November 2018.) Link: https://crsreports.congress.gov/product/pdf/R/R42778

These Congress-wide trends compound the capacity challenge, particularly for S&T topics. In Congress, while the cost of living in the District of Columbia has risen, the overall inflation-adjusted compensation for congressional policy staff has declined. TechCongress, a program that supplies S&T fellows to Congress from the private sector, said that most TechCongress Fellows are taking pay cuts, some estimated to be as much as 70 percent.

Legislative Branch Support Agencies

Legislative branch support agencies are creatures of Congress and provide nonpartisan policy expertise at Congress' request. These agencies include the CRS, the Congressional Budget Office, the GAO, and the defunct OTA. Like Congress itself, these agencies have experienced staff and budget cuts over the past several decades. A 2016 study by the Congressional Management Foundation[27] found that, "Congress needs to improve Member and staff access to high-quality, nonpartisan policy expertise within the Legislative Branch." Specifically, 81 percent of senior congressional staff considered access to high quality, non-partisan policy expertise "very important" but only 24 percent said they were very satisfied and 44 percent said they were "somewhat satisfied" with the S&T support available for them.[28]

Congressional Research Service

In 1914, Congress passed legislation to establish a separate department within the Library of Congress called the Legislative Reference Service to serve the legislative needs of the Congress. In 1970, Congress passed the Legislative Reorganization Act, which renamed the agency the Congressional Research Service (CRS) and significantly expanded its statutory responsibilities. Today, CRS provides Congress with research and analysis that is objective, nonpartisan, authoritative and timely. It does so through confidential consultative services for Congress and products that are published for general access on CRS.gov and Congress.gov. From 1979 to 2015, the CRS' staff shrunk by 28 percent -- a loss of 238 positions, reflected in Figure 3 below.[29]

[27] Note: This was an online survey, in which 1,900 questionnaires were sent out. A total of 206 responses were received (11 percent response rate), but the reported results sample 184 respondents (9.5 percent response rate), as more junior staffers were dropped from the sample. Of that amount, approximately 25 percent of respondents were in state and district offices.

[28] Congressional Management Foundation. *State of the Congress: Staff Perspectives on Institutional Capacity in the House and Senate.* (Washington, D.C.: Congressional Management Foundation, 2017).

[29] Some have attributed this to increased efficiencies from technology and the Internet, including CRS staff.

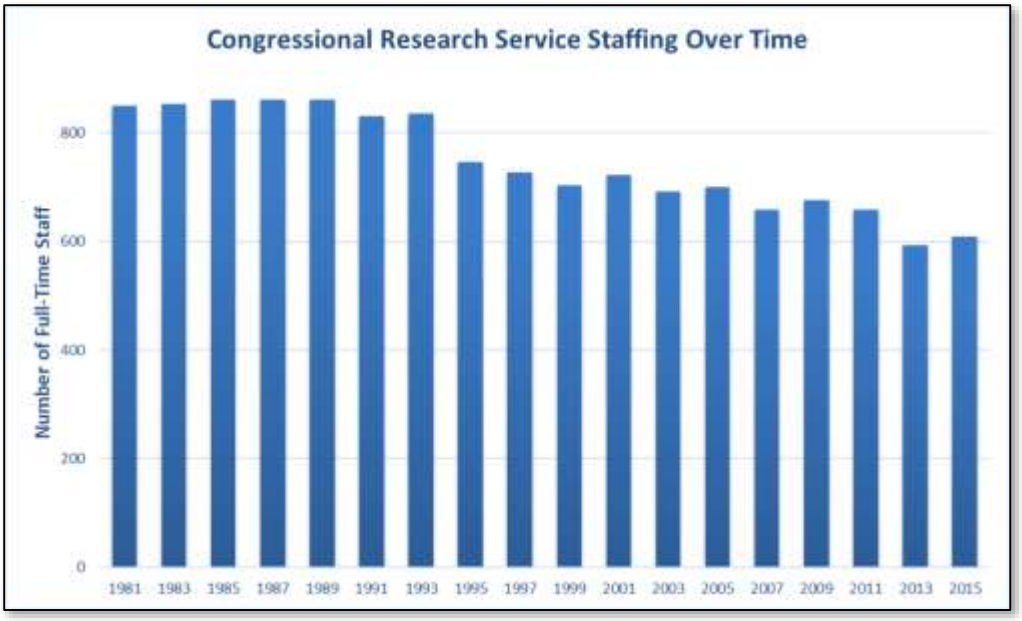

Figure 3 - (Source: Vital Statistics on Congress, The Brookings Institution. [Table 5-8])

Government Accountability Office

Congress has oversight of $4 trillion in annual federal spending across a large range of agencies. The Budget and Accounting Act of 1921 created the GAO to investigate all matters related to the use of public funds. The act also requires the GAO to report on their findings and recommend ways to increase economy and efficiency of government spending. From 1979 to 2015, the GAO's staff was cut by 44 percent, a loss of 2,314 positions, reflected in Figure 4 below.

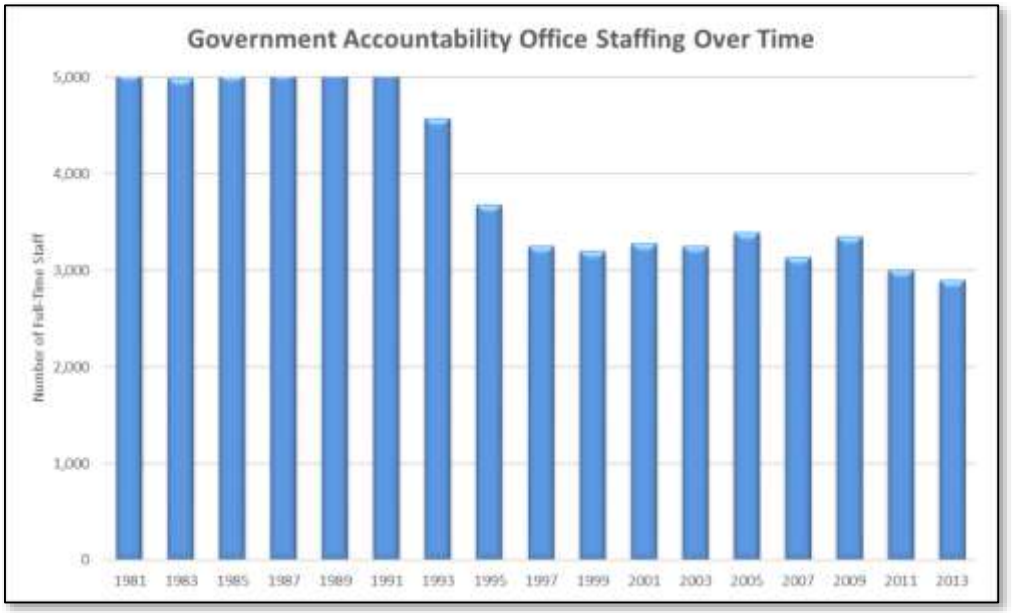

Figure 4 - (Source: Vital Statistics on Congress, The Brookings Institution. [Table 5-8])

Summary

Thus, as the Nation experiences accelerated S&T developments, certain indicators of Congress' ability to absorb, understand, analyze, and deal with the developments have declined. Chapter 3 examines what Congress needs to improve its readiness and understanding of S&T issues.

Chapter 3: Taxonomy of Congressional Needs

Members of Congress and their staff members (Congress) demand a vast array of products and services related to S&T. These diverse needs can mirror the varying backgrounds, interests, constituencies, and agendas of the 535 Members themselves.

This chapter presents a taxonomy of congressional needs for S&T advice and analysis.

Our Approach to Determining Congressional S&T Resource Support Need

As discussed in Chapter 1, the study team used a combination of direct and indirect approaches to determine congressional need. The indirect approach used key indicators to reveal environmental S&T trends, as well as trends in congressional capacity, in Chapter 2. This chapter is largely a product of our direct approach.

In our effort to understand and classify congressional needs, the study team used structured interviews with current and former Members and staff, along with technical experts providing advice to Congress.

As noted in Appendix B, the study team conducted interviews with personal and professional congressional staff members, as well as current and former Members. Additional interviews were conducted with close observers of Congress, from academia and research institutions across the country. [30]

The study team would have liked to conduct many more interviews, touching a larger cross-section of S&T-focused members and staff, S&T-oriented offices and committees, as well as individuals across Congress of both political parties. In its concerted effort, the study team reached out to dozens of additional offices. Notwithstanding the study team's substantial efforts, the study encountered noticeable challenges in securing time for discussions. In some cases, no response to a meeting request was received despite repeated attempts. In others, potential interviewees on the Hill said they were simply too busy to speak with the study team, even when the study team highlighted that the focus of the report was designed to assist the Congress in undertaking its responsibilities on behalf of the American people.

Almost every organization studying Congressional activities, including the Belfer Center whose report on congressional S&T capacity has been cited in this report, have encountered similar challenges in obtaining the direct views of those involved in the day-to-day of the Hill, whether securing interviews, in-person meetings, or responses to surveys. These challenges may not be so surprising, given how each individual congressional office can be extremely busy, as it balances

[30] In addition, panel members informally interviewed former OTA employees, NASEM and NAPA fellows, and scientists who have previously been research staffers.

unique and extensive responsibilities, and they speak to the Panel's concerns about the absorptive capacity of the Congress, which is addressed in Chapter 6 of this report.

It is important to stress that the quality of the dozens of interviews among current and recently retired members and staff was consistently high, plumbing the key aspects of Congress' needs for S&T advice, whether shortfalls, best practices, and potential areas for improvement. In working with the study team, which itself includes experience of former congressional staff members, the Panel members considered interview materials and findings with expert lenses that comes from decades of experience working with Congress. It was clear in that dynamic review process that a consistent narrative emerged that informed this research.

We also reached beyond the U.S. during our interview process. Since the end of the OTA, over a dozen countries have established technology assessment functions, many reporting directly to their Parliaments. We gathered information on their structure, budget and staffing, support functions, and reporting requirements and outputs.

In order to organize our insights from interviews with congressional consumers of S&T information, the study team constructed a taxonomy of congressional S&T demands. This taxonomy categorizes the type of S&T product or service required by Congress, the timeframe for delivery, and characteristics of the product or service. During the course of our work, the study team found broad agreement with this taxonomy of need among interviewees.

Congressional Needs for S&T Support

There are four general categories of S&T support that Congress requires in order to more effectively conduct its work: 1) quick-turnaround support, 2) networking, 3) consultative support, and 4) several types of detailed studies, including horizon-scanning reports. See Table 2, below, for a summary of these categories.

Category of Support	Summary of S&T Support Demand From Congress	Approx. Timeframe	Approx. Product Length
Quick Turnaround	Questions that require a prompt response with facts, figures, and descriptions; for example, a legislative correspondent working to respond to a constituent's inquiry or a brief overview of key S&T issues	one hour to three weeks	one to five pages
Networking	Access to a wide array of outside S&T experts embracing academia, industry, and non-profit segments	on-going	NA
Consultative	Readily available, consistent consulting with experts who provide more personal assistance to Members and staff, and can provide clear recommendations, if requested	on-going	NA
Report: Short-to Medium-Term	Studies and analyses of S&T trends that can be completed relatively quickly to allow critical issues to be addressed; detailed summaries of policy issues with original information gathered from stakeholders in all sectors, including government, nonprofit, and industry reports that lay out options to deal with the challenges or	one to twelve months	three to twenty pages

	leverage the opportunities; generally, peer-reviewed by outside experts		
Report: Technology Assessment	Detailed research into the impact of S&T trends and avenues to either mitigate the challenges or take advantage of opportunities; this type of study has a formal methodology that must be followed and is peer-reviewed by outside experts, going through a high degree of scrutiny before release	twelve to twenty-four months	fifty to 200 pages
Report: Horizon Scanning	Identifies emerging S&T technology trends and the opportunities and issues that might result from them in future	six to eighteen months	twenty to sixty pages

Table 2 - Taxonomy of Congressional S&T Support Needs

Quick Turnaround

All parties that make up Congress—Members, committee staff, personal staff—have a nearly constant stream of questions that require prompt responses. For example, a professional staff member from a committee might be drafting a piece of legislation for consideration and require confirmation of certain factual information. A legislative correspondent working in a Member's office might be trying to help his or her member respond to a constituent's inquiry that requires a response with facts, figures, and descriptions. A member could decide to deliver remarks on the floor, and thus, may need S&T information to provide broader context and details to enhance their message. Members may need background information for a vote on appropriations in areas like hypersonics or cyber. Written responses to Congress in response to these inquiries tend be no more than five pages, though these responses can often be longer.

When Members and staff ask for information, the deadline is often a matter of days, not weeks. Indeed, there is an "unending appetite" for this type of factual information and expeditiously developed policy reviews.

One particular aspect of quick turnaround advice called out in several interviews relates to education and orientation. Almost every legislative corner of Congress would like to expand knowledge of major S&T issues and trends that come before Congress. Such demand can abruptly materialize due to an outside event that drives an unexpected debate, amendment, or vote. Several congressional staff noted a regular stream of constituent visits to offices with requests for federal funding or legislative relief. Those staffers wanted to understand the underlying technologies or scientific principles on which these applications rest, while arranging for sit-down sessions for their Member to receive quick, but informative, briefings.

There is also a desire for an ongoing series of open education sessions by top experts on major, emerging S&T issues that come before Congress, such as autonomous vehicles, 5G communications, online privacy, and gene editing, whether in the form of hearings or floor debate. Several staffers expressed interest in detailed courses, almost like a university courses, that could cover these topics in much greater depth over a number of weeks.

Networking

There is a widespread demand for what the study team will call "networking" support. This term means assisting Congress in gaining access to outside S&T experts wherever they reside, including academe, industry, and non-profits.

Members and staff expressed desire to have ready access to leading authorities on the latest S&T issues of the day, whether to bring them in for hearing testimony or to ask for clarification. Instead of searching on their own to identify those individuals and finding contact information, they would like a single point that could provide this liaison connection. It would also be helpful, in the words of those interviewed, to have a standing roster of experts in various technological areas and scientific disciplines who are competent to respond to questions. Such a register would be more broadly available than an individual Member's contact list.

There is a desire to have key members of an expert network come together in-person to discuss critical S&T matters with staff and Members. Such sessions would provide Congress with varying perspectives from key communities that have knowledge of a particular S&T issue, identify areas of agreement and disagreement, and highlight potential sensitivities. These convened sessions could serve to enhance development of consensus on various options and ways ahead, potentially facilitating the passage of new policies through the legislative process.

Consultative

There is a strong desire to have readily available and consistent consultations with experts outside the Congress to provide assistance that is more personal to Members and staff. These individuals could help them understand trends, identify potential policy avenues, and think about potential options to take advantage of the opportunities and/or mitigate the harmful side effects connected with certain S&T issues. For example, key Members of one of Congress' science committees might decide to craft a piece of legislation after a hearing or a public occurrence brings an issue to light. In this instance, an expert might be brought in to help understand the main and second-tier impacts of various proposals. These "consultants" might also highlight issues previously unidentified. Members and staff expressed a desire to receive firm recommendations from those steeped in S&T, offering a "you need to do this," in the words of several Members and staff.

Several individuals interviewed talked about the need for a hyper-intensive form of S&T consultations similar to what the Joint Committee on Taxation[31] provides in the area of tax policy-making. This unique panel examines the fiscal impacts of various revenue proposals and provides very direct advice on how to achieve the expressed goals. The Joint Committee Staff is tied in at every stage of the tax-writing process, actually crafting and analyzing proposals, developing revenue estimates for tax legislation, legislative histories for tax-related bills. The Joint Committee is fully integrated in the process, providing specific consultations regularly as requested.

[31] More information on the Joint Committee on Taxation can be found at https://www.jct.gov/

Reports and Studies

In addition to quickly provided information, the capacity to link up with outside expertise and receive guidance on the way ahead, Congress also desires in-depth reports. Before crafting legislation that can reshape whole industries and touch the lives of every American, Members and their staff would like studies based on evidence and rigorous analysis that meets the highest professional standards.

Requests for studies usually come from congressional committees that have primary jurisdiction for formulating legislation and conducting oversight over a particular area of S&T. These reports often serve as the baseline guidance that shapes major legislation linked to S&T topics. The study team outlines several types of these high-demand, detailed reports, including Medium-Term Reports, Technology Assessments, and Horizon Scanning.

Short to Medium-Term Reports

Members and staffs request thorough studies and analyses of S&T trends that can be completed relatively quickly, in many cases well under a year, to allow critical issues to be addressed. Such reports, around three to twenty pages, would provide detailed summaries of policy issues with original information gathered from stakeholders in all sectors, including government, nonprofit, and industry. These types of reports lay out options to deal with the challenges or leverage the opportunities. They are generally peer-reviewed from outside experts.

An example of a topic for these medium-term reports might involve a sensitive realm like cyber-security. Congress has a desire to understand the basic technological problems, as well as legal, policy, and investment options to prevent compromise of Personal Identifiable Information (PII) in U.S. Government IT systems. A model for informative studies is the Parliamentary Office of Science and Technology (POST), the United Kingdom Parliament's S&T advisory office, which produces UK PostNotes, which are four to six page reports that can be based on twenty to thirty interviews and delivered in less than three months.[32]

Technology Assessments

Congress expressed a desire for extensive, in-depth reports known as Technology Assessments (TAs). TAs examine the impact of S&T trends and provide avenues to mitigate the challenges and take advantage of opportunities. This type of study has a formal methodology that must be followed. They are peer-reviewed by outside experts and go through a high degree of scrutiny before release. The rigid review requirements extend completion timelines, and it can take upwards of eighteen to twenty-four months to complete a single TA and can be over 200 pages in length.

TAs are requested by Congress when there are questions on a complicated topic, such as the potential effect of so-called space weather on the nation's electrical grid or whether there are more

[32] Examples can be found here: https://www.parliament.uk/mps-lords-and-offices/offices/bicameral/post/post-publications/postnotes/

sustainable ways to produce chemicals. Congress will commission a TA through the GAO to examine the underlying S&T issues to understand how they might affect daily life.[33]

Horizon Scanning

These studies identify emerging S&T technology trends and the opportunities and issues that might result from them. Horizon Scans anticipate what S&T issues might arise in the future and should incorporate broad developments and important innovations into the report. They try to capture all major breakthroughs and significant advancements across vast activity areas, making some predictions as to when these might develop.[34] Horizon Scans provide Congress with an oversight tool, allowing the Congress to scrutinize federal activities for whether they are either keeping ahead of emerging trends, or reacting to them. These reports also allow Congress to know whether it is postured to be successful in responding, whether in terms of its structure, activities, and agenda. Relative to the other areas of need, Horizon Scans are seen as less urgent though several staff and Members are fierce champions, using them to look ahead to what is coming. Horizon Scans, which can be twenty to sixty pages in length, typically require preparation time of six to twelve months. In the case of some technologies, horizon scanning may need to be maintained on an ongoing basis. However, to function as an effective early warning system, scanning needs to go beyond an episodic 'look ahead' and become a way of doing business.

Characteristics of Products and Services Needed by Congress

Just as important as the *type* of information that is provided to Congress, is the *way* it is provided. To have the most impact with Members and staff, our research indicates that the various products and services must have certain key attributes. These qualities were derived from extensive discussions with Members and their staffs, and largely comport with the observations of longtime advisors to Congress, like Peter Blair of the NASEM. [35] Products should be:

Authoritative and Competent

S&T information provided to Congress must come from recognized experts demonstrating a superior command of the topic, as this information can serve as a basis for writing legislation that affects Americans as well as potentially the global community. Congress only wants to take action based on information and analysis that is thorough and highly credible.

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[33] Timothy Persons et. al., *"Critical Infrastructure Protection: Protecting the Electric Grid from Geomagnetic Disturbances"*, GAO-19-98, Dec 19, 2018. https://www.gao.gov/products/GAO-19-98 and Timothy Persons et. al, *"Technologies to Make Processes and Products More Sustainable,"* GAO-18-307, Feb 2018. https://www.gao.gov/assets/690/689951.pdf
Technology Assessment: Artificial Intelligence: Emerging Opportunities, Challenges, and Implications GAO-18-142SP: Mar 28, 2018

[34] Sarah Grand-Clement, *"How Horizon Scanning Can Give the Military a Technological Edge,"* The RAND Blog, February 2019, https://www.rand.org/blog/2019/02/how-horizon-scanning-can-give-the-military-a-technological.html

[35] Fluitt, Aaron and Alexandra Givens, *Improving Tech Expertise in Congress: Time to Revive OTA?,* June 2018, https://georgetown.app.box.com/s/2dt0lq0tb6p7kqdf68c7plwewseg3hxs

Unbiased, Independent, and Non-Partisan

The information and analysis provided to Congress must not be seen as serving the political agenda of one party or another. Members and staff seek S&T input that is objective, independent, and not from sources that are funded by outside interests or advocates that may have a self-serving agenda.

Timely, Relevant, and Actionable

As our description of congressional desire for medium-term studies highlighted, Congress would like the various products and services to conform with its work calendar with relevant background, findings, and recommendations available relatively quickly as it drafts legislation. Similarly, Members and staff said the information must be timely, related to the topics that Congress is addressing, and actionable, providing concrete steps to enable actual measures.

Easy-to-Understand

Congress desires that S&T products be provided in a manner that is easy to understand for non-S&T experts, allowing extremely busy staffs and Members to quickly grasp key information and, sometimes, central recommendations. Our research revealed a desire for resource support containing substantive but short executive summaries of reports or background briefings. To be most useful, products and services should avoid jargon and be delivered in an understandable manner. This outcome can be achieved in a number of ways with graphics, plain language, and use of the right analogies.

Summary Observations and Findings

Congress requires a broad array S&T resource support, and no one segment of the taxonomy of needs presented in this chapter is more important than another is. Each product or service described contributes in a unique, but important, way to support the legislative process. That said, our research indicates that highest demand across the board in Congress is for quick-turnaround assessment, networking assistance, and consulting help. Separate from the large number of Members and staffs, our research indicates that certain Committees that remain central for formulation of legislation, like the Commerce, Science, Judiciary, Armed Services, and Agriculture committees have a high-demand for more detailed analyses and studies. This work can take years to complete. However, there is a clear need for work on S&T issues that can be launched, conducted, and completed in a shorter period more in line with the fast pace of the legislative session and the incredibly fast pace of change associated with S&T advances.

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Chapter 4: Inventory and Analysis of Current Resources

This chapter examines the mission, capabilities, and service delivery of the GAO and the CRS to assess the features, challenges, limitations, and merits of expanding the provision by these agencies of S&T policy analyses to the Congress. It includes an assessment of the number and skill sets of staff members at the agencies focused on S&T policy, the agency organizational cultures, and the potential for strengthening S&T assessment within the current organizational models of these agencies. The analysis also considers options that evolve from the current organizational structure, such as strengthening entities and reporting structures that provide S&T expertise and analysis within these agencies.

In addition to the GAO and the CRS, the study team briefly considers the NASEM. While NASEM is not a congressional agency, it is congressionally chartered to provide advice on science and technology-related issues and has provided S&T analyses to Congress in the past.

The study team then overlays the taxonomy developed in Chapter 3 to the analyses provided in this chapter in order to identify current gaps in S&T support to Congress. This gap analysis provides the basis for considering options and developing recommendations offered in Chapter 5.

Government Accountability Office

Overview

The GAO provides S&T support to Congress through written reports and other types of S&T products/services, including technology assessments, technical briefings, on-demand expert consultation, testimonies, and oversight of federal technology and science programs.[36]

The 2019 Legislative Branch Appropriations Bill Conference Report directed the GAO to expand its capacity to provide S&T support and reorganize its S&T function.[37] In January 2019, the GAO announced the creation of the Science, Technology Assessment, and Analytics (STAA) mission team. This new team has four functions:[38]

1. Technology Assessments
2. Performance Audits of Federal S&T programs

[36] U.S. Government Accountability Office, *GAO Science, Technology Assessment, and Analytics Team: Initial Plan and Considerations Moving Forward,* April 10, 2019.

[37] U.S. Congress, House, *Energy and Water Development and Related Agencies for the Fiscal Year Ending September 30, 2019, and for Other Purposes*, Conference Report to Accompany H.R. 5895, 115th Congress, 2nd Session, https://www.congress.gov/115/crpt/hrpt929/CRPT-115hrpt929.pdf

[38] U.S. Government Accountability Office, *GAO Deepens Science and Technology Capabilities,* January 29, 2019, https://www.gao.gov/about/press-center/press-releases/gao_deepens_science_tech.html

3. Best Practices Guides in engineering sciences (lifecycle cost estimating, schedule, and technology readiness assessment)
4. An audit innovation lab to explore advanced analytic capabilities

Figure 5 below presents the organizational structure of the GAO's STAA team.

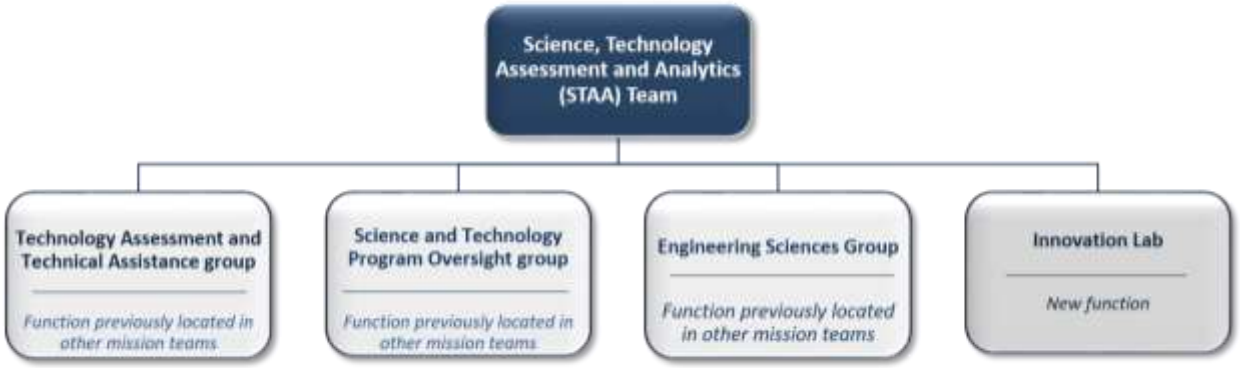

Figure 5 – GAO STAA Organizational Structure[39]

Source: Government Accountability Office

In April 2019, the GAO submitted a detailed public plan to Congress for establishing the STAA team.[40] According to the plan, this new team will utilize the GAO's existing staff from various disciplines (e.g., policy analysts, S&T experts, economists, statisticians, attorneys, etc.) across the agency. In addition, the plan includes hiring new staff to enhance its capacity. The goal is to increase the STAA staff to seventy Full-time Equivalent Employees (FTE) by the end of FY 2019[41] and double this number over the next two or three years.

This section provides a summary of the GAO's current S&T functions.

Reports

Technology Assessments

Over the past seventeen years, the GAO has produced eighteen TAs to provide Congress thorough analysis of critical scientific and technological issues. The GAO's previous TAs cover a wide array of topics. Some recent examples include *Critical Infrastructure Protection: Protecting the Electric Grid from Geomagnetic Disturbances* (December 2018); *Artificial Intelligence: Emerging Opportunities,*

[39] U.S. Government Accountability Office, *GAO Science, Technology Assessment, and Analytics Team: Initial Plan and Considerations Moving Forward,* April 10, 2019, pg. 15.
[40] Ibid.
[41] The GAO's ability to achieve this recruitment goal is contingent on adequate funding,

Challenges, and Implications (March 2018); and *Chemical Innovation: Technologies to Make Processes and Products More Sustainable* (February 2018).

In our research, the study team heard different views from stakeholders on the quality of the GAO's TAs. Some interviewees believe that, generally speaking, the GAO did a good job on TAs and could further expand its capacity in this area, while others argue that the GAO's TAs do not provide in-depth analysis of S&T issues in the same way that the OTA's reports did. There is no consensus among stakeholders on how to measure the quality of TAs, nor is there a clear articulation of the appropriate outputs and/or outcomes of a high quality TA.

Our analysis of the GAO's TA model focuses on three aspects: organizational culture, staff capabilities, and TA preparation processes.

Organizational Culture

An overarching concern about the GAO's TA model raised by stakeholders is the cultural differences that appear to exist between the GAO's traditional audit and program evaluation culture and the culture needed for effective TAs. Some stakeholders argue that while audits and performance evaluations tend to focus on, "principles and standards" and generally "look back" to assess the performance of a program or an agency, TAs require a more, "forward looking" mentality and, "an effective integration of technical and nontechnical considerations, and the creative identification, exploration and evaluation of alternative policy options."[42]

GAO officials are aware of stakeholder skepticism about whether the GAO can produce both high-quality audits and evaluations, and TA work. Those interviewed at the GAO, however, do not share such skepticism. They state that GAO's culture is "consultative"—i.e., the GAO works with congressional Members and staff to understand the type of oversight or programmatic research they need and employs a variety of methodologies to respond. These GAO officials emphasize that the agency has a proven record in taking on new tasks and responsibilities while maintaining the quality of the broad range of its work. As evidence, the GAO notes that, through the Budget and Accounting Act of 1921, the Agency was created to primarily focus on voucher auditing.[43] Over the decades, the agency's mission and responsibilities have changed significantly in response to evolving congressional and national needs.[44] A major mission shift in the GAO's history occurred in the early 1970s. At that time, the agency expanded its work to include program evaluation and analyses of a broad range of federal activities. To support these new functions, the GAO hired scientists, actuaries, policy analysts, etc.[45] The 2004 GAO Human Capital Reform Act changed the agency's legal name from the General Accounting Office to the Government Accountability Office, reflecting the agency's evolving roles and responsibilities.

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[42] Fri et al, *An External Evaluation of the GAO's Assessment of Technologies for Border Control*, pg. 17.
[43] U.S. Government Accountability Office, *GAO at a Glance*, January 2019.
[44] U.S. Government Accountability Office, *The History of GAO: Working for Good Government Since 1921*, pg. 1.
[45] U.S. Government Accountability Office, A*t a Glance*, https://www.gao.gov/about/what-gao-is/history/

While the GAO traditionally focused on oversight functions, the field of foresight work[46] is not a completely new field for the agency. GAO officials stated that, to achieve its mission of improving government performance and ensuring accountability, it is critical to provide valuable foresight to help Congress focus on long-term policy issues and encourage early actions to address them, as needed.[47] Goals to enhance foresight skills and capacity are identified in the agency's strategic plan.[48] The GAO has already performed foresight activities in a variety of policy areas. For example, in the fiscal policy field, the GAO developed fiscal models to provide reliable forecasting information to help legislators grasp the significant fiscal challenges facing the nation and the long-term implications of their policy decisions. Additionally, GAO's TA work has been forward looking and used a variety of methodologies and techniques, such as scenario based analysis and modified Delphi methods.

Staff Capabilities

The STAA staffs are currently tasked to work on both TAs, as well as the GAO's other engagements, including performance audits of federal S&T programs. Thus, the STAA's S&T experts produce TAs and provide support on S&T issues as part of the agency's oversight work. Several stakeholders expressed strong concern that, under this "shared-staffing" model, there is no guarantee that the GAO's TA work will receive sufficient resources and attention. During our meetings, GAO officials clearly acknowledged this potential challenge and indicated plans to develop policy guidance that prioritizes TA work and ensures timely delivery of high quality TA.

Our research indicates that TAs require a wide range of expertise, including S&T, social sciences, legal expertise, etc. The GAO interviewees noted that the agency's existing staffs have extensive knowledge and expertise in a range of social science disciplines. These staff will be available to STAA as necessary to support its methodologies and analysis. Efforts to bolster the new STAA team focus on recruitment of additional S&T experts. According to its FY2020 Budget Request, the GAO's recruitment plan focuses on five areas of expertise, including biological/life sciences, computer/systems/electrical engineering, applied math/statistics/computer science, nuclear physics, and physics/aerospace engineering.[49]

Some stakeholders have expressed concerns that the GAO does not have a strong reputation in the S&T community, and S&T experts do not always view the GAO as the most attractive employer. In response, GAO officials countered that the Agency does not have major challenges in hiring top S&T experts. According to the GAO's data, 48 percent[50] of the GAO TA staffs possess Ph.D. degrees in S&T

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[46] Foresight work—forward-looking work. GAO uses this term to describe its forward looking activities, such as TAs, horizon scanning, fiscal sustainability models, etc.

[47] Presentation by the Honorable David M. Walker, Comptroller General of the United States, *Focusing on Foresight,* July 28, 2006.

[48] U.S. Government Accountability Office, *Strategic Plan 2018-2023*, GAO-18-1SP, https://www.gao.gov/assets/700/690260.pdf

[49] U.S. Government Accountability Office, *FY 2020 Budget Request,* GAO-19-403T, February 23, 2019.

[50] Human resources data provided by U.S. Government Accountability Office.

fields. GAO officials emphasized that academic achievements (e.g., number of publications) are not the only qualification requirements for the STAA staff. Therefore, GAO officials said their recruitment efforts also consider that the ability to communicate effectively S&T information in a political environment and the skills to conduct complex, technically based policy analysis are critical to deliver high-quality TA. The GAO is also looking for staff members who can be objective on policy matters and are comfortable in a multi-disciplinary environment.

In addition to recruiting S&T experts, the agency has taken actions to develop stronger linkages with academic communities across the country and build a broader network that will allow the agency to draw on the most up-to-date S&T expertise. The GAO is particularly focusing on academic programs with a nexus between public policy and S&T, including at Arizona State University and Carnegie Mellon University. Also, the GAO is actively building collaborative relationships with Federally Funded Research and Development Centers (FFRDCs), such as the MITRE Corporation and the Institute for Defense Analyses among others, to leverage their expertise and networks.[51]

Some interviewees highlighted the importance of bringing in temporary staff and noted that the GAO, operating under its current policies, is obliged to follow strict government personnel policies and rules that do not allow flexibilities with respect to hiring experts in targeted fields on a temporary basis. Some observers suggest that the quality of work on TAs may suffer from these personnel constraints. However, according to GAO officials, the agency has the resources and mechanisms to bring in rotational or temporary staff (e.g., Intergovernmental Personnel Act,[52] fellows, post-doctoral researchers, etc.) to augment its S&T capacity. Based on our research, there seem to be no structural or organizational barriers that prevent the agency from recruiting external experts for short-term assignments to meet project-specific needs. The agency does not have a hiring plan for temporary S&T staff because the need for temporary staff is variable and driven by research topics and workload.

Process

In its plan for building the STAA team, the GAO compares its process for developing TAs with the process for developing audit-related products (see Appendix D). The GAO intends to use its existing Congressional Protocols for accepting and prioritizing TA requests from committees (i.e., the GAO primarily serves committee chairs and ranking Members). GAO officials note that the Congressional Protocols have proved effective in allowing the agency to interact effectively with Congress and protect the agency's ability to provide non-partisan, independent information and analysis.

TAs are developed based on extensive literature reviews, interviews with relevant stakeholders, and meetings and workshops with subject matter experts from government, universities, industry,

[51] U.S. Government Accountability Office, *GAO Science, Technology Assessment, and Analytics Team: Initial Plan and Considerations Moving Forward*, April 10, 2019, pg. 18.

[52] According OPM's rules, the Intergovernmental Personnel Act provides for temporary assignment of personnel between the Federal government and state and local governments, colleges and universities, Indian tribal governments, the FFRDCs and other eligible organizations.

and nonprofit organizations. Many stakeholders pointed out that the GAO's TA methodology appears very similar to its audit methodology. GAO officials explained that a TA is governed by the agency's existing Quality Assurance Framework, which is, "a standardized engagement management process that provides consistency in the application of key controls."[53] In essence, four process components are common to both TA and audits: 1) interacting with Congress, 2) assembling project teams, 3) defining project scope and methods, and 4) writing and reviewing final reports.

In seeking to distinguish between its TA and traditional audit work, the GAO emphasized a number of differences that set TAs apart from audits and performance evaluations. The TA work is not governed by the Generally Accepted Government Auditing Standards (GAGAS).[54]. The GAO's TA process is divided into four phases—1) initiation, 2) design agreement, 3) message development, and 4) external review. A key difference between the TA and the GAO's traditional audit work is that TA work requires external peer review. The GAO convenes a panel of external experts to oversee and ensure quality control for each TA. The expert panel is consulted early in the study process (i.e., the design agreement and message development phases) to help define the project scope and provide guidance on research methodology. These external experts also serve as peer reviewers of the draft report developed by the GAO staff. An expert panel typically consists of fifteen to twenty-five experts and is customized in its makeup for every study. Panelists are generally selected with assistance from NASEM. Panelists are drawn from a wide range of backgrounds, knowledge, and experiences that include not only S&T experts but also experts from social science and other disciplines relevant to the study, such as economics, finance, and criminal justice. The GAO's past TAs do not include policy options, but the agency plans to incorporate policy options and recommendations into its TAs when warranted to inform policy decisions.

The GAO is still in the process of finalizing its TA methodology framework (i.e., TA Handbook) that will outline the key concepts in designing and executing TAs. In this context, it is important to note that our research shows that there is no clear consensus among outside experts on what an ideal TA model should look like. The GAO is developing its TA methods and framework based on an extensive consultation with national and international experts from academia, industry, and other government entities and plans to make the draft handbook available for public comment by the end of calendar year 2019.

To help address stakeholder concern about a lack of access to external S&T expertise, the GAO has a standing contract with NASEM to leverage its network of experts for TA work (since 2002). The GAO is testing a partnership effort with the National Academy of Medicine (NAM) to produce co-branded TA products. NAM staff members, as well as external peers, will review these products.

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[53] U.S. Government Accountability Office, *GAO Science, Technology Assessment, and Analytics Team: Initial Plan and Considerations Moving Forward*, April 10, 2019, pg. 23.

[54] GAGAS apply to most of GAO's work (i.e., audits)

To engage external experts in its governance of S&T work, the GAO is establishing an advisory board of external experts from industry, academia, nonprofits, and government to focus on critical S&T issues.

Horizon Scanning

The GAO's existing horizon scanning efforts include the following components:

- The development of "Trends Affecting Government and Society" as part of the GAO's strategic planning process. The trends analysis is based on internal and external environmental scanning efforts.
- Continuous environmental scanning efforts (on a daily, weekly, and monthly basis) to develop plans to serve the Congress.
- Recent establishment of the Center for Strategic Foresight in the GAO to engage external experts in the GAO's horizon scanning efforts.
- Establishing various expert advisory boards and networks. For example, the Comptroller General Forums serves as an important mechanism to bring leading experts together to discuss emerging issues important to the nation and the federal government.

The GAO currently does not have in-house resources to systematically focus on horizon scanning work related to S&T issues for Congress. However, the agency's existing horizon scanning efforts provide a foundation to further expand capacity in this area.

Other types of S&T Resource Support

Quick-turnaround Support and Consultative Support

The GAO provides some quick-turnaround technical assistance through on-demand expert consultation, informal briefings, and support for hearings, testimonies, and quick turnaround research (without a written request), Congressional details, and other types of technical support. In the past, the GAO's quick-turnaround support and consultative support was provided on an informal basis and mostly connected with the agency's prior work/projects. According to GAO officials, the agency plans to expand its capacity in these areas.

The GAO is exploring new product formats to provide quick-turnaround support to Congress. For example, the STAA staffs are gearing up to produce one-page reports that focus on emerging technology issues and relevant policy context and questions. The GAO published a series of one-page reports (i.e., Science & Tech Spotlight) in September 2019.[55]

[55] GAO-19-704SP *Blockchain & Distributed Ledger Technologies*. https://www.gao.gov/assets/710/701363.pdf; GAO-19-705SP: *Hypersonic Weapons.* https://www.gao.gov/assets/710/701363.pdf; GAO-19-706SP: *Opioid Vaccines*.

Congressional Research Service

Overview

In 1914, Congress passed legislation to establish a separate department within the Library of Congress called the Legislative Reference Service to serve the legislative needs of the Congress. In 1970, Congress passed the Legislative Reorganization Act, which renamed the agency the Congressional Research Service (CRS) and significantly expanded its statutory responsibilities. Today, CRS provides Congress with research and analysis that is objective, nonpartisan, authoritative and timely. It does so through confidential consultative services for Congress and products that are published for general access on CRS.gov and Congress.gov.

CRS provides confidential consultative support to nearly every Member office and committee each year, handling 62,769 confidential requests in fiscal year 2018. Products and services provided on a confidential basis to Members and their staff in response to their requests include email and telephone responses, in-person briefings and consultations, and confidential memoranda. CRS employees are also available to testify before committees.

The Service also publishes a variety of products for general access on CRS.gov and Congress.gov that both prospectively identify potential issues and respond to emergent congressional interests. In fiscal year 2018, the Service published more than 3,000 new or updated products of this nature. Products written by CRS staff range from top-level overviews to in-depth analyses. Examples of these products include long-form reports, two-page executive level briefing documents, infographics, and timely updates on emerging policy and legal issues. The Service also prepared nearly 6,000 bill summaries in fiscal year 2018.

The agency employs about 600 staff, working in Washington D.C. Over 400 of the 600 staff are policy analysts, attorneys, and information professionals that work across a range of disciplines. This staff group is organized into five research divisions: 1) American Law Division, 2) Domestic Social Policy Division, 3) Foreign Affairs, Defense and Trade Division, 4) Government and Finance Division, and 5) Resources, Science and Industry Division. In addition, the Knowledge Services Group[56] responds to congressional requests and partners with analysts and attorneys to provide authoritative and reliable information for Congress. (See Figure 6 below, for the organizational chart.)

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https://www.gao.gov/products/GAO-19-706SP? ; GAO-19-707SP: *Probabilistic Genotyping Software*. https://www.gao.gov/products/GAO-19-707SP

[56] Library of Congress: https://www.loc.gov/crsinfo/research/div-ksg.html

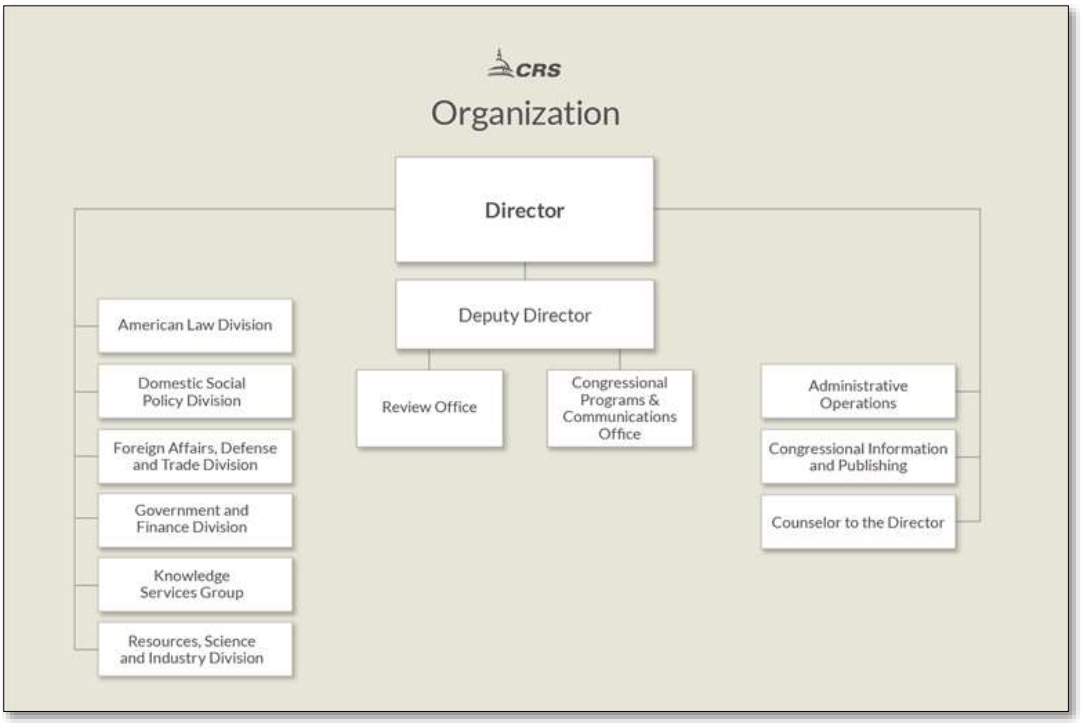

Figure 6 - CRS Organizational Chart (Source: Congressional Research Service)

In a fast-paced, ever-changing environment, the CRS provides Congress with analytical support to address complex public policy issues facing the nation. Its work incorporates expertise in programs and legislative processes, quantitative methodologies, public policy, and legal and economic analysis. The CRS is authorized to appoint specialists and senior specialists in many broad fields, including science and technology.[57]

The CRS first established an S&T function in 1964, called the Science Policy Research Division. The Division was disbanded in 1999 during an organizational realignment, and other units within the CRS absorbed its employees. Today, the Resources, Science, and Industry Division (RSI) is a key node in CRS's coverage of S&T issues. However, at least 3 other divisions do touch S&T topics during the course of their work.

Consultative and Quick Turnaround Support

The CRS specializes in consultative, quick turnaround support for the Congress. More specifically, CRS provides consultation and quick turnaround support on S&T issues. The CRS' work is delivered through many mediums, including over the phone, in-person, via email, and via confidential memoranda to specific congressional clients.

The CRS is intentionally designed to provide consultative and quick turnaround support equally to all congressional clients. Their organizational model is very flat, and the CRS entrusts individual

[57] *Congressional Research Service, U.S. Code § 166*.

analysts and specialists with significant autonomy and authority to make critical decisions in the process of responding to Congress.

Our research identified that a significant number of congressional jobs require quick turnaround analyses that summarize and synthesize specific issues (see Chapter 3 for a more detailed discussion of this support). These key congressional tasks include understanding a constituent's request, identifying important issues that may warrant congressional attention, assessing the credibility of technical information, and conducting policy analysis of potential legislative options. Many of these quick turnaround analyses for congressional consumers include a consultative component.

As noted, in FY 2018, the CRS produced approximately 62,769 pieces of custom analysis and research for congressional clients.

Figure 7 - Breakdown of CRS Custom Products and Services in FY18 (Source: Congressional Research Service)

Because the CRS's work in response to congressional requests is largely confidential, our analysis of the CRS' consultative and quick turnaround products and services was constrained. In light of this constraint, the study team organized its analysis of the CRS's consultative and quick turnaround work with regard to two key congressional tasks, as illustrated below. However, note that CRS performs a variety of other tasks and produces a wide array of products and reports, the scope of which go beyond that described in the two tasks below.

Key Congressional Tasks **Task #1: Assisting congressional clients with understanding a stakeholder's[58] request and position.**
The CRS will review material provided to congressional staff and offices and explain the different perspectives on that topic. However, the CRS does not make value judgments. Instead, the CRS assesses the credibility of the information against the scientific and technical consensus on an issue. **One common situation encountered by the CRS is when Congress initially requests a technical perspective on an S&T issue, but then needs to understand other decision-making factors like the underlying ethical or legal perspective. The CRS is well suited to adapt to these changing needs and can integrate across the organization to tap many different types of expertise to help Congress address issues. Common examples of this situation are questions about issues like gun control or the effects of smart meters. The CRS does not presuppose how the client will think about an issue; rather, the CRS team responds to each congressional client's particular request with the desired lens.[59]**
Key Congressional Tasks **Task #2: Conducting policy analysis of potential legislative options.**
The majority of the CRS's policy analysis of potential legislative options is provided to clients in confidential memoranda. CRS employees advised that they receive two general types of requests from congressional clients when asked to conduct policy analysis of potential legislative options. These two general types are illustrated by the examples below[60]: 1) **"I want to regulate a large technology company. How could I do that?"** 2) **"Here's how I want to regulate a large technology company. What would the positive and negative effects of that approach be?"** **In many situations, there is an infinite array of policy options that Congress could pursue. When analyzing or presenting potential options, the CRS weighs them against criteria like political will, feasibility, legal and regulatory basis, stakeholder backing, effectiveness, and potential impacts to narrow down the options. When conducting options analysis, its value increases dramatically as the number of options narrows.** **For analyses like these, the CRS is well positioned to understand the various positions and motivations of their congressional clients, because they are closely integrated into daily congressional operations and attuned to legislative rhythms. The CRS is also well suited to analyze the federal role and the extent to which Congress can address an issue.**

Table 3 – Key Congressional Tasks

[58] The general term "stakeholders" includes, but is not limited to, congressional constituents, policy advocates, the Executive Branch, and the broader congressional community.

[59] The CRS would not respond with the desired lens if that particular lens was partisan. CRS' work remains consistent with its core values of confidential, authoritative, and objective and nonpartisan.

[60] The CRS provides analysis on all types of issues, not just regulatory questions, as suggested by the two examples provided.

Reports and Other Types of S&T Support

In addition to its consultative and quick turnaround work, the CRS produces reports on S&T topics. The CRS' written work is provided in confidential memoranda that respond to specific request and through reports for general distribution to the Congress, which are made available to the public, through https://crsreports.congress.gov. The CRS does not perform formal Technology Assessment or Horizon Scanning.[61]

In FY 2018, the CRS produced 1,036 new reports and other general distribution products and issued updates to 1,994 existing CRS reports and products. They also produced 5,946 bill summaries in the Library Information Service at www.congress.gov.

According to interviews with CRS employees, they produce three general categories of reports.

1) A report on a topic that congressional clients have submitted multiple requests. In this case, CRS analysts and specialists will create a general distribution product for use as an entry point into a topic and as a reference point for clients on the Hill.
2) A report on a current issue or pending piece of legislation that is immediately relevant to the Congress, i.e., a natural disaster or pending Supreme Court decision.
3) A report on an issue that Congress will likely be interested in within the next two legislative cycles.[62]

Within these three general categories, CRS provides a wide array of products and reports with a variety of foci, including highly technical topics[63], broad overviews of S&T issues[64], and technology issues with wide, near-term impacts[65]. Since October 2018, CRS has authored and updated more than 150 products addressing S&T topics. Some examples of the topics and corresponding products include:

- Analyses of military use of emerging technologies. For example, *Navy Lasers, Railgun, and Gun-Launched Guided Projectile: Background and Issues for Congress* (R44175)
- Renewable electricity generation. For example, *Maintaining Electric Reliability with Wind and Solar Sources: Background and Issues for Congress* (R45764).
- Adoption of telehealth technology. For example, *Department of Veterans Affairs (VA): A Primer on Telehealth* (R45824).
- Impacts from the changing climate. For example, *Military Installations and Sea-Level Rise* (IF11275) and *Projected Economic Impacts of Climate Change* (IF11156)

[61] Although the CRS does not perform formal horizon scanning, they do perform some "anticipatory" work, wherein they look ahead in order to anticipate future congressional needs.

[62] There is not an explicit limitation as to the horizon, but the CRS only looks forward two legislative cycles.

[63] See *Life-Cycle Greenhouse Gas Assessment of Coal and Natural Gas in the Power Sector* (R44090).

[64] See *Science and Technology Issues in the 116th Congress* (R45491).

[65] See *Fifth-Generation (5G) Telecommunications Technologies: Issues for Congress* (R45485).

In addition to reports, the CRS also provides testimony[66], seminar series (for instance, on Disruptive Technologies.[67]) and other informal gatherings with congressional clients.[68]

National Academies of Sciences, Engineering, and Medicine

Overview

An Act of Congress, signed by President Lincoln in 1863, established the National Academy of Sciences (NAS) to provide independent, objective advice to the nation on matters related to science and technology. The National Academy of Engineering and the National Academy of Medicine (formerly known as the Institute of Medicine) were founded under the NAS charter in 1964 and 1970, respectively. The three member-elected academies work together as the NASEM to improve government decision-making and public policy, increase public understanding, and promote the acquisition and dissemination of knowledge in matters involving science, engineering, technology, and health.

To fulfill its mission, the NASEM delivers—largely through the National Research Council (NRC), which is NASEM's operating arm—a range of activities and products. The signature product of the NASEM is the "consensus study." These studies are characterized by a consensus of a panel of experts on recommendations regarding S&T related issues. Consensus studies are widely recognized as the gold standard for scientific and technical advice. The NASEM also provides access to expertise through a variety of convening activities, including workshops, roundtable and forums, standing committees, and expert meetings. Of these, only workshops result in a written product, and these products are limited to summarizing individual views expressed during the workshop. Only the consensus study may contain formal recommendations.[69]

The NASEM does not receive direct appropriations from the federal government. However, most of NASEM's projects are funded by the federal government, with most commissioned by federal agencies and a small percentage commissioned directly by the Congress. Their work extends

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[66] Consumer Data Security and the Credit Bureaus. Testimony included Potential Options for Congress, including, 1) Authorize a federal agency to examine for information security; 2) Regulate personal data collection and use; and 3) Require data transparency

[67] To assist Congress in determining how to respond S&T opportunities and challenges, CRS held a series of seminars for Congress (including a seminar on disruptive technologies), which drew on expertise from a variety of disciplines including foreign policy, science, and law. Seminar examples include: Understanding Blockchain Technology and Its Policy Implications, Autonomous Vehicles: Technology and Cybersecurity Issues, U.S. Military Use of Robotics and Automated Systems, Emerging Technologies and Electronic Warfare, Electric Vehicles: Federal and State Policy Issues, and Online Speech and Section 230 of the Communications Decency Act.

[68] For example, on January 31, 2019, the CRS hosted an open house on Science, Technology, and Innovation.

[69] See Blair PD (2016), *The evolving role of the U.S. National Academies of Sciences, Engineering, and Medicine in providing science and technology policy advice to the U.S. government.* Palgrave Communications. 2:16030 doi: 10.1057/ palcomms.2016.30.

beyond fulfilling federal government requests, into foundations, state governments, and the private sector.

Technology Assessments and Horizon Scanning

The NASEM has done some TA work; and in the wake of OTA defunding, the NASEM has been considered as a possible alternative source of technology assessment for Congress. However, observers are skeptical that the NASEM could serve as an alternative to OTA for two main reasons. First, the NASEM study process is focused on delivering consensus-based recommendations and is not well suited to developing and assessing policy options, especially those that may involve value judgments and social or economic trade-offs beyond the scope of technical analysis. Second, the NASEM is an independent entity external to Congress that must be engaged by contract. This is a lengthy process, which can often take as long as a year. In addition to the contracting process, congressionally mandated studies require inclusion in legislation or leverage existing authorizations or agency contracts.[70]

The NASEM has done some horizon scanning work in the past. However, NASEM's consensus-based process is not well suited to horizon scanning for the same reasons that it is not well suited to technology assessment.

Other Types of S&T Resource Support

In concluding our discussion on the NASEM, how the NASEM's work might address other categories in our taxonomy is discussed below.

Consultative

NASEM's consultative work with Congress is limited to in-person briefings to congressional staff and testimony on ongoing and completed studies.

Quick Turnaround

The NASEM seldom performs this kind of work.

Networking Services

As noted earlier, the NASEM provides access to expertise through a variety of convening activities. GAO has entered in arrangements with NASEM to leverage this capability. GAO has a contractual arrangement with the NASEM to provide access to experts to serve on panels for its technology

[70] These arguments are most fully articulated in publications by Peter Blair, the director of one of NASEM's seven study divisions and a former assistant director of the Office of Technology Assessment. See Peter D. Blair, *"Scientific Advice for Policy in the United States: Lessons from the National Academies and the former Congressional Office of Technology Assessment,"* In Lentsch, Justus and Peter Weingart (eds.), *Between Science and Politics – Quality Control in the Advisory Process*, London: Cambridge University Press, 2011. Similar points are made in a recent policy workshop on the subject of reviving the OTA. See: I*mproving Tech Expertise in Congress: Time to Revive OTA?* – Strategies for Improving Science and Technology Policy Resources for Congress – Report from June 2018 Policy Workshop.

assessments. Also GAO recently entered an arrangement with the NASEM that will allow for NASEM study staff to serve as external reviewers of future STAA products.

Chapter 5: Options and a Recommendation for Enhancing S&T Support for Congress

In this chapter, the Panel integrates and synthesizes their research to provide both options and a recommendation to address congressional demands. The Panel employs the research to identify categories of S&T support in demand by Congress using key indicators, congressional interviews, and expert interviews. The Panel overlays this taxonomy onto the inventory and analysis of the support currently provided to Congress by the CRS, the GAO, and NASEM in order to determine the gaps between current supply and congressional need for S&T support. Then, the Panel addresses the question of how to fill these gaps, while minimizing duplication.

Congressional Needs and the Supply Gaps

As discussed in the previous chapters, timely and expert S&T support attuned to congressional needs is more vital now than ever before as S&T issues become increasingly relevant to the Congress and congressional capacity to deal with those issues has declined. There are unmet congressional demands for S&T resource support not systematically met by the CRS and the GAO. More particularly, our research shows that the CRS' quick turnaround support and the GAO's TA function generally meet congressional needs in these areas. However, there is a modest gap in the areas of networking, consultative support, and medium-term S&T studies/reports. By "modest gap," the Panel indicates that congressional clients in these categories desire additional resource support. They also find a gap in S&T horizon scanning, and no existing agency expressly targets preparation of this category of support as a tailored, unique product. Table 4 below provides an overview of the four types of congressional S&T needs, the current providers, and supply gaps in each area.

Category of Support	Summary of S&T Support Demand From Congress	Approx. Timeframe	Approx. Product Length	Current Providers
Quick Turnaround	Questions that require a prompt response with facts, figures, and descriptions; for example, a legislative correspondent working to respond to a constituent's inquiry or a brief overview of key S&T issues	one hour to three weeks	one to five pages	CRS
Networking	Access to a wide array of outside S&T experts embracing academia, industry, and non-profit segments	on-going	NA	Modest gap
Consultative	Readily available, consistent consulting with experts who provide more personal assistance to Members and staffs who can provide clear recommendations, if requested	on-going	NA	Modest gap CRS, but desire for additional S&T consultation
Report: Short-to Medium-Term	Studies and analyses of S&T trends that can be completed relatively quickly to allow critical issues to be addressed; provide detailed summaries of policy issues with original information gathered from stakeholders in all sectors, including government, nonprofit, industry, and government; these types of reports lay out options to deal with the challenges or leverage the opportunities; they are generally peer-reviewed from outside experts	one to twelve months	three to twenty pages	Modest gap[71] with CRS and GAO seeking to respond
Report: Technology Assessment	Detailed research into the impact of S&T trends and provide avenues to mitigate the challenges and take advantage of opportunities; this type of study has a formal methodology that must be followed and are peer-reviewed by outside experts, going through a high degree of scrutiny before release	twelve to twenty-four months	fifty to 200 Pages	GAO
Report: Horizon Scanning	Identify emerging S&T technology trends and the opportunities and issues that might result from them in future	six to eighteen months	twenty to sixty pages	Gap

Table 4 - Congressional S&T Support Needs and Gaps

In this chapter, the study team examines potential solutions to improve congressional capacity by either enhancing the capabilities of an existing legislative branch support agency, such as the CRS or the GAO and/or creating a new one. In either case, actions should be taken to enhance S&T resource support to Congress.

[71] While the Panel notes a "gap" in this category, they recognize that both the CRS and the GAO offer medium-term resource support to Congress as requested. Even so, neither agency expressly stresses this segment of resource support as its principal focus, but rather as an ancillary focus in response to occasional demand. Thus, the Panel notes it this way.

Evaluative Criteria

Our assessment of potential options for meeting congressional needs employs the, "balanced breakthrough model."[72] The balanced breakthrough model is a commonly used innovation framework created by Larry Keely of Doblin, Incorporated. The model includes three key decision-making criteria: desirability, feasibility, and viability (see Figure 8 below). The fundamental premise of this model is that the most effective solutions are those that match what people desire with what is operationally feasible, and what is viable as a long-term solution.

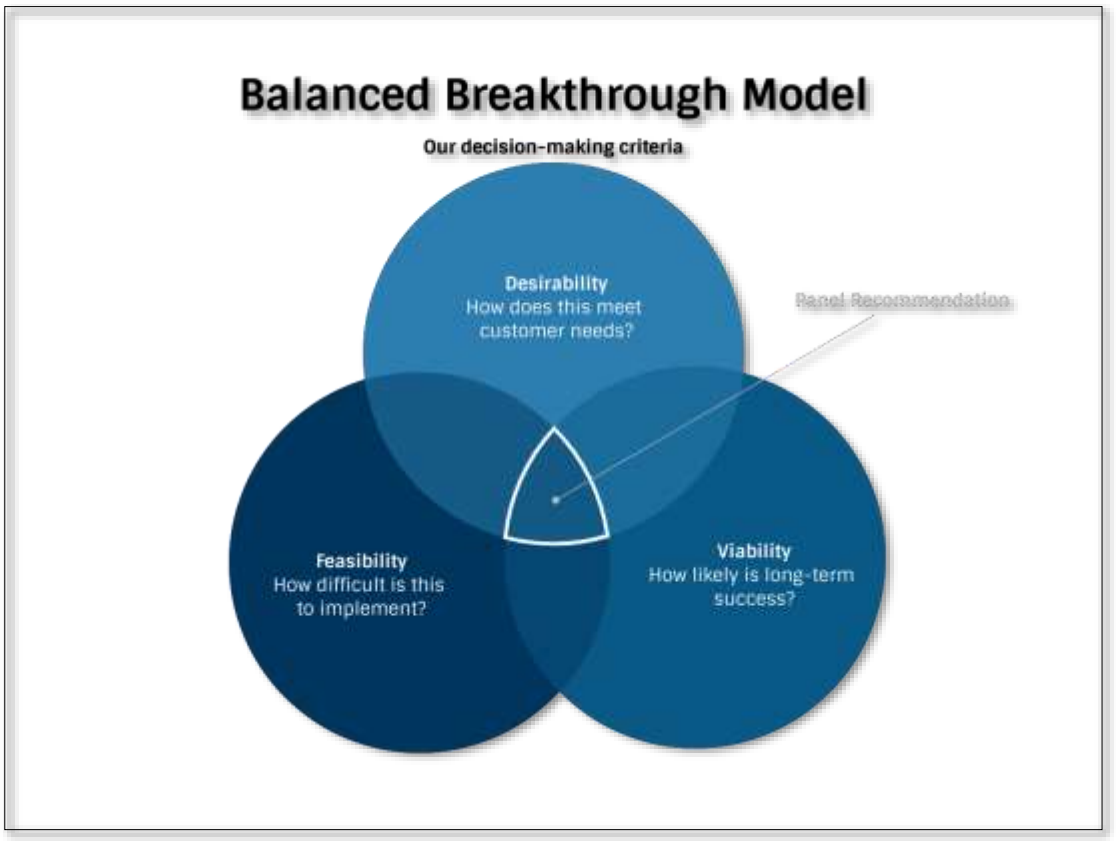

Figure 8 - Decision-making Criteria for Options

Based on the study team's research, the Panel elaborates on each of these three characteristics (see Table 5 below).

[72] McGaw, David and Zachary Jean Paradis, *Naked Innovation: Uncovering a Shared Approach for Creating Value*, September 2013.

	Key Decision-making Criteria for Options Analysis	
Feasibility	Start-up and Implementation Costs	
	Time to Full Implementation	
Viabilility	Political Durability	
	Duplicative Potential	
Desirabilty	***Capabilities***	Highly-trained experts in relevant fields, organized in interdisciplinary teams
		Effective mechanisms in place to bring in experts on a temporary basis
		Agile organizational design to adapt to changing congressional needs
		Balances daily short-term service with longer-term analysis and research
	Processes	A well-developed, transparent study process (technology assessments)
		Enhanced mechanisms for study/service initiation funding and administration
		Closely integrated into the legislative process
	Stakeholder relationships	Strong reputation within the S&T community and access to authoritative expertise
		Strong reputation in Congress as a credible, objective, and nonpartisan resource

Table 5 - Key Decision-making Criteria for Options Analysis (Source: National Academy of Public Administration)

Feasibility

A key aspect of our analysis is assessing the difficulty of implementation of potential solutions. Because the scope of potential solutions is so broad, the Panel emphasizes the importance of implementation. This criterion emphasizes the practicality of the solution. Key questions used to understand the feasibility of a potential option include:

- What are the potential start-up and implementation costs?
- What is the likely length of time to full implementation?

Viability

Congress and its various operating entities must weather regular political shifts, changing policy priorities, and funding uncertainties in order to be successful. The Panel believes that potential solutions should be able to remain durable despite external developments and political shifts. Key questions used to understand the viability of a potential option include:

- Is this solution politically durable?
- How likely is this solution to duplicate existing resources?

Desirability

As noted in Chapter 1, our analysis focuses on identifying and formulating demand-driven solutions—solutions that meet what congressional staffs and Members have described as their most pressing S&T research support needs. Desirability means: how well does this potential solution meet customer needs? By using desirability as one of three decision-making criteria, our analysis favors options that best address Congress' needs. While the study team posed several questions in their research with the aim to hone in on how best to meet congressional needs, a few key questions used to understand them include:

- Does this solution have the capability to provide S&T support?
- Does this solution have effective processes in place to provide S&T support?
- Does this solution have a strong reputation on the Hill and within S&T communities?

As an essential feature of our review of desirability in this model, the Panel began by reviewing research findings connected with the characteristics and features of a solution that will be well suited to fulfill congressional demands for S&T support, particularly as related to the identified gaps in our taxonomy. These characteristics and features were amalgamated from interviews and documentary research, and reflect several dimensions of how a successful agency might operate in order to fill S&T gaps for Congress.

While the Panel believes all three decision-making criteria are important, greater weight is placed on "desirability" in the overall decision-making process. The Panel takes this view because the overall outcome of our recommendation should be to maximize S&T support resources available to Congress, providing a comprehensive solution that enhances the likelihood of a successful outcome.

Potential Options and Analysis

In preparing a recommendation, the Panel developed and assessed three options. These options follow in part from the common-sense logic of the project tasking. This tasking includes: (1) assessing whether identified gaps can be addressed by enhancing the capabilities of existing legislative entities; and (2) assessing the pros and cons of creating a separate entity, with attention to avoiding duplication of effort. The three options are:

1) Enhance Existing Entities: The Panel assessed the effectiveness of enhancing the capabilities of existing legislative branch support agencies, examining potential improvements to current models.
2) Create a New Agency: The Panel assessed the creation of a separate, new agency to fill any existing gaps, with attention given to avoiding duplication of effort.
3) Enhance Existing Entities and Create an Advisory Office: The Panel examined a third option that called for both enhancing existing entities and addressing an "absorptive capacity" gap in Congress by creating an S&T advisory office, led by a Congressional S&T Advisor.

Finally, regardless of which option Congress adopts, the Panel recommends that there be an independent, non-partisan evaluation of the results observed from the chosen solution twenty-four months after implementation. This review should focus on the effectiveness and efficiency of taking the particular actions.

This section provides a description and assessment of each option based on the balanced breakthrough model described above. Our analysis examines the feasibility, viability, and desirability of each option. The Panel evaluates the options by assigning, for each criterion, one of

three levels of performance—high, medium, or low.[73] Table 6 shows how the Panel considers each performance level in this study.

Evaluative Criteria	Performance Levels	
Feasibility • Start up costs • Time to Full Implementation	High	• Relatively low potential start-up and estimated implementation costs (up to $1-2 million) • Short implementation time (up to one year)
	Medium	• Modest start-up and implementation costs (up to $8-10 million) • Modest implementation time (between 12 and 24 months)
	Low	• High potential start-up and implementation costs ($10 million or more) • Long implementation time (more than two years)
Viabilility • Political durability • Duplicative Potential	High	• Structured in a manner that could stand political opposition (e.g., perceived bias, budget, complexity of governance) • Less potential for duplication of effort (e.g., fewer entities work in the S&T field; limited additional efforts to coordinate the activities of multiple entities will be required)
	Medium	• Structured in a manner that introduces political vulnerability • Greater potential for duplication of effort
	Low	• Structured in a manner that appears to be vulnerable to political oppostion • Significant potential for duplication of effort (e.g.,multiple entities work in the S&T field; substantial additional efforts to coordinate the activities of multiple entities will be required)
Desirabilty • Staff capability • Effective process	High	• Strong staffing capability and well-developed processes to provide S&T support • Strong reputation in Congress and within the S&T community
	Medium	• The solution seems promising to be able to provide strong S&T support and shows potential to provide good support; no major inadequacies in staffing capacity or processes • Some concerns among stakeholders exist
	Low	• Lack of high-quality staff • Lack of effective processes • Lack of strong reputation in Congress or within S&T communities

Table 6 – Performance Levels

[73] Before commencing with an assessment of the three options, the Panel needs to comment upon a unique and challenging feature of one of the three options. Option #2 introduces a theoretical construct into the analysis, as the "new agency's" performance (since it does not exist yet) is not observable. Refunding "OTA," called the "new agency," is a future action. There are several significant uncertainties presented. First, there are inherent difficulties embedded in starting a new agency. Second, there is no way to ensure that quality controls in the new agency will be in place to ensure high quality performance of it in the future. Given these and other uncertainties, the Panel nevertheless decided to make the basic assumption that a newly created agency might be able to perform at a high level. The Panel deems this reasonable, if not even generous, under present circumstances. However, with respect to the other two criteria—involving feasibility and viability—the Panel deems there are some existing bases of consideration that can inform their decision-making. As such, the Panel is able to take into account some existing factors when determining one of the three performance levels for these.

In Table 7, the Panel provides a summary of the analysis that follows for the three options.

	Options Scorecard		
	Feasibility	Viability	Desirability
Option #1 – Enhance Existing Entities	High	High	Medium
Option #2 – Create a New Agency	Medium	Low	High
Option #3 – Enhance Existing and Create an Advisory Office	Medium	High	High

Table 7 - Options Scorecard

Option 1—Enhancing Existing Entities

Describing Option 1

Under Option 1, the CRS and the GAO are the primary support agencies that could enhance Congress' capabilities to engage in complicated S&T matters. This option has three key components. First, the GAO expands its delivery of S&T support to Congress via written reports, including TAs, medium-term reports, and horizon scanning. The GAO would use the same Congressional protocol that it does for its audit-related work to ensure committees have adequate support. Second, the CRS continues to provide quick turnaround support and consultative support for all Members and staffs of Congress. Third, the GAO works with NASEM to build S&T advisory networks to support Congress. The following section provides an overview of how both the CRS and the GAO might expand their current capacity to respond to all four areas of congressional S&T demands identified in Chapter 3.

Reports

In this option, the GAO would focus on both long-term and short-to-medium-term S&T studies and analysis, including but not limited to, TAs that are critical for congressional committees to conduct business. To enhance its capabilities to produce quality S&T studies and analysis, the GAO should:

- establish a separate team within the STAA to focus on foresight work (e.g., TAs and medium-term reports);
- expand the peer review process for TAs to engage stakeholders and gain support from S&T communities;
- receive authority and develop capability to explore innovative network models to more quickly produce work for Congress, engaging with outside networks to leverage external expertise, like the FFRDCs and universities; and
- engage national and international experts in developing its methodology for improving medium-term S&T studies.

Additionally, the GAO should build on its existing efforts to develop S&T horizon scanning capacity. The GAO should, in close coordination with NASEM, produces an annual horizon scanning report for Congress to identify emerging S&T trends and potential policy implications.

Quick turnaround and consultative support

The CRS should continue its on-going efforts to strengthen and expand S&T resources to provide quick turnaround and consultative support to all Members and staffs of Congress. One potential opportunity to strengthen the CRS' S&T support would be to enhance awareness of the agency's capabilities on the Hill and better highlight the nature and quality of CRS products provided to congressional clients. Additional resource support from Congress will be important to help the CRS drive continuous improvement in providing these important S&T support services.

In this option, the GAO also provides some quick turnaround and consultative support to Congress on topics related directly to its prior work, with close collaboration with the CRS to avoid duplicative efforts.

Networking

The GAO and the CRS should work closely with one another (in consultation with NASEM) to provide a range of services (e.g., arranging and facilitating meetings, organizing briefings, or offering trainings) to ensure that Congress has reliable, timely access to outside S&T experts.

Assessing Option 1

Feasibility (High)

The feasibility of Option 1—enhancing the capability of existing legislative branch entities—is high. As noted earlier, Congress directed the GAO to develop a plan for expanding its work on S&T issues,[74] and GAO launched a new STAA team dedicated to providing S&T support earlier this year. The GAO provides a range of S&T products and services to Congress. In Chapter 4, the report provides a detailed analysis of the GAO's existing products and services, and our research does not suggest any significant problems with the GAO's S&T functions. Similarly, the CRS has long experience in providing quick turnaround and consultative S&T support to Congress. Both the GAO and the CRS have established the basic structure to offer S&T support to Congress. With additional resources, this approach would provide a cost-effective, politically expedient option to meet the S&T needs of Members of Congress and congressional staff.

Viability (High)

The viability of Option 1 is high. The Panel believes that elements of political opposition that led to the demise of the OTA in 1995 may still exist. Thus, this approach would be less vulnerable to political challenges. It could furthermore render greater protection from future political cost-cutting or changing S&T concerns and priorities in Congress. The GAO and the CRS, as existing

[74] U.S. Congress, House, *Energy and Water Development and Related Agencies for the Fiscal Year Ending September 30, 2019, and for Other Purposes*, Conference Report to Accompany H.R. 5895, 115th Congress, 2nd Session, https://www.congress.gov/115/crpt/hrpt929/CRPT-115hrpt929.pdf

agencies with strong reputations, can serve to insulate these functions and activities in established entities that currently enjoy broad-based support. The CRS and GAO have existing processes in place to coordinate and limit duplication of efforts, but as the GAO expands capabilities these processes may need to be enhanced.

Desirability (Medium)

As discussed in Chapter 4, the GAO and the CRS have demonstrated their ability to support Congress on critical S&T issues in a non-partisan, useful manner. First, the Panel finds that the CRS' present model to provide quick turnaround S&T support and consultative support generally meets important congressional demand in these areas. A key strength of the CRS is its immense knowledge of legislative process and history. The CRS has a strong reputation for being responsive to congressional requests. As CRS officials emphasize, most of the congressional requests to the CRS have a tight timeframe, and they aim to never miss a deadline or ignore a request from Congress.

Chapter 4 provides a detailed analysis of the GAO's current S&T functions. The Agency is committed to enhancing its capacity to meet the needs of Congress in a variety of ways. The GAO STAA team's existing staffs include engineers, chemists, physicists, environmental scientists, and geologists, [75] and the agency provided its recruitment plan to bring in additional experts in various S&T disciplines. The GAO has the mechanisms in place to hire temporary staff to meet project-specific needs and plans to explore additional recruitment flexibilities and authorities. Regarding its processes, the GAO is refining its TA methodology framework based on an extensive engagement with external experts. The GAO relies on its existing Congressional Protocol for accepting and prioritizing TA requests from committees. Moreover, in the audit realm, the GAO has a strong reputation on the Hill for the quality of its work and has taken actions to increase its capacity to conduct S&T work, including TAs.

While our research did not find any major inadequacies in the GAO's and CRS' current models, there are a number of concerns among stakeholders about whether these two agencies are adequately equipped to meet the increasing congressional demand for S&T support. For example:

- There is no consensus on whether oversight work (i.e., audits & program evaluations) and foresight work (e.g., TA) can co-exist successfully in one agency. Some stakeholders have concerns that the GAO's traditional audit culture poses a significant challenge to building requisite S&T capacities. While the study team did not find the two functions incompatible, it will take time for the GAO to build the reputation as the "go to" place for S&T questions and advice.
- Under its existing Congressional Protocol, the GAO primarily serves committee chairs and ranking Members. As some stakeholders point out, the GAO's services are not easily "accessible" to many Members (especially junior Members). The ability to initiate new work

[75] U.S. Government Accountability Office, *GAO Science, Technology Assessment, and Analytics Team: Initial Plan and Considerations Moving Forward*, April 10, 2019.

is primarily reserved for committee chairs and ranking members due to resource constraints.[76]

Option 2—Creating a New Agency

Describing Option 2

Figure 9 – Description of Option 2

A key feature of Option 2 (visualized in Figure 9 above) is establishing a new, separate congressional entity to perform functions to fill the identified gaps (i.e., medium-term S&T analysis and studies, horizon scanning, and networking). In addition to this new entity, under this option, the GAO would continue to provide long-term studies (i.e., TA) to support congressional committees, and the CRS would continue to offer quick turnaround support and expert consultation to all congressional clients. The following sections provide an overview of how this new entity, the CRS, and the GAO might work together to address congressional demand for S&T resource support.

Reports

In this arrangement, the GAO's STAA team should continue to produce TAs to strengthen Congress' ability to deal with complicated S&T issues. In order to further enhance its TA model, the GAO should:

- establish a separate team within the STAA to focus on TAs;
- expand the peer review process for TAs to engage stakeholders and gain buy-in from S&T communities; and
- explore innovative network models to more quickly produce work for Congress. The GAO should have the authority and capability to engage out to networks and leverage external expertise like the FFRDCs and universities.

In this option, a new agency would be established to focus on medium-term S&T studies and horizon scanning studies for Congress. This new agency would serve all Members and staffs of Congress.

[76] GAO's work is available to all congressional clients via the Agency's website. GAO's reports are posted to the website, and there is a "find an expert" link on the website that gives contact information for GAO executives and their areas of specialization. In addition, GAO staff are available to brief Congressional Members and staff on the Agency's past work and areas of general expertise. Moreover, GAO also has interactions with Members when Agency executives testify before their committees.

Quick turnaround support and Consultancy

Similar to our discussion on Option 2, the CRS should strengthen its S&T related capabilities and continue to provide quick turnaround support and consultative support to all Members and staffs of Congress. One potential opportunity to strengthen the CRS' S&T support would be to enhance awareness of the agency's capabilities on the Hill and better highlight the robust products it provides to congressional clients.

In this arrangement, the GAO and the new entity also provide some quick turnaround support and on-demand expert consultation to Congress on topics related directly to their prior studies.

Networking

The new agency should take the lead in creating and maintaining an advisory network of experts who would be readily available to provide S&T assistance to Members and staff. This new agency should work with the CRS, the GAO, and NASEM to hold regular conferences around vital topics to help Congress engage S&T experts.

Assessing Option 2

Feasibility (Medium)

There is a long-standing debate among stakeholders about whether and how to build the S&T support function for Congress. There have been various legislative attempts to re-fund the OTA or establish a new organization since the OTA's demise in 1995; however, progress has been very slow. While a proposal to restore the OTA has recently gained momentum through support from some stakeholders, there are a number of interviewees who were either not convinced that a new agency's creation is optimal, or who outright opposed re-establishing an "OTA." After all, it is still challenging to gather sufficient resources and political support to establish a new entity, especially in the current political and fiscal environment. It is both costly and time-consuming to stand up a new organization with highly qualified staff and policies of operation to readily and effectively address congressional demands.

Viability (Low)

A new organization would have similar vulnerabilities that led to the dis-establishment of the OTA. A new entity would provide important information/services to support Congress. However, such services are not essential for legislators to actually craft legislation, because Congress has multiple sources for S&T information/analysis already and can move legislation forward without a new agency.[77] According to some interviewees, the OTA's reports were not critical parts of the legislative deliberation and decision-making processes during its existence. A new agency conducting helpful but not essential work would struggle to integrate into the day-to-day legislative activities of Congress, and thus could result in questions of relevancy and leave it potentially vulnerable to political challenges. Moreover, given that three agencies would be simultaneously

[77] The report provides some examples of entities that provide essential work for Congress: The Budget Committee cannot complete the annual budget resolution without CBO analysis, while tax legislation cannot move forward without the Joint Committee's involvement and input.

working in the S&T space, there is a greater potential for duplication of effort, unnecessary overlap, and competition for resources.

Desirability (High)

As noted at the outset, our assumption is that a new agency can perform at a high level with respect to all desirability criteria. This option—having an agency exclusively dedicated to providing S&T support—would help address stakeholders' concerns about the CRS' and the GAO's abilities to respond to congressional S&T needs in a timely manner. This new entity could recruit directly from top universities and research organizations and therefore have a stronger connection with S&T communities. Furthermore, creating a dedicated S&T entity would have symbolic value. Such an effort would show that Congress is committed to understanding and finding solutions to the complicated science and technology trends currently underway.

Option 3—Enhance Existing Entities and Create Office of the Congressional S&T Advisor

Describing Option 3

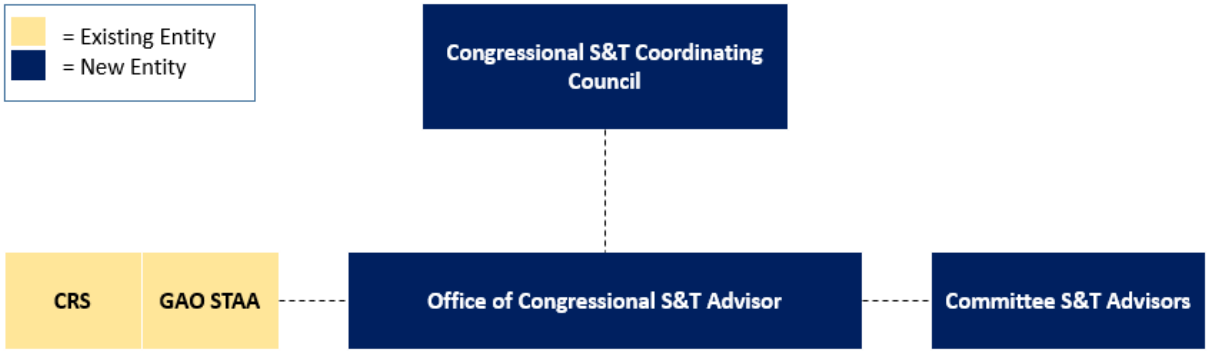

Figure 10 – Description of Option 3

Option 3 has four key components (visualized in Figure 10 above).

1) Congress entrusts the CRS to continue to provide its quick-turnaround and consultative services and provides resources to enhance and expand the S&T support work it already does.
2) Congress entrusts the GAO to expand its S&T support functions to further develop the STAA's capability to meet some of the supply gaps identified in this report (i.e., TA, short-to-medium term reports, and networking), along with providing GAO the requisite resources to do so. Additionally, the GAO makes the appropriate changes in its organization and operating policies to accommodate unique features of TA and other foresight work.
3) Congress creates an Office of the Congressional S&T Advisor (OCSTA) to focus on efforts to build the absorptive capacity of Congress, including supporting the recruitment and hiring of S&T advisors for major committees. Every major committee should have at least one S&T

advisor with the expertise to support policy making activities. OCSTA will also be responsible for S&T horizon scanning.

4) Congress creates a Coordinating Council to be led by OCSTA and include representatives from the GAO, the CRS, and the NASEM with the objective to limit duplication and coordinate available resources to most benefit the Congress.

The GAO's STAA team should focus on both TA's and short-to-medium-term S&T studies and analyses. To enhance its capabilities to produce quality S&T studies and analysis, the GAO should:

- Establish a separate team within the STAA to focus on foresight work (e.g., TA and medium-term reports);
- Expand the peer review process for TAs to engage a wide group of stakeholders and gain broader support from S&T communities;
- Explore innovative network models in preparing reports to Congress that allow for accelerated work products for Congress. The GAO should have the authority and capability to reach out to networks of experts and leverage external expertise, like the FFRDCs, universities, and other groups; and
- Engage national and international experts in developing its methodology for preparing medium-term S&T studies.

The GAO should work closely with the CRS and the NASEM to provide networking services to ensure that Congress has reliable, timely access to external experts when needed.

In addition to enhancing the GAO's capacity to provide S&T support, in collaboration with the CRS, Congress should establish an Office of the Congressional S&T Advisor (OCSTA) that would serve both chambers. A Congressional S&T Advisor (Advisor), jointly appointed by House and Senate leaders, should lead OCSTA. The Advisor would hire a small team of experts to staff the OCSTA.

The OCSTA's mandate would be to serve as Congress' S&T capacity-builder. Its key duties would include:

- Liaise with a wide variety of stakeholders, including those from the private sector, the Executive Branch, associations, academia, and other S&T representatives and entities both domestic and foreign;
- Serve as Congress' S&T ombudsman, coordinating disparate pools of S&T expertise within the Congress and outside the Congress, like the AAAS and TechCongress fellowships (discussed further in the next chapter);
- Support congressional committees in recruiting and hiring their own S&T advisors, including providing assistance in interviewing candidates and providing funding from a centralized pool; and
- Perform ongoing S&T horizon scans for Congress and develop an annual horizon scanning report. OCSTA should have the authority and resources to conduct horizon scanning studies through a contract with external experts/organizations.

The OCSTA would not have the authority to direct the work of the GAO and the CRS, though emerging issues identified by OCSTA would be shared with both organizations. Additionally, the OCSTA should be physically located in the Capitol.

The Panel identified a number of key characteristics and features that this new Office should prominently reflect:

- Operate in a nonpartisan manner;
- Maintain agile working methods;
- Foster coordination among various S&T actors in the congressional environment;
- Enhance the leverage of S&T resources within the Legislative Branch; and
- Provide a visible point of access for external stakeholders who seek to engage the Congress on S&T issues.

Part of the OCSTA's job would be to support the recruitment and hiring of S&T advisors for House and Senate committees with major S&T components. This idea stems from our view that major congressional committees should have one or more S&T advisors with the requisite expertise to identify important S&T intersections with, and implications for, public policy. These expert advisors could provide the networking, consulting, and quick turnaround types of S&T resource support that make up the resource gap discussed in Chapter 3. In addition, these individuals can help ensure long-term studies are structured in the optimal way. The OCSTA's budget would compensate these advisors, and they would be detailed to congressional committees.

Finally, Congress should create a Congressional Science and Technology Coordinating Council (Council) to coordinate legislative S&T support efforts, limiting duplicative work. The Council should be led by the Advisor and include representatives from the GAO's STAA, the CRS, and a NASEM Ex Officio member. The Council should meet quarterly to maintain an environment where Congress is supported as effectively as possible.

Assessing Option 3

Feasibility (Medium)

While Option 3 looks similar to Option 1 (with the GAO and the CRS responding to congressional S&T resource needs), feasibility is graded as medium (rather than high, as in Option 1) because creating a small, advisory agency in the Congress, such as the OCSTA, will require Congress to legislate, appropriate new funding and hire an S&T Advisor. This is likely to be challenging given the current congressional environment, but it should be less difficult than creating an entirely new agency as in Option 2.

Viability (High)

As noted in Option 1, our analysis indicates that the viability of enhancing the CRS and the GAO is high.

Our analysis indicates that the viability of establishing a small, advisory agency for the Congress, such as the OCSTA, should be evaluated as high. Bearing in mind that congressional needs frequently change, a new agency must be agile and adaptive to those needs. Therefore, an advisory office with a small staff focused exclusively on S&T issues is likely to identify and address these needs and would be well positioned to connect congressional staff with disparate S&T resource support.

The OCSTA would drive enhanced visibility of congressional S&T efforts. With the creation of the Coordinating Council, it would foster opportunities for collaboration and limit duplication of efforts between the CRS and the GAO.

Desirability (High)

Our analysis indicates that combining enhanced product development at the GAO with an advisory body within Congress to build S&T capacity is highly matched to congressional needs.

A significant driver of Congress' S&T capacity deficiencies stem from poor absorptive capacity and technical literacy, which is compounded by some supply gaps. Because of this, pairing enhanced product development with an advisory body within Congress will be more likely to solve daily congressional demands.

In addition, horizon scanning is identified as a critical function that allows Congress to identify S&T issues that might arise in the future and have significant policy implications. No agencies/organizations currently provide this type of support to Congress. Under Option 3, OCSTA fills the gap to provide horizon scanning, and this arrangement would significantly increase the visibility of S&T issues facing the Congress'. An annual horizon scanning report would be produced with wide distribution to the Congress, industry, academia, and others with an interest in emerging S&T issues and policy.

Panel Recommendation

Based on the analysis provided above, the Panel recommends that Congress implement Option 3. It has four key components which we collapse into three parts of a Panel recommendation. This approach addresses both parties that make up the challenging environment analyzed in this report: providing resources to Congress, and enhancing Congress' capacity for absorbing S&T advice. In this sense, it is a comprehensive solution.

Our three-part recommendation should be considered an integrated whole. First, the Panel recommends that Congress enhance existing congressional S&T support agencies – the GAO in particular – to expand and enhance S&T support to Congress. The leaders of both the CRS and the GAO should evaluate how each may adopt continuous improvement actions in its delivery units connected with S&T support. Additionally, there are several additional specific actions recommended for the GAO. Requisite authorities and resources should be made available by Congress to discharge these enhanced responsibilities at the CRS and the GAO. Second, the Panel recommends that Congress create a new advisory office mandated with expanding the S&T capacity

of the Congress. Third, the Panel recommends that the Congress conduct a thorough independent, nonpartisan, review to evaluate the performance and impact of this solution on the S&T needs of Congress. This should take place 24 months after the implementation of these recommendations.

This option is the most attractive based on our analysis of the three elements in our analytical model: desirability, feasibility, or viability. The Panel recommends that existing legislative support agencies (i.e., the GAO and the CRS), both with long history and respected performance, be given authority and resources to further develop their ability to respond to congressional inquiries and expand their capabilities to close the S&T resources support supply gap. The GAO should be granted such authorities and resources required to build on its extensive experience in studies and analysis and add short-to-medium term reports to its recent focus on TAs. The CRS should continue to provide quick turnaround and consultative support and heighten its ongoing out-reach and "marketing" to all congressional Members. The CRS should also focus on continuous improvement of its current ability to provide its unique product of quick-turnaround consultative support.

In addition, the House and the Senate should together establish an Office of the Congressional S&T Advisor, appointing an eminent expert with S&T credentials to work cooperatively with Members, staff, committees, and legislative support agencies to provide ongoing counsel and recommendations to address the overall capacity of Congress to address complicated S&T issues. This key congressional advisor would be the Chair of a new Congressional S&T Support Coordination Council in order to advance the quality of S&T resource support for Congress. The Coordination Council is intended to raise the visibility of S&T issues and encourage ongoing cooperation among the GAO and the CRS to provide the most dexterous and comprehensive support to Congress.

More detailed information is offered in the following discussion on the Panel's three-part recommendation.

Part 1 – Enhance Existing Entities

Congressional Research Service

The CRS should continue to expand and improve its S&T quick turnaround and consultative services to all of Congress, conducting an outreach and educational campaign to enhance congressional awareness of its S&T capabilities.

Government Accountability Office

The GAO, through an enhanced STAA, should become the locus for studies and analyses that are critical for congressional Committees to conduct business, including TAs and short-to-medium term studies. In addition, the GAO should take the lead in providing a variety of networking services to Congress, such as arranging meetings and organizing briefings.

To fulfill these functions, the Panel recommends that the GAO introduce the following five changes:

1) **The GAO should create a dedicated core team within the STAA to focus solely on TAs and short-to-medium term reports**. Staff assigned to this team should not work on S&T performance assessments and audit work, which are vital, principal tasks of this agency. The core group can be supplemented by experts from other STAA groups and/or other teams of the GAO, and temporary staff when necessary, to obtain specific expertise. Given long-standing concern among some external stakeholders about the cultural differences between how GAO staff members might approach traditional audit and performance evaluation work, on one hand, and TAs on the other, the Panel believes it critical to establish a team dedicated to TAs and short-to-medium term reports. By doing so, there is opportunity to build a culture best suited to the unique features of TAs, and which are quite different in important ways to audit and performance assessment work. Some degree of separation between audit and TAs will also help the GAO preserve the independence and objectivity of its audit work, the Agency's core mission.

   Notwithstanding the foregoing, the Panel recognizes that there may be some specific challenges to achieving what the Panel has as its optimal scenario. As a result, the Panel recommends that GAO be granted flexibility to propose to Congress other ways to overcome this concern over cultural incompatibility should there be other organizational actions GAO's leaders conclude could be followed to achieve the same aims.

2) **The GAO should continue to enhance its capabilities to deliver high-quality TAs.** The agency should continue to refine its methodology to include an expanded use of peer-review to ensure the quality of TAs and engage external experts, balancing the heightened quality that comes from external review with the resulting delays in completion. The GAO should explore innovative network models and have the authority and capability to engage external expertise to more quickly produce the desired products for Congress in a responsive timeframe.

3) **The GAO should expand its research products to fill the identified gaps in short-to-medium term studies**. For short-to-medium studies, the STAA should engage national and international experts and look to the models in other countries (e.g., UK POST[78]) to develop its methodology framework.

4) **The GAO should continue to build its relationships with S&T communities and work with the CRS and the NASEM to provide networking services** to ensure that Congress has timely and effective access to a broad array of external S&T experts when needed.

5) **The GAO should generally use the same prioritization scheme that it does for its performance audits** that ensure Committees responsible for formulating legislation have adequate support. The GAO should continue to provide quick-turnaround responses and consultation to congressional offices on topics related directly to its studies when it has available resources. The GAO should make every effort to take a network approach to its

[78] POSTnotes is the UK POST's main product (a four-page comprehensive synthesis of an S&T issue). UK POST defines the methodology in its training manual.

work, while ultimately providing its materials in a digestible fashion. Like the CRS, the GAO should conduct a broad-scale outreach effort across both the House and the Senate to ensure members and staffs know about its capabilities.

The Panel recommends that the GAO fill the most pronounced gaps in short-to-medium instead of creating a new separate entity for a variety of reasons. As the analysis in Chapter 5 underscored, while a newly created agency (or a reestablished OTA) could provide effective consultations and studies across Congress, the agency start-up costs (feasibility) will be problematic to secure. Furthermore, the GAO has a record of accomplishment of balancing disparate congressional needs. The GAO consistently highlighted products, services, and capabilities that provide some confidence that the agency can, and is prepared to, expand its capabilities to fill the identified gaps with marginal additional resources. It is incumbent upon Congress to provide pertinent authorization and resources to the GAO to discharge these responsibilities.

Part 2 – Congressional Actions

Create an Office of the Congressional S&T Advisor

The Panel recommends creating an Office of the Congressional S&T Advisor (OCSTA) led by the Congressional S&T Advisor, appointed by House and Senate leaders. The OCSTA would work collaboratively with congressional leaders, committee chairs, and key staffs to identify ways to improve Congress' ability to address S&T issues, with a particular focus on enhancing the capacity of Congress to absorb and utilize the S&T support available from the GAO and the CRS as well as external resources. The Congressional S&T Advisor should be an eminent individual, widely recognized and respected across the S&T community encompassing government, academia, and industry. A small, but highly qualified staff would support the Advisor. The Congressional S&T Advisor would interact with other science advisors across the U.S. Government, as well as foreign government and parliamentary counterparts. The Congressional S&T Advisor could chair the coordinating council described below, as well as be a key point-of-contact for congressional committee S&T advisors, which the Panel recommends should be created for every major committee. Committee S&T advisors should be funded centrally through OCSTA.

OCSTA should also be responsible for performing S&T horizon scanning for Congress. OCSTA would conduct on-going horizon scanning related to S&T issues, and in consultation with GAO, produce an annual horizon scanning report for Congress to identify emerging S&T trends and political policy implications. The report should also be available to the public. OCSTA should have the authority and resources to contract with external organizations/experts to conduct S&T horizon scanning and develop this annual report.

For OCSTA, the Panel recommends establishing a relatively small organization with a modest budget. The OCSTA will need funding to hire expert staff, facilitate travel, enable some level of contracting capability to support S&T horizon scanning, and coordinate with the GAO and the CRS.[79]

Create a Congressional S&T Coordinating Council

While the Panel finds that cooperation and communication already exist between the CRS and the GAO, it recommends the establishment of a Congressional S&T Coordination Council to bolster this cooperation and communication in the context of the more expansive and innovative efforts to be undertaken by the GAO and the CRS. Comprised of senior leaders and technical experts from the CRS and the GAO and chaired by the new Congressional S&T Advisor, the Council should meet regularly to share information, discuss ongoing work and future projects, and discuss ideas to enhance the support and services provide to Congress. More frequent meetings of lower-level boards and panels might also be drawn from these two organizations, which will, along with more informal contacts, enhance this aim of regular inter-agency communication. Key non-governmental organizations like the NASEM should be invited to participate.

Part 3 – Conduct a Two-Year Review

Within two years of the full stand-up of the OCSTA and the expansion of the GAO's STAA, an independent, nonpartisan organization should complete a comprehensive assessment of the solution's effectiveness. While the review would examine the overall effectiveness of this enhanced legislative support to Congress, a key aspect of the assessment would be to evaluate whether the GAO has received adequate resources and/or whether the GAO has fully developed the comprehensive capabilities to meet congressional needs. This report should also assess the potential benefits of unifying S&T support under the OCSTA.

In summary, the Panel's recommendation ties together three fundamental elements critical to addressing S&T congressional requirements in the 21st century. The Panel calls on the CRS and the GAO that are already operating with policies, staff, and infrastructure, to remain engaged and enhance their operations, providing analyses needed by Congress. The Panel also addresses an important absorptive issue by calling for a new office in Congress to enhance how S&T information is identified, shared, and provided to committees (in Chapter 6). Finally, the Panel recommends a review mechanism to ensure there is accountability by Congress and the operating agencies and assessment of the effectiveness of these new modes of operation.

[79] The OCSTA office should start at a modest level with a budget of approximately $5 million and support up to 10 FTE, plus S&T advisors for key committees, until more experience is gained with this new office. The ultimate size and funding level for this office would be part of the 24-month review recommended in this report.

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Chapter 6: Addressing the Absorptive Gap

As discussed earlier in the report, and as highlighted by our three-part recommendation, effective laws and policies enacted by Congress that address complicated S&T issues are impacted both by the form in which S&T resource support is provided and by how well the resource support is received and incorporated into the work of Members and staff. As such, our analysis would lack an essential element if this report only speaks about the supply side of the equation, i.e., how S&T resource support is provided (the focus of the previous chapters). In this chapter, the Panel is compelled to speak about how Congress might take actions in order to be better poised to absorb and utilize enhanced S&T resource support. Improved outcomes with respect to congressional capacity and ability to address complex S&T topics inevitably result from improvements in the overall engagement between the providers and receivers of these important resources. By addressing both sides of the equation, this report closes the communication circle; and underscores that those who seek resources, and those who provide resources, are inextricably intertwined in a mission to enhance S&T national policy outcomes.

While Congress' absorptive capacity is not the principal focus of this study, there are several of areas Congress could focus on in order to enhance its internal capacity. There are three general areas where Congress might make changes that should result in an enhanced absorptive capacity: (1) committee structure and activities; (2) attract and retain S&T talent to congressional staff; and (3) proceedings – debate and deliberation.

When providing context for the discussion and analysis that followed from Chapter 2, the Panel highlighted the reduction in overall congressional S&T resource support capacity. A relatively small number of Members and staffs come into Congress with S&T backgrounds. Furthermore, the institution appears to dedicate less time and resources to tackling these issues than it did two decades ago. An enhanced CRS and GAO, and the creation of a congressional science advisor will not compensate entirely for this degradation of capability, even though such improvements will significantly help.

Some interviewed to prepare this report, both within and outside Congress, repeatedly cited Congress' own personnel practices, human resources policies, and proceedings as a greater barrier to the body's understanding and basic ability to tackle complicated science trends. The question of reviving an Office of Technology Assessment (OTA) like entity or improving of the GAO and the CRS is seen by many as a distraction from the main issues that constitute problems that are more fundamental.

Absorption Gap Recommendations

While congressional capacity is not the main focus of this study, several recommendations related to committee structure, staffing, and proceedings became readily apparent in the course of the study.

The chart (Table 8) on the next page provides a summary of the Panel's absorption gap recommendations.

Areas	RECOMMENDATIONS
Committee Structure and Activities	• Provide in-house S&T advisors to support committees • Create External Technical Advisory Groups to enhance access to cutting edge thinking and insights
Building a Competent and Experienced S&T Congressional Staff Team	• Attract and retain congressional staff with requisite S&T skills and experience. • Expand fellowships and federal detailees
Proceedings – Debate and Deliberation	• Increase the number of hearings • Open debate and discussion on the respective Floor of the House and Senate
Congressional Science and Technology Act for the 21st Century	• Congress should codify the recommended actions, both the external legislative support and its own internal workings

Table 8 – Panel Absorption Gap Recommendations for Congress

Committee Structure and Activities

Congressional committees, to include Members and committee staffs, are the central focal point of our recommendations. Even when congressional committee leaders play a greater role in formulating legislation, they draw primarily on the work of committee staffs. Increases in capacity within the committees, especially those with particularly strong science focus like Appropriations, Armed Services, Judiciary, and Commerce and Science, Energy, and Health, among several others, would have great impact. The Panel provides two recommendations in this respect.

Provide In-House S&T Advisors

It is a governmental best practice for major organizations to have one or more S&T advisors with the requisite expertise to identify important S&T intersections with, and implications for, policies. Indeed, such experts can provide the networking, consulting, and quick turnaround types of S&T resource support that make up the support gap discussed in Chapter 3. In addition, these individuals can help ensure long-term studies are structured in the optimal way.

This recommendation has already been modeled by Executive Branch agencies, both civilian and defense. They have a science advisor who advises the uniformed and civilian leadership on major S&T opportunities, concerns, and trends. Since 2001, the President's Council of Science and Technology Advisors (PCAST) has provided the Office of the President with ready access to the full range of science advice. The PCAST is supplemented with expertise from the Institute for Defense Analyses, a FFRDC.

As discussed in Chapter 5, Congress should consider whether committees with a major S&T component should have at least one separate S&T advisor in the same way that every committee staff has legal counsel. This person could be held responsible for a portfolio of S&T issues, advise Members and staffs on S&T aspects of legislation, serve as contacts for those agencies providing

S&T resource support, and develop a wider network with outside S&T organizations whether in academia, industry, or the public.

Create External Technical Advisory Groups

Congressional committees should consider creating Technical Advisory Groups similar to that of the Senate Intelligence Committee, which can enhance access to cutting-edge thinking and insights. This group is comprised of leaders in their field, including scientists, retired top governmental officials, leading consultants, and technical experts. These individuals become available to answer questions, provide consults, and write reports, which the committee can decide to release. These individuals can provide behind-the-scenes advice or write reports that can be released either independently or in conjunction with hearings to shine a spotlight on key issues. Because these panels are informal, the congressional panels maintain full flexibility to embrace the consultations or simply take the input in consideration.[80]

As an example, in December 2018, the Senate Intelligence Committee released reports from its advisory group on Russia's Internet Research Agency's efforts to influence U.S. politics through social media. Substantively, the reports provided important insights to the committee and the public on the continued efforts of a foreign government to influence the U.S. electoral process, while symbolically allowing the Committee to demonstrate its interest in addressing the challenge without having to go through the challenging process of forging agreement among its Members necessary for release of a full-fledged committee report.[81]

Building a Competent and Experienced S&T Congressional Staff Team

With respect to staffing and personnel policies, the Panel offers two recommendations that may improve congressional absorptive capacity.

Attract and Retain Congressional Staff with Requisite S&T Skills and Experience

As highlighted in Chapter 2, attracting talented individuals with S&T backgrounds to congressional staff remains a significant challenge. In the same way that more committee in-house expertise would improve the ability to tackle complicated S&T issues, Members would benefit from such expertise in their personal offices. Several Members and staffs interviewed said getting talented staff Members would make a substantial difference in the ability of Congress to tackle complex S&T trends.[82]

Those interviewed identified several barriers to attracting and retaining talent. Pay levels are most frequently mentioned, as salaries among key staffs—legislative assistants and legislative directors –

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[80] U.S. Congress, Senate, Committee on Intelligence, *"Committee Activities: January 3, 2017 – January 3 2019,"* Government Printing Office, March 28, 2019, p. 15. https://www.intelligence.senate.gov/publications/report-select-committee-intelligence-united-states-senate-covering-period-january-3

[81] U.S. Congress, Senate, Committee on Intelligence, *"New Reports Shed Light on Internet Research Agency's Social Media Tactics,"* December 17, 2018. https://www.intelligence.senate.gov/press/new-reports-shed-light-internet-research-agency%E2%80%99s-social-media-tactics

[82] Bill Pascrell Jr., *"Why is Congress so Dumb?"* Washington Post, January 11, 2019.

range about a one-third less than comparable positions in the executive branch, though the fact that each member sets pay levels makes detailed comparisons challenging. The pay disparity with the private sector is even more pronounced.

Another barrier to attracting and retaining top S&T talent relates to opportunities for professional development. Continuing education is particularly valued among S&T experts. While private sector and federal government have tuition assistance and outside education programs that can provide yearlong studies away from a position, Congress offers few of these opportunities.

Another key factor is that it is essential that legislative branch staffs tasked with providing quality, non-partisan advice on S&T issues, whether at the GAO, the CRS, the new OCSTA, or detailed to the committees, have confidence that neither they nor their parent institutions will be pressured or attacked in cases where some members of Congress may disagree with their analysis or conclusions. High quality S&T support cannot thrive in an atmosphere where threats of reprisals exist.

Finally, Congress tends not to conduct targeted recruiting efforts for graduates with specialized backgrounds. Our research indicates that each individual member makes hiring decisions, and collective efforts to focus hiring on a particular category through on-campus interview sessions and/or Science, Technology, Engineering, and Mathematics (STEM) job fairs are a rarity.

The combination of these policies and practices can contribute to high staff turnover that undermines development of the deep well of expertise necessary to understand, analyze, and, in turn, resolve complicated S&T problems. Congress should consider examining its personnel system for bringing in and keeping staff with advanced S&T backgrounds. It can look at targeted recruiting efforts, increasing pay, and developmental opportunities to better compete with the executive branch and the private sector for talented individuals.

Expand Fellowships and Federal Detailees

In addition to the support OCSTA would provide to committees, there are a number of S&T fellowships, including TechCongress and the American Association for the Advancement of Science (AAAS) Fellows[83] that allow Members to bring in trained experts to directly advise on key S&T

[83] So-called AAAS Fellows are sponsored through the American Association for the Advancement of Science (AAAS), a membership non-profit primarily comprised of scientists who advocate for evidence-based policy, and the nation's continued support for the scientific community. These Fellows are funded in partnership with other scientific organizations like the American Geophysical Union. Fellows are selected from a competitive application process for the one-year Hill terms as part of the formally named Science Technology Policy Fellows (STPF) program. The Fellowship existed since 1973, and, each year, many of the 250 participants serve their fellowships in federal agencies. TechCongress Fellowship is a more recent and limited endeavor in participant numbers. The effort is specially focused on bringing high-tech talent into Congress to enhance policy-making in this realm, as well as increase communication between Washington, D.C. and Silicon Valley.

matters. Fellows serve for one year directly on staff like regular congressional staff. The constant influx of fellows from industry and academia means Members get the benefit of the latest knowledge of broader developments found in the global marketplace. In addition to TechCongress and AAAS Fellows, executive branch agencies also provide personnel on long-term assignment—detailees—directly to Congress to serve in congressional offices.

Fellows and detailees are not one-for-one substitutes for permanent staff even with the invaluable perspective and contribution they can bring. The temporary nature may mean a staff member cannot follow through on issues that can take an entire two-year Congress to wend their way through the legislative process. Executive branch detailees are perhaps further limited in that they may act, or may be perceived to act, as maintaining too strong an affiliation with their home agency, which would be responsible for a person's long-term career prospects. Those limitations notwithstanding, both fellowships and details should continue and expand as appropriate.

Proceedings – Debate and Deliberation

There are several changes in the way that Congress operates that would enhance its ability to absorb a wider array of S&T resource support made available to it. The Panel recommends altering the recent trends toward piecemeal hearings and away from a more consistent set of hearings. Furthermore, the Panel recommends that Congress allow for greater debate and deliberation when complicated S&T legislative initiatives come to the Floor, which might contribute to a greater understanding of complicated S&T issues among Members and staffs.

Increase the Number of Hearings

Congressional hearings, especially when conducted in a series over several months or years, provide the optimal forum for Congress to come to grips with complex S&T issues. These open sessions provide a forum by which to introduce various perspectives on complicated issues, while allowing Members to ask questions. A recent report of the Belfer Center for Science and International Affairs noted, as an illustration, the important role of almost a dozen Congressional hearings in the early 1980s to look at the corporate structure of AT&T. The issues raised during the hearings became the baseline for legislation considered in both the House and the Senate.[84] Hearings have more recently become more of an opportunity to transmit political messages rather than wrestle with and understand the impacts of S&T trends on the public. This report recognizes that the almost impossible time demands on congressional Members would be a major barrier to a more deliberative approach to hearings. Nevertheless, making hearings a priority and finding a way to allocate time for them would be extremely beneficial.

Open Floor Discussion

Similarly challenging, but important to implement, would be to open debate and discussion on the respective Floor of the House and Senate. Legislation, when it advances so far along in the

[84] Technology and Public Purpose Project, *"Big Tech and Democracy,"* Belfer Center for Science and International Affairs, April 2019. https://www.belfercenter.org/sites/default/files/2019-04/BigTechDemocracy.pdf

legislative process, is considered among so-called "Closed Rules" in the House or post-cloture restrictive procedures in the Senate. Such procedural moves restrict discussion and debate, particularly preventing Members with strong interest in these S&T matters who are not Members of the sponsoring committee to participate in the debate and deliberations. When there is open discussion and Members are given the opportunity to offer amendments, discuss changes, and defend their views, the final product of S&T legislation will be improved.[85] Debate and deliberation fundamentally improve understanding and contribute to efforts to drive a consensus.

Congressional Science and Technology Act for the 21st Century

Congress should codify the recommended actions, both to enhance the capabilities of GAO and CRS and to improve its own absorptive capacity. The enhancement of CRS and GAO capabilities can be accomplished within existing statutory authorities and Congress can take the steps to improve its staff capacity without new authorizing legislation. However, the Panel recommends that Congress enact new authorizing legislation not only to codify the recommended actions, but also to provide for a deliberative hearing process and extensive congressional Floor debate, which would both educate and engage Members on these vital issues and announce to the public at large its commitment to keep the country on the cutting-edge of S&T issues.

[85] Willis, Derek and Paul Kane, *"How Congress Stopped Working,"* ProPublica, November 5, 2018. https://www.propublica.org/article/how-congress-stopped-working

Appendix A: Panel Members and Study Team Biographies

Panel Members

Elizabeth Fretwell (Chair) is a Senior Vice President for SMART at Switch. Ms. Fretwell held former positions for the City of Las Vegas: City Manager, Deputy City Manager; Assistant City Manager. Former Director, Intergovernmental Relations, City of Henderson; Strategic Issues Manager, Management Analyst II & I, Clark County.

David Rejeski is a Visiting Scholar at the Environmental Law Institute. He has been a, Guest Researcher, International Institute for Applied Systems Analysis (IIASA) and Visiting Fellow, Yale University School of Forestry and Environmental Studies. Mr. Rejeski held former positions with Woodrow Wilson International Center for Scholars: Director, Science, Technology and Innovation Program and Foresight and Governance Project. Former positions with The White House: Director, Interagency Environmental Technology Task Force of the Council on Environmental Quality; Policy Analyst, Office of Science and Technology Policy. Former Head, Future Studies Unit, Office of Policy, Planning & Evaluation, Environmental Protection Agency; Consultant, Environmental Agency, Hamburg, Germany. He has served on advisory boards and panels of the Environmental Protection Agency (EPA), National Science Foundation (NSF), Defense Advanced Research Projects Agency (DARPA), Food and Drug Administration (FDA), and National Academy of Sciences, Engineering and Medicine (NASEM).

James Hendler is currently Professor of Computer Science at Rensselaer Polytechnic Institute. Professor Hendler held former positions as: Professor, Computer Science, University of Maryland; Program Manager/Chief Scientist (IPA), Information Systems, Defense Advanced Research Projects Agency (DARPA); Open Data Advisor, New York State (unpaid), New York State Government; Internet Web Expert (unpaid), Data.gov project, IPA to the General Services Administration (GSA), working with the Office of Science and Technology Policy (OSTP); Member Advisory Committee, Homeland Security (DHS) Science and Technology Advisory Committee, DHS; Board Member, Board on Research Data and Information, NASEM; Director's Advisory Committee Member, National Security Directorate, Pacific Northwest National Laboratories.

Kathleen Peroff is the owner of Peroff and Associates, LLC. Formerly, Ms. Peroff was Deputy Associate Director, National Security, the Office of Management and Budget (OMB), Executive Office of the President. Former positions with the OMB: Deputy Associate Director; Energy, Space, Science, and Water Division; Branch Chief, Housing Branch and Division of Special Studies. Former Deputy Director and Visiting University Fellow, Division of Special Studies, Office of Policy Development and Research, U.S. Department of Housing and Urban Development; Assistant Professor, Political Science and Public Policy, University of Maryland.

Michael McCord is the Director of Civil-Military Programs at the Stennis Center for Public Service and an Adjunct Research Staff Member at the Institute for Defense Analyses. He was formerly the Under Secretary of Defense (Comptroller) and Chief Financial Officer, U.S. Department of Defense; Professional Staff Member, Senate Armed Services Committee; Budget Analyst, House Budget

Committee; and Assistant Analyst, Congressional Budget Office. He also served as a member of the congressionally-appointed Commission on the National Defense Strategy for the United States.

Academy Study Team

Brenna Isman, *Director of Academy Studies.* Ms. Isman accepted her initial appointment with the Academy in 2008. She currently provides oversight for all Academy's studies. Ms. Isman recently served as the Project Director for the Academy's project that assisted a financial oversight board in developing and implementing its strategic plan. She also directed the Academy's statutorily required assessments of the National Aeronautics and Space Administration's use of its Advisory Council and the Environmental Protection Agency's practices for determining the affordability of regulatory mandates, as well as the Academy's organizational study of the U.S. State Department's Office of Inspector General. Her prior consulting experience includes both public and private sector clients in the areas of communication strategy, performance management, and organizational development. Prior to joining the Academy, Ms. Isman was a Senior Consultant for the Ambit Group and a Consultant with Mercer Human Resource Consulting facilitating effective organizational change and process improvement. Ms. Isman holds a Masters of Business Administration (MBA) from American University and a Bachelor of Science (BS) in Human Resource Management from the University of Delaware.

Roger Kodat, *Senior Project Director.* Mr. Kodat has led more than 25 projects for the Academy. He brings twenty years of commercial and investment banking experience with JPMorgan Chase, and six years of senior level federal government experience at the Department of the Treasury. Appointed by President George W. Bush in 2001 to serve as Deputy Assistant Secretary of Treasury, he was responsible for Federal Financial Policy. Some of his tasks at Treasury included policy formulation for the 2006 Postal Accountability and Enhancement Act; rule making and oversight of Federal loan and loan guarantee programs; and management of the Federal Financing Bank (a $32 billion bank at that time). Mr. Kodat holds a BS in Education from Northwestern University and both an MBA in Finance and Masters of Arts (MA) in Political Science from Indiana University.

Daniel Ginsberg, *Senior Advisor.* Mr. Ginsberg is a defense, health care policy, and human capital consultant in Washington, DC. From 2009 to 2013, he served as the Assistant Secretary of the Air Force for Manpower and Reserve Affairs, leading the Air Force's efforts to provide trained and ready personnel, while transforming human capital management for the almost 700,000-person armed service. Mr. Ginsberg served for a decade as the senior defense policy advisor to U.S. Senator Patrick Leahy of Vermont. He is also a former member of the staff of the U.S. Senate Committee on Armed Services during the Chairmanship of U.S. Senator Sam Nunn of Georgia.

Jonathan Tucker, *Senior Research Analyst.* Dr. Tucker is a senior analyst and project director at the Academy. His areas of expertise include strategic planning/foresight, organizational design, change management, and S&T/innovation policy. His public management consulting experience includes projects with twenty federal agencies. Recent projects include assessment of research coordination function at the U.S. Department of Transportation; developing a strategic plan for the Office of

Urban Indian Health Programs (U.S. Indian Health Service); developing options for the establishment of a new Under Secretary at USDA focused on international trade; developing a white paper for the Project Management Institute on institutionalizing project and program management in the federal government; assessing Census transformation initiatives; developing a long-term strategic plan for operational transformation at the Social Security Administration. In addition to his consulting activities, Jon contributes to the work of the Academy's Strategic Foresight Panel (part of the broader Academy Transition 2016 initiative). Dr. Tucker also has experience assessing science and technology policies and programs, with a focus on supporting innovation. He has worked for organizations including Battelle; the National Research Council; the National Institute of Standards and Technology; and the New York State Department of Economic Development. He holds a Ph.D. in Public Policy (with a concentration in Science and Technology Policy) from George Mason University, an MS in Science and Technology Studies from Rensselaer Polytechnic Institute, and a Bachelor of Arts (BA) from New College of Florida.

Chloe Yang, *Senior Research Analyst.* Since joining the Academy in 2009, Ms. Yang has worked on projects involving a range of federal agencies, including the National Science Foundation, the OMB, Pension Benefits Guarantee Corporation, Amtrak Office of Inspector General, U.S. Coast Guard, and the GAO. Her expertise spans the fields of strategic planning, intergovernmental collaboration, and financial and performance management. Before joining the Academy, Ms. Yang was the research intern at the Foundation of Environmental Security and Sustainability. She also worked as an intern at the Woodrow Wilson Center for Scholars and research assistant at George Mason University (GMU). Ms. Yang is a Ph.D. candidate at GMU, from which she also holds a Masters of Public Administration degree. She also holds a bachelor's degree in Financial Management from the Renmin University of China.

Elijah Evans, *Research Analyst.* Mr. Evans joined the Academy in February 2017. He currently is supporting an assessment of strategies for enhancing the technology policy resources available to the U.S. Congress and a strategic planning and employee engagement project for the Defense Nuclear Facilities Safety Board. Prior to this, he supported the Academy's assistance to a financial oversight board in developing the agency's strategic and performance plans. He also served on congressionally directed engagements that examined the U.S. Environmental Protection Agency's guidelines for affordability of infrastructure investments and National Aeronautics and Space Administration's use of its Advisory Council. He leads internal efforts driving digital modernization efforts at the Academy. Mr. Evans received a BS in Convergence Journalism and Political Science from Abilene Christian University in December 2016.

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Appendix B: Interviewee List

(Titles and positions listed are accurate as of the time of the Academy's initial contact)

Alan Inouye, Senior Director, Public Policy and Government Relations, American Library Association
Ali Nouri, President, Federation of American Scientists
Amber Mace, Interim Executive Director, California Council on Science and Technology
Andrew Rosenberg, Director, Center for Science and Democracy, Union of Concerned Scientists
Angela Evans, Dean, LBJ School of Public Affairs, The University of Texas at Austin
Arati Prabhakar, Fellow, Center for Advanced Study in the Behavioral Sciences, Stanford University
Armin Grunwald, Director, Office of Technology Assessment, German Parliament
Arnold Sauter, Deputy Director, Office of Technology Assessment, German Parliament
Bernice Steinhardt, President, Art and Remembrance
Bill Westermeyer, Former OTA Staff
Bradford Fitch, President and Chief Executive Officer, Congressional Management Foundation
Caroline Wagner, Associate Professor, Milton & Roslyn Wolf Chair in International Affairs, John Glenn College of Public Affairs, The Ohio State University
Christopher T. Hill, Professor Emeritus of Public Policy and Technology, George Mason University
Daniel Chenok, Executive Director, IBM Center for the Business of Government
Daniel D'Arcy, Policy Analyst, Bipartisan Policy Center
Daniel Mulhollan, Former Director, Congressional Research Service
Daniel Schuman, Policy Director, Demand Progress
David Walker, Former Comptroller General of the United States
Deborah Stine, President, Deborah Stine Consulting
Elisabeth Ehrensperger, Director, Swiss Foundation for Technology Assessment
Evan Michelson, Program Director, Energy and Environment Program, Alfred Sloan Foundation
Franz Wuerfmannsdobler, Senior Advisor, Bipartisan Policy Center
Gerald Epstein, Distinguished Research Fellow, Center for the Study of Weapons of Mass Destruction, National Defense University
Grant Hill-Cawthorne, Head, Parliamentary Office of Science and Technology, United Kingdom
Grant Tudor, MPP/MBA Candidate, Harvard Business School
Jayme Fuglesten, Director, Office of Congressional Relations, RAND Corporation
Jerome Glenn, Co-Founder and Chief Executive Officer, The Millennium Project
Jessica Wilkerson, Director of Cybersecurity Research, The Linux Foundation
John Price, Chief Operating Officer, The Boone Group
Jon Peha, Professor, Engineering and Public Policy, Carnegie Mellon University
Jonathan Mayer, Assistant Professor of Computer Science and Public Affairs, Princeton University
Justin Warner, MPP/MBA Candidate, Harvard Business School
Katherine Pratt, Former Fellow, TechCongress
Kevin Kosar, Vice President of Policy, R Street Institute
Lars Kluver, Director, Danish Board of Technology Foundation
Laura Manley, Director, Technology and Public Purpose Project, Belfer Center, Harvard Kennedy School

Leon Fuerth, Founder and Director, The Project on Forward Engagement
Mahmud Farooque, Clinical Associate Professor, School for the Future of Innovation in Society, Arizona State University
Mark Lewis, Director, Science and Technology Policy Institute, Institute for Defense Analyses
Mark Strand, President, Congressional Institute
Maurice Turner, Senior Technologist, Center for Democracy and Technology
Max Stier, President and Chief Executive Officer, Partnership for the Public Service
Michael Halpern, Deputy Director, Center for Science and Democracy, Union of Concerned Scientists
Michael Nentwich, Institute of Technology Assessment, Austrian Academy of Sciences
Neal Lane, Senior Fellow in Science and Technology Policy, Baker Institute for Public Policy, Rice University
Patrick Windham, Lecturer, Public Policy Program, Stanford University
Peter Blair, Executive Director, Division of Engineering and Physical Sciences, NASEM
Reinhard Grunwald, International Liaison, Office of Technology Assessment, German Parliament
Rich Girven, Director, Cyber Intelligence Policy Center; National Security Research Division, RAND Corporation
Richard Sclove, President, The Loka Institute
Robert Atkinson, President, Information Technology and Innovation Foundation
Robert Cook-Deegan, Professor, School for the Future of Innovation in Society, Arizona State University
Sarah Brady, Interim Deputy Director, California Council for Science and Technology
Theodoros Karapiperis, Head of Unit, Scientific Foresight Unit, European Parliamentary Research Service
Travis Moore, Founder and Executive Director, TechCongress
Victor David Hanson, Senior Fellow, The Hoover Institution
Zach Graves, Head of Policy, Lincoln Network

U.S. Government Accountability Office

Bill Carrigo, Assistant Director, Science, Technology Assessment, and Analytics
Gene Dodaro, Comptroller General of the United States
Hayden Huang, Senior Engineer, Science, Technology Assessment, and Analytics
Jenn Beddor, Senior Engineer, Science, Technology Assessment, and Analytics
Jenny Chanley, Senior Design Methodologist, Applied Research and Methods
John Neumann, Managing Director, Science Programs
Karen Howard, Assistant Director, Science, Technology Assessment, and Analytics
Karl Maschino, Chief Administrative Officer
Katherine Siggerud, Chief Operating Officer
Nick Marinos, Director, Cybersecurity & Data Protection Issues
Orice Williams-Brown, Managing Director, Congressional Relations
James-Christian Braxton Blockwood, Managing Director, Strategic Planning and External Liaison
Stephen Sanford, Strategic Planning and Innovation Manager, Strategic Planning and External Liaison Office
Timothy Persons, Chief Scientist

Tom Armstrong, General Counsel
Valerie Martin, Unknown
Walter Vance, Assistant Director, Applied Research and Methods

Congressional Research Service

Adam Stoll, Section Research Manager, Domestic Social Policy
Cathy Hurst-Weber – Counselor to the Director
Chris Jaikaran, Analyst in Cybersecurity Policy, Government and Finance Division
Dan Morgan, Specialist, Science and Technology Policy, Resources, Science and Industry Division
Dana Shea – Assistant Director, Resources, Science, and Industry Division
Eric Fischer, Senior Specialist, Science and Technology, Resources, Science and Industry Division
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Jeff Hantson, Counsel, Sen. Mazie K. Hiron, U.S. Senate
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Jessica Berry, Minority Clerk, Subcommittee on Legislative Branch, Committee on Appropriations, U.S. Senate
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Kevin Holmes, FCC Counsel on Detail, Committee on Commerce, Science, and Transportation, U.S. Senate
Kim Binstead, Advisor, Sen. Sheldon Whitehouse, U.S. Senate
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Mark Stephenson, Legislative Director, Committee on Oversight and Reform, U.S. House of Representatives
Newt Gingrich, Speaker, U.S. House of Representatives (Former)
Nick Leiserson, Legislative Director, Rep. Jim Langevin, U.S. House of Representatives
Rachelle Schroeder, Professional Staff, Committee on Rules, U.S. Senate
Robert Harvey, Deputy Chief of Staff, Joint Committee on Taxation
Robert Smith Walker, Chair, Science Committee, U.S. House of Representatives (Former)
Rush Holt, Congressman, U.S. House of Representatives (Former)
Sara Barber, Professional Staff, Research and Technology Subcommittee, Committee on Science, Space, and Technology, U.S. House of Representatives
Sarah Boliek, Majority Clerk, Subcommittee on Legislative Branch, Committee on Appropriations, U.S. Senate
Thomas Barthold, Chief of Staff, Joint Committee on Taxation
William Mallison, Staff Director, Subcommittee on Technology Modernization, Committee on Veterans Affairs, U.S. House of Representatives

Appendix C: Selected Bibliography

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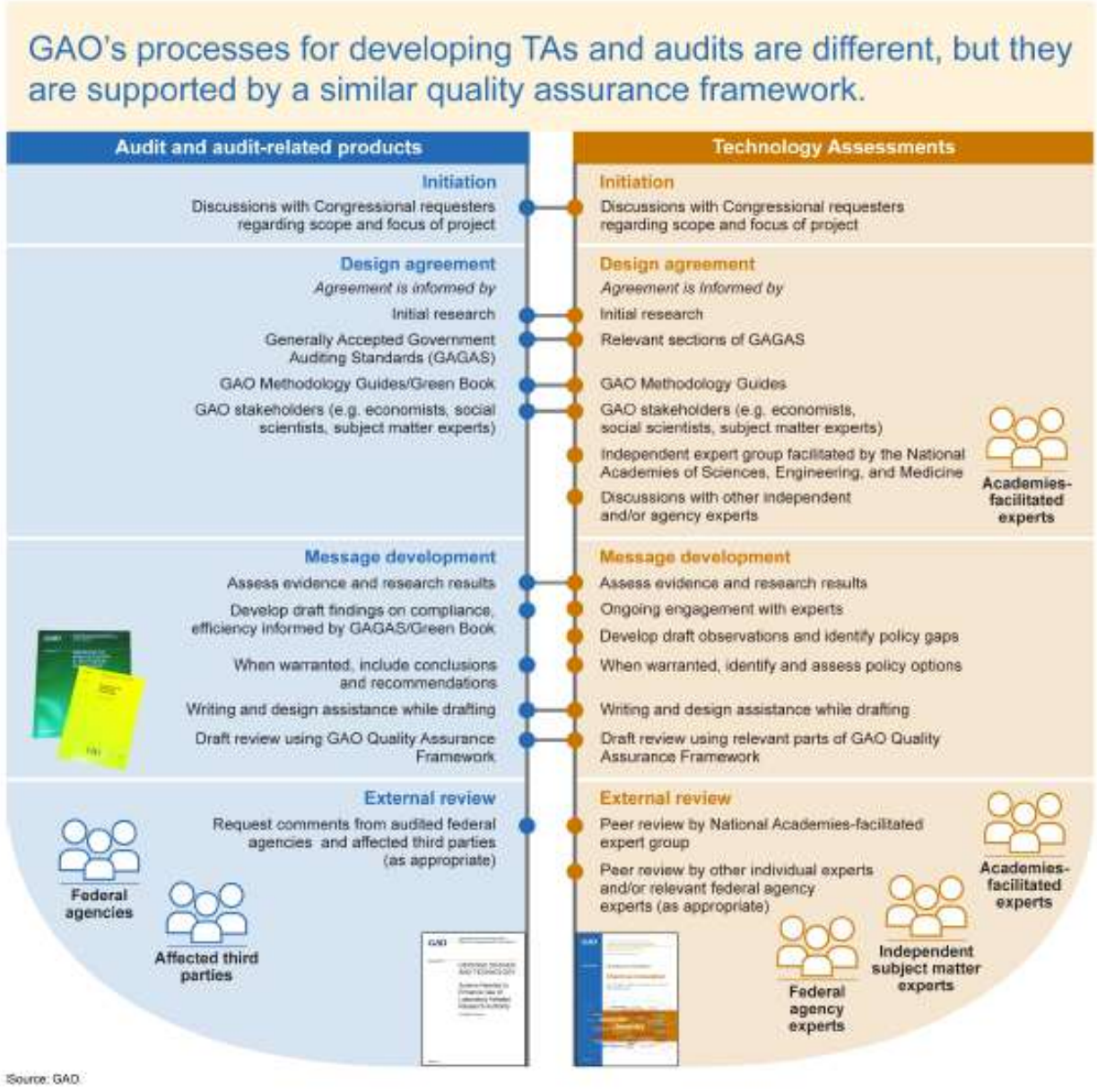
Appendix D: Comparison of the GAO's process for Developing Audit & Audit-related reports and Technology Assessment Reports



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