EXPERTS NEEDED: OPTIONS FOR IMPROVED SCIENCE AND TECHNOLOGY ADVICE FOR CONGRESS

HEARING

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY HOUSE OF REPRESENTATIVES

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C O N T E N T S

December 5, 2019

EXPERTS NEEDED:
OPTIONS FOR IMPROVED SCIENCE AND TECHNOLOGY ADVICE FOR CONGRESS

THURSDAY, DECEMBER 5, 2019

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Committee met, pursuant to notice, at 10:02 a.m., in room 2318 of the Rayburn House Office Building, Hon. Eddie Bernice Johnson [Chairwoman of the Committee] presiding.

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HEARING CHARTER

Experts Needed: Options for Improved Science and Technology Advice for Congress

Thursday, December 5, 2019
10:00 am – 12:00 pm
2318 Rayburn House Office Building

PURPOSE

On Thursday, December 5, 2019 at 10:00 am, the Committee on Science, Space, and Technology will hold a hearing to examine Congress's needs for advice to understand and address the growing number of science and technology policy issues facing the nation. The Committee will also assess the gaps in accessible science and technology resources and advice, and explore the opportunities and challenges for addressing such gaps, including whether a renewed Office of Technology Assessment would meet the needs.

WITNESSES

- **The Honorable Michael McCord**; Director, Civil-Military Programs; Stennis Center for Public Service
- **Ms. Laura Manley**; Director, Technology and Public Purpose Project; Belfer Center for Science and International Affairs; Harvard Kennedy School of Government
- **Dr. Tim Persons**; Chief Scientist and Managing Director; Science, Technology Assessment, and Analytics; U.S. Government Accountability Office
- **Dr. Peter Blair**; Executive Director, Division on Engineering and Physical Sciences; The National Academies of Sciences, Engineering, and Medicine

KEY QUESTIONS

- How does Congress use science and technology advice to inform its legislative and oversight activities?
- What are the current internal and external sources of science and technology advice for Congress? How does Congress solicit and receive such advice?
- What gaps exist in accessible science and technology resources and advice to Congress? How do these gaps affect Congress's ability to carry out its responsibilities?
- What options are available to improve science and technology advice for Congress? What are the strengths and weaknesses of these options?

OVERVIEW

Congress is routinely faced with decisions that involve complex science and technology (S&T) issues. Examples include developing environmental regulations, appropriating funds for research programs, developing legislation on issues like agriculture and health care, and responding to the risks and opportunities that come with emerging technologies like synthetic biology and artificial intelligence. Since Members of Congress and their staff typically don't have scientific or technical backgrounds, they rely on expert advice from a range of sources internal and external to the legislative branch.

From 1972 to 1995, Congress had a small nonpartisan support agency within the legislative branch dedicated to providing legislators with S&T advice. The Office of Technology Assessment (OTA) prepared reports on a broad range of S&T topics to help inform congressional decision-making.

OTA was created with bipartisan support out of a concern about the imbalance in Congress's analytical capability relative to that of the Executive Branch. While the Executive Branch had its own technical experts on staff and the Office of Science and Technology Policy (OSTP) at its disposal, Congress was often forced to rely on analyses provided by Federal agencies or third parties with their own interests. Many saw the lack of independent capabilities for technical analysis as an impediment to Congress's ability to fulfill both its legislative and oversight responsibilities. However, bipartisan support for the OTA began to falter, and in 1995, Congress eliminated funding for the OTA as part of an effort to reduce the national budget.

The remaining sources of S&T advice for Congress include the Government Accountability Office (GAO), the Congressional Research Service (CRS), the National Academy of Sciences, Engineering, and Medicine (NASEM), science and engineering professional societies, think tanks, and lobbyists. Some congressional offices also employ staff with S&T backgrounds.

Since the closure of OTA, concerns have been raised about gaps in S&T advice available to Congress. A variety of efforts have been made to close these gaps, most notably by expanding GAO's technology assessment function. However, many consider these measures to be insufficient and remain concerned about Congress's ability to address the challenges of an increasingly technological world and to provide a check on the activities of the Executive Branch.

The debate over how to meet Congress's need for S&T advice has intensified in recent years. While Congress has expressed support for enhancing its access to S&T expertise, the House and Senate appear divided on how to achieve that goal. In its FY 2020 Legislative Branch Appropriations report the Senate included support for enhancing the capabilities at GAO, while the House report includes funding for a renewed OTA. A highly-anticipated 3rd party assessment of options for meeting Congress's needs was released in November. The congressionally-mandated National Academy of Public Administration (NAPA) report confirms the existence of a gap in S&T advice for Congress and recommends a hybrid approach for closing that gap.

BACKGROUND

Office of Technology Assessment

Congress created the Office of Technology Assessment (OTA) in 1972 to aid Congress "in the identification and consideration of existing and probable impacts of technological application."[1] As a dedicated congressional support agency, OTA provided Congress with objective and authoritative analysis of science and technology issues to inform policy decisions. It was governed by the twelve-member Technology Assessment Board (TAB), populated with six members of Congress from each party – half from the Senate and half from the House of Representatives. Technology assessments were approved by the TAB and could be requested by committee leadership, a majority of committee members, the TAB, or the OTA Director.

At its peak, OTA had a staff of approximately 200 and a budget of about $22 million annually ($37 million today).[2] Between 1972 and 1995, OTA produced over 750 studies (an average of about 30 per year) on a broad set of technology issues, including those relevant to agriculture, intellectual property, defense, public health, energy, and the environment.[3] On average, OTA studies took 1-2 years to produce. OTA reports generally did not offer policy recommendations, but rather evaluated the implications of various policy options.

Funding for OTA was eliminated in 1995 as part of an effort to reduce the size of the congressional budget and bureaucracy. Arguments made by proponents of eliminating OTA included (1) OTA reports took over a year to complete and, therefore, were not available in a timeframe aligned with the legislative process, (2) Congress could obtain similar advice from GAO, NASEM, and CRS, and (3) some OTA reports were not pertinent to the legislative agenda or reflected a political bias. Some have also argued that the lack of access to OTA services by rank-and-file Members suppressed support for the office, making it politically vulnerable. While OTA has not been funded since 1995, its authorizing statute remains in effect.

Since it was defunded, there have been various efforts to revive and modernize the OTA. The House voted in June 2018 on an appropriations amendment[4] that would have funded the office with an initial budget of $2.5 million, but it failed 195-217.

This year, the bipartisan Select Committee on the Modernization of Congress in the House unanimously approved a recommendation for "reestablishing and restructuring an improved Office of Technology Assessment."[5] The House Appropriations Committee voted along party lines to approve a FY 2020 Legislative Branch Appropriations bill that includes $6 million to

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[1] OTA was created by the Technology Assessment Act of 1972 (2 U.S.C. 471) http://www.princeton.edu/~ota/ns20/act_f.html

[2] Equivalent to less than 1 percent of the legislative branch budget.

[3] Princeton, "OTA Publications," https://www.princeton.edu/~ota/ns20/year_f.html

[4] https://amendments-rules.house.gov/amendments/TAKANO_061530180942394239.pdf

[5] Select Committee on the Modernization of Congress, "Select Committee Unanimously Approves Second Round of Congressional Recommendations," July 25, 2019, https://modernizecongress.house.gov/news/press-releases/select-committee-unanimously-approves-second-round-congressional-recommendations

reestablish an OTA that will "complement the work of the Government Accountability Office in the area of science and technology."[6] In September, bipartisan, bicameral legislation was introduced by Representative Mark Takano (D-CA) and Senator Thom Tillis (R-NC) to amend the authorizing statute for OTA and revise the office's functions and duties.[7]

Government Accountability Office

Seven years after OTA closed, Congress directed GAO to initiate a pilot program in technology assessment (TA).[8] In 2007, Congress authorized this function on a permanent basis and provided $2.5 million in appropriations to support it, stating "it is necessary for the Congress to equip itself with effective means for securing competent, timely and unbiased information concerning the effects of scientific and technical developments and use the information in the legislative assessment of matters pending before the Congress."[9] GAO has since expanded its TA activities, standing up a Science, Technology Assessment, and Analytics (STAA) team in January 2019 and releasing a plan to further enhance its TA capabilities in April 2019.[10]

To date, GAO has published 15 technology assessments on topics such as border security, cybersecurity, nuclear reactors, sustainable chemistry, artificial intelligence, and agriculture.[11] GAO's TA work is subject to congressional request and adheres to the same congressional protocols as its other work. GAO gives congressional mandates top priority, followed by requests from congressional and committee leadership. Individual Member requests are prioritized last.[12]

GAO is taking a number of steps to build on its existing capabilities with a focus on (1) growing the STAA team, (2) developing additional product types and formats, (3) designating staff with a primary TA focus, (4) continuing engagement with external experts, and (5) developing policy options to aid in congressional decision-making. In addition to TA, the STAA team plans to provide technical assistance, oversight of Federal S&T programs, and best practices guides. Most notably, the STAA team plans to identify and analyze policy options, when relevant, in future technology assessments. Currently, the team is focusing on artificial intelligence and automation, augmented reality, cryptocurrencies and blockchain, genome editing, and quantum information

[6] H. Rept. 116-64, "Legislative Branch Appropriations Bill, 2020", May 16, 2019, https://www.congress.gov/congressional-report/116th-congress/house-report/64/1?overview=closed
[7] H.R. 4426, "Office of Technology Assessment Improvement and Enhancement Act", September 19, 2019, https://www.congress.gov/bill/116th-congress/house-bill/4426/cosponsors
[8] H. Rept. 107-259, "Making Appropriations for the Legislative Branch for the Fiscal Year Ending September 30, 2002, and for other purposes," October 30, 2001, https://www.congress.gov/congressional-report/107th-congress/house-report/259/1
[9] H. Rept. 110-198, "Legislative Branch Appropriations Bill, 2008," June 19, 2007, https://www.congress.gov/congressional-report/110th-congress/house-report/198/1
[10] GAO, "GAO Science, Technology Assessment, and Analytics Team: Initial Plan and Considerations Moving Forward," April 10, 2019, https://www.gao.gov/pdfs/about/GAOScienceTechPlan-2019-04-10.pdf
[11] GAO, "Technology and Science," https://www.gao.gov/technology_and_science#t=1
[12] GAO, "GAO's Congressional Protocols," July 17, 2017, https://www.gao.gov/assets/690/685901.pdf

science. GAO also plans to establish a science and technology advisory board of policy experts from academia, industry, non-profits, and prior government officials.

The STAA team does not have its own staff of dedicated technical specialists and policy analysts, but rather utilizes shared staff from across GAO. The team is divided into four core groups (Technology Assessment and Technical Assistance; Engineering Sciences; Science and Technology Program Oversight; and Innovation Lab) and is headed by two managing directors, Dr. Tim Persons (GAO's Chief Scientist) and Dr. John Neumann. GAO anticipates the need to grow the STAA team from its current staffing level of 49 to 140 full-time staff. To help meet project-specific needs, GAO is considering options for adding limited term staff, such as interns, fellows, and Intergovernmental Personnel Act (IPA)[13] detailees.

The Analysis Gap

Advocacy groups and policy experts from both sides of the aisle have raised concerns about the lack of a dedicated source of scientific and technical advice and assessment for Congress. They argue that the resources currently available do not provide Congress with in-depth and forward-looking analysis, including analysis of multiple policy options, in a form and on a schedule that is useful to legislators.[14,15,16,17,18,19] A 2016 survey found that only 24 percent of House and Senate senior staff said that they were very satisfied with congressional access to "high-quality, nonpartisan policy expertise", despite 81 percent saying they found this access to be "very important" to their duties.[20] Many also point to Congress's inability to absorb the vast quantities of information to which it has access.

Over the last 24 years, congressional support agencies and NASEM have filled in some gaps but they have thus far been unable to fulfill all elements of OTA's mission. Whereas OTA evaluated

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[13] The Intergovernmental Personnel Act Mobility Program provides for the temporary assignment of personnel between the Federal Government and state and local governments, colleges and universities, Indian tribal governments, federally funded research and development centers, and other eligible organizations. https://www.opm.gov/policy-data-oversight/hiring-information/intergovernment-personnel-act/

[14] Center for American Progress, "Congress Should Revive the Office of Technology Assessment," May 13, 2019, https://www.americanprogress.org/issues/green/news/2019/05/13/469793/congress-revive-office-technology-assessment/

[15] Bipartisan Policy Center, "Congress Needs the Office of Technology Assessment to Keep up with Science and Technology," July 25, 2019, https://bipartisanpolicy.org/report/congress-needs-the-office-of-technology-assessment-to-keep-up-with-science-and-technology/

[16] R Street Institute, "Bring in the nerds: Reviving the Office of Technology Assessment," January 24, 2018, https://www.rstreet.org/wp-content/uploads/2018/04/Final-128-1.pdf

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

[18] Belfer Center, "Building a 21st Century Congress: Improving Congress's Science and Technology Expertise," September 2019, https://www.belfercenter.org/publication/building-21st-century-congress-improving-congresss-science-and-technology-expertise

[19] AEI, "Congress should revive the Office of Technology Assessment," December 6, 2018, https://www.aei.org/articles/congress-should-revive-the-office-of-technology-assessment/

[20] Congressional Management Foundation, "State of the Congress: Staff Perspectives on Institutional Capacity in the House and Senate," August 8, 2017, http://www.congressfoundation.org/projects/resilient-democracy-coalition/state-of-the-congress

a host of policy implications, the Congressional Budget Office (CBO) is primarily concerned with the economic impact of proposed policies.[21] Due to its broad mandate, the Congressional Research Service (CRS) has limited staff with STEM backgrounds.[22] GAO does not provide forward looking analysis to alert Congress of emerging science and technology issues. GAO also lacks the in-house expertise that OTA had, which limits its capacity to provide informal advice on short notice. Notably, CRS and GAO staffing have decreased by 17 and 31 percent, respectively, since OTA closed.[23,24] Finally, some have expressed concern about the differences between GAO's traditional audit and program evaluation culture and the culture needed for effective TA.

NASEM must be funded by a Federal agency to perform work for Congress, which can at times be a source of friction. The Academies is also not accustomed to assessing policy options, but rather developing policy recommendations by consensus. Finally, an Academies report takes one to two years to complete, a timeline that is not well aligned with the legislative cycle.

NAPA Report

The congressionally-mandated NAPA report was published on November 14, 2019.[25] The study committee identified gaps in the areas of "networking, consultative support, short- and medium-term S&T-related reports" and "S&T horizon scanning."

The study committee recommended that Congress should not stand up an OTA-like entity within the legislative branch, but instead should provide GAO and CRS with the authority and resources to build their S&T capacity and create an S&T advisory office and a coordinating council to bolster the cooperation and communication between GAO and CRS. The committee also recommends that Congress assess the outcome of these efforts 24 months after implementation.

The advisory office, called the Office of the Congressional Science and Technology Advisor (OCSTA), would be headed by a Congressional S&T Advisor and mandated with "expanding the S&T capacity of the Congress." The S&T Advisor, appointed by House and Senate leaders should be an "eminent individual, widely recognized and respected across the S&T community encompassing government, academia, and industry" and 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." OCSTA would also be charged with horizon scanning for emerging S&T trends through contract with external organizations.

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[21] CBO, "10 Things to Know About CBO," February 14, 2019, https://www.cbo.gov/about/10-things-to-know
[22] CRS, "History and Mission," November 15, 2012, https://www.loc.gov/crsinfo/about/history.html
[23] LOC, "Fiscal Year 2020 Budget Justification," https://www.loc.gov/static/portals/about/reports-and-budgets/documents/budgets/fy2020.pdf
[24] GAO, "Fiscal Year 2020 Budget Request," February 27, 2019, https://www.gao.gov/assets/700/697133.pdf
[25] NAPA, "Science and Technology Policy Assessment: A Congressionally Directed Review," November 14, 2019, https://www.napawash.org/studies/academy-studies/science-and-technology-policy-assessment-for-the-us-congress

The study committee did assess an alternative option in which a new OTA-like congressional entity is established to "focus on medium-term S&T studies and horizon scanning studies for Congress" while CRS strengthens its S&T capabilities and GAO continues to enhance its STAA team. While the committee rated the "desirability" of this option as "high", it rated the "viability" as "low" and "feasibility" as "medium", citing potential vulnerability to political challenges, the difficulty in gathering "sufficient resources and political support", and the potential for duplication of effort with CRS and GAO.

While the study committee acknowledged that standing up an advisory office like OCSTA "is likely to be challenging given the current congressional environment," they state without explanation that "it should be less difficult than creating an entirely new agency." The committee did not address the potential for OCSTA to be vulnerable to political challenges.

Chairwoman JOHNSON. Good morning. This hearing will come to order. And without objection, the Chair is authorized to declare a recess at any time.

Welcome, everyone, especially our witnesses.

The history of a technology assessment function within the legislative branch is tied to our Committee's early history. Beginning in the mid-1960s the Committee's then-existing Subcommittee on Science, Research, and Development organized a series of hearings on the relationship between science, technology, and society and the need for Congress to be informed about emerging technology risk.

Several years and many hearings and reports later Congress enacted the *Technology Assessment Act of 1972*, creating the Office of Technology Assessment (OTA). During its 20 years of operation, OTA created 700 reports on the science and technology (S&T) relevant to issues of importance to Congress. As we all know, the OTA was defunded and disbanded in 1995. My friend and former Republican colleague, Congressman Sherry Boehlert, defended the OTA during the debate to defund it. In his remarks, he questioned the wisdom of disbanding OTA, arguing that the public wanted us to do more with less, not to do more knowing less.

Today, the Science, Space, and Technology Committee has its own expert staff, many of whom have Ph.D.s, to help Members of this Committee navigate tough science and technology issues. Science Committee staff also serve as a resource for personal offices across the House, and in some case for other committees. But committee staff are not a replacement for OTA. Our Committee and others also rely heavily on expertise at the executive branch agencies and from entities outside the government such as the National Academies. But the fact is much of the information we receive from outside sources comes from individuals or organizations with a particular point of view that we must sort through.

We also turn to GAO (Government Accountability Office) to fill some of our science and technology needs. However, GAO is still far from filling the gap left by the defunding of OTA. In short, since 1995 there has not been a single, trusted, comprehensive, and authoritative source of science and technology advice for Congress.

Since its disbanding, there have been a few persistent champions for bringing back the OTA. In the last couple of years, those few voices have become a chorus, with support from both sides of the political spectrum. The reason is clear. With every passing year, scientific and technological issues are becoming more complex and with increasing societal impacts. Absent an OTA, we are often left struggling to make sense of the competing expert opinions but still having to make policy decisions in this murky context, with potentially grave consequences. The alternative is to be paralyzed into inaction, ceding decisionmaking to the private sector or to other countries, including our adversaries.

Today's discussion will cover a range of topics relevant to how Congress receives and uses scientific and technical advice. And these topics are all important. However, the central question for today's hearing is this: Do we bring back a modernized OTA, or do we provide GAO with additional mandates and resources to fill that gap? My hope is that in addressing this question, we can tem-

porarily set aside questions of what is politically expedient and get to the core arguments weighing in favor and against each option for meeting the needs of Congress. In other words, I hope this hearing emulates the practice followed by OTA in providing this Committee with the sound policy options, while leaving it to Congress to figure out the politics. While we no longer have a legislative jurisdiction, it is appropriate that 55 years after the first hearing, the Science Committee continues to lead this discussion.

I thank the expert witnesses for being here today, and I look forward to your testimony.

[The prepared statement of Chairwoman Johnson follows:]

Good morning and welcome to our witnesses. The history of a technology assessment function within the legislative branch is tied to our own Committee's early history. Beginning in the mid1960's the Committee's then existing Subcommittee on Science, Research, and Development organized a series of hearings on the relationship between science, technology, and society, and the need for Congress to be informed about emerging technology risks.

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Chairwoman JOHNSON. Before I recognize Ranking Member Lucas for his opening statement, I'd like to present for the record

a letter from the R Street Institute and Lincoln Network regarding this hearing.

The Committee now recognizes Mr. Lucas.

Mr. LUCAS. Thank you, Chairwoman Johnson, for holding this hearing today. I appreciate the opportunity to discuss ways to improve the resources available to Congress for science and technology issues.

Over the last few years, we've heard that some Members of Congress do not believe they have the resources they need to evaluate science and technology issues. In response, the Appropriations Committee has taken a number of steps to address these concerns.

First, they have directed the Government Accountability Office to expand its technology assessment capacities. Since 2007, Congress has funded GAO to do this S&T work. At the direction of the appropriators, GAO also stood up a separate Science, Technology Assessment, and Analytics team. I look forward to hearing from Dr. Persons about that effort, and the plan to grow that team to meet the needs of Congress.

Second, appropriators directed the Congressional Research Service (CRS) to commission a study by the National Academy of Public Administration to identify gaps in congressional S&T resources and make recommendations. That report was just released a few weeks ago. And I appreciate the thoughtful work the study committee did to understand the needs of Congress and recommend thoughtful solutions. We'll hear more about those recommendations today from a member of the study committee, Mr. McCord.

I believe Chairwoman Johnson and I agree that one of our most important jobs as a Committee is to serve as a resource on science and technology issues that come before us, not just for our Committee Members but for the entire House. We're fortunate to have staff on both sides of the aisle with a variety of expertise in science, engineering, policy, and the law. Our staff provides good counsel, and they also can tap into a wealth of knowledge from outside expertise on subjects ranging from quantum computing to engineering biology.

However, I recognize that our staff does not have the capacity to provide the type of support and analysis needed by every Member of Congress. So I'm eager to hear more about the resources GAO is providing and NAPA's (National Academy of Public Administration's) recommendations on how we can best meet our informational needs.

In my time in Congress, I have witnessed Committee and Member office budgets shrink and our ability to retain and pay staff diminish. I look forward to hearing ideas from our panel about how to attract and retain S&T talent; also, thoughts on how to communicate to our constituents the importance of Congress being able to have the capacity to fulfill its constitutional duties, particularly when it comes to dealing with the challenges and opportunities of emerging technologies.

I'm one of the few Members of the Committee who was actually, I guess the Chair and I and Congresswoman Lofgren were Members of Congress when the Office of Technology Assessment was defunded and when those functions were later transitioned to GAO and CRS. At the time, many on my side of the aisle saw OTA as

duplicative of other resources. Many also believed that the office had strayed from its intended purpose of being an unbiased, nonpartisan organization.

Over the last few years, there's been a small but passionate contingent of Congress Members and think tank experts who've advocated for restoring OTA. I think there's a tendency to look to the past with rose-colored glasses and that if we just went back to the way things were, everything that's wrong with Congress would be fixed. Well, not everything in Congress worked perfectly when I came here in 1994, and it's certainly not working perfectly now. I acknowledge that. I think there is merit in evaluating what would serve our Members best in the 21st century, as we are doing here today.

I still believe the U.S. Congress is the best deliberative body in the world. I look forward to a positive, bipartisan discussion today on how to make it better and to best serve the American people.

And with that, I yield back, Madam Chair.

[The prepared statement of Mr. Lucas follows:]

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So I'm eager to hear more about the resources GAO is providing, and NAPA's recommendations on how we can best meet our informational needs.

In my time in Congress, I have witnessed Committee and Member office budgets shrink, and our ability to retain and pay staff diminish. I look forward to hearing ideas from our panel about how can attract and retain S&T talent.

Also, thoughts on how to communicate to our constituents the importance of Congress being able to have the capacity to fulfill its constitutional duties, particularly when it comes to dealing with the challenges and opportunities of emerging technologies.

I am one of the few Members of this Committee who was in Congress in 1994 when the Office of Technology Assessment was defunded, and when those functions were later transitioned to the GAO and CRS.

At the time, many on my side of the aisle saw the OTA as duplicative of other resources. Many also believed that the office had strayed from its intended purpose of being an unbiased, nonpartisan organization.

For the last few years, there has been a small but passionate contingent of Congress Members and think tank experts who have advocated for reinstating the OTA. I think there is a tendency to look to the past with rose colored glasses. And that if we just went back to the way things were, everything that's wrong with Congress would be fixed.

Well, not everything in Congress worked perfectly when I came here in 1994, and it's certainly not working perfectly now. I think there is merit in evaluating what would serve our Members best in the 21st Century, as we are doing today.

I still believe the U.S. Congress is the best deliberative body in the world. I look forward to a positive, bipartisan discussion today on how to help make it better, to best serve the American people.

Chairwoman JOHNSON. Thank you very much.

If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

At this time I'd like to introduce our witnesses. Our first witness is the Honorable Michael McCord. Mr. McCord is the Director of Civil-Military Programs at the Stennis Center for Public Service. He also serves as an Adjunct Research Staff Member at the Institute of Defense Analysis and is a Fellow of the National Academy of Public Administration. Previously, Mr. McCord served 8 years at the U.S. Department of Defense as Under Secretary of Defense (Comptroller)/Chief Financial Officer, and before that as a Principal Deputy Under Secretary for Defense, Comptroller. In these roles he has advised Secretaries of Defense Gates, Panetta, Hagel, and Carter on all budgetary and financial matters.

Our next witness, Ms. Laura Manley. Ms. Manley is the inaugural Director of the Technology and Public Purpose Project at the Harvard Kennedy School Belfer Center for Science and International Affairs. In this role, she is responsible for all project research and programs, including societal due diligence assessments for tech investors, emerging tech briefing guides for policymakers, and strategies for increasing congressional S&T capacity. Previously, Ms. Manley cofounded the Center for Open Data Enterprise, a nonpartisan research organization that works with governments to leverage data for social and economic good. She's also the Senior Consultant for the World Bank Group and the United Nations' Department of Economic and Social Affairs.

After Ms. Manley, Dr. Timothy Persons. Dr. Persons is the Chief Scientist and Managing Director of the Science, Technology Assessment, and Analysis Team of the U.S. Government Accountability Office. He also founded GAO's Innovation Lab and directs GAO's science, technology, and engineering portfolio. In these roles, he has led a large interdisciplinary technical team, which has advised Congress and informed legislation on a number of topics, including artificial intelligence, sustainable chemistry, and advanced data analysis, among others. Prior to joining GAO, Dr. Persons served as Technical Director for the Intelligence Advanced Research Projects Agency.

Our fourth witness, Dr. Peter Blair. Dr. Blair is Executive Director of Engineering and Physical Sciences at the National Academies of Sciences, Engineering, and Medicine. From 1983 to 1996 Dr. Blair served in several capacities at the congressional Office of Technology Assessment, concluding as Assistant Director of the agency and Director of the Industry, Commerce, and International Security Division. He's also author of the book, "Congress' Own

Think Tank: Learning from the Legacy of the congressional Office of Technology Assessment."

Our witnesses should know that you will have 5 minutes for your spoken testimony. Your written testimony will be included in the record for the hearing. When all of you have completed your spoken testimony, we will begin with questions. And each Member will have 5 minutes to question the panel. So we'll start with Mr. McCord.

TESTIMONY OF THE HON. MICHAEL MCCORD, DIRECTOR, CIVIL-MILITARY PROGRAMS, STENNIS CENTER FOR PUBLIC SERVICE

Mr. MCCORD. Good morning, Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee. Thank you for the opportunity to be part of this hearing and of the effort to make this institution more informed and effective on science and technology issues.

I testify today in my role as a Fellow of the National Academy of Public Administration and specifically as a member of the five-person panel that analyzed science and technology support to Congress. The Academy is a nonprofit independent organization helping governments at all levels solve the Nation's complex public management challenges and, like the National Academy of Sciences, we are chartered by Congress.

Our report on this was posted on the Academy website on November 14. As Mr. Lucas noted, this report was prepared for the Congress and at the direction of the Congress in the Fiscal Year 2019 legislative branch appropriations bill. I thank the Committee for making our full report part of the record of this hearing, along with my written statement and for the opportunity to appear before you to discuss our findings and recommendations.

As part of our panel's efforts, our staff interviewed over 100 stakeholders. Although they may not agree with our recommendations, we did talk to all of my fellow witnesses at this table today in conducting our analysis.

The accelerating rate of change in science and technology in the 21st century brings enormous benefits and challenges to both individual citizens and to those of you who are responsible for evaluating how these changes impact society as a whole. In this context, Congress needs to improve its capacity to deal with science and technology-related issues. You have some resources available to you now. The question is are they adequate to meet your needs?

Our task, as laid out in the appropriations conference report, was, first, to review the current science and technology resources available within the legislative branch, including GAO and CRS; next, to assess the potential need to create a separate entity to provide nonpartisan advice on these issues such as the former Office of Technology Assessment; and then finally, to address whether creating that kind of office would duplicate services already available to you.

Our report identified several types of S&T products or services that Congress requires to do its work. They are summarized in the table that is part of my written statement. We then looked at the supply of staff resources available to you and assessed whether it

was sufficient to meet the demands that we identified. We concluded that current resources are not sufficient and assessed options for filling the gaps that we saw.

First, we looked at relying on the existing agencies like GAO and CRS. We also looked at creating a new agency, and finally, we looked at a hybrid approach of building on the existing resources but allowing for some new organization or entity to fill gaps.

In assessing these options, we tried to balance how well each option would provide the capabilities that are needed to meet your demands with how difficult it would be to implement and how likely would it be to succeed and be sustainable over the long-term.

So let me now describe our recommendations, which is the hybrid approach of enhancing existing capabilities and creating a new advisory office. There are sort of two parts of this recommendation. First is on what I would call the supply side, increasing support resources for Congress, and second is on your ability as an institution to absorb and make use of additional capabilities.

So on that first track, increasing the supply of resources available to you, our recommendation is, first, that CRS should enhance and expand its quick turnaround and consultative services; second, that GAO should further develop the capability of its Science, Technology Assessment, and Analytics (STAA) mission team to meet some of the gaps identified in our report and should separate those STAA experts to the maximum extent possible from its audit and oversight function, which is somewhat of a different culture.

Next, Congress should create an office of the congressional S&T Advisor, which would focus on efforts to build the absorptive capacity of Congress to include supporting recruiting S&T advisors for House and Senate Committees with major oversight responsibilities so that you have greater S&T expertise in the Committees where legislation is being produced. This new office would also be responsible for horizon scanning, which we would envision being communicated to Congress in the form of an annual report and annual testimony by this advisor.

Finally, we believe Congress should create a coordinating council to be led by this advisor to limit duplication across this advisor's office, CRS, GAO, et cetera.

The second track of our recommendation is improving Congress' ability to absorb greater levels of information about S&T policy issues. We believe that's just as important as what resources you ultimately decide to add on supply side. We believe our recommendations will address your needs. That said, we also recommend that Congress conduct a thorough review to evaluate the performance of these reforms 24 months after implementation so you can adjust where needed.

Finally, we recommend that Congress pass legislation to carry out these reforms. Even if you could do these changes by fitting it in existing authorities, we strongly urge you to pass a bill that lays out the course the House and Senate agree on to create that public record and to force a compromise and buy-in from both bodies.

I would summarize our approach as, first, make more use of and enhance the tools already in your workshop. Thank you, and I'll be happy to answer your questions and provide further details.

[The prepared statement of Mr. McCord follows:]

TESTIMONY OF THE HONORABLE MICHAEL MCCORD
DIRECTOR, CIVIL-MILITARY PROGRAMS
STENNIS CENTER FOR PUBLIC SERVICE

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
December 5, 2019

"Science and Technology Policy Assessment: A Congressionally Directed Review"

Good morning Chairwoman Johnson, Ranking Member Lucas, and members of the Committee. I am Michael McCord, and I served as a member of a five-person Panel of Fellows of the National Academy of Public Administration (the Academy) that prepared a report on science and technology assessment resource support to Congress. I testify today in my role as a Fellow of the Academy and member of the Panel that prepared this report. My colleagues on the Panel were our Panel chair, Elizabeth Fretwell, James Hendler, David Rejeski, and Kathleen Peroff. Our report was submitted on October 31, 2019 and was made public on the Academy web site on November 14, 2019.

In addition to being a fellow of the Academy, I am the director of civil-military programs for the Stennis Center for Public Service, a bipartisan and bicameral agency of Congress devoted to promoting public service and the professional development of congressional staff; and also an Adjunct Research Staff Member at the Institute for Defense Analyses (IDA). The report and testimony I am presenting today are the recommendations of NAPA and not of the Stennis Center or IDA. I would also note that a separate division of IDA than the one I am employed by provides science and technology support to the President's Council of Science and Technology Advisors, but that has no bearing on my testimony today. Finally, I will note that NAPA fellows like myself are not employees of the Academy and receive *de minimus* compensation only for those few days we meet together in person as a panel.

Thank you for the opportunity to appear before you to discuss the report's findings and recommendations.

The Academy is a non-profit, independent organization of top public management and organizational leaders who tackle the Nation's most critical and complex public management challenges. The Academy, like the National Academy of Sciences with which this committee is very familiar, is chartered by Congress under Title 36 of the United States Code. The Academy is a nonprofit, nonpartisan organization focused on improving governance, public administration, and therefore policy outcomes at the federal, state and local levels. With a network of more than 900 distinguished Fellows and an experienced professional staff, the Academy is uniquely qualified and trusted across government to provide objective advice and practical solutions based on systematic research and expert analysis. Established in 1967 and chartered by Congress in 1984, the Academy continues to make a positive impact by helping federal, state, and local governments respond effectively to current circumstances and changing conditions.

The exponential rate of change in science and technology in the 21st century brings 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 the Fiscal Year 2019 Legislative Branch Appropriations bill, Congress directed the Congressional Research Service (CRS) to contract with 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. In conducting our review, our Panel and study team staff interviewed numerous experts in this field inside and outside the legislative branch, including all of my fellow witnesses for this hearing. A complete list of those we interviewed is included in our full report which I ask be made part of the record of this hearing.

The Panel's approach to this research was guided by the following features:

- Adopt demand-driven solutions
- Create a taxonomy of congressional needs for S&T policy resources
- Consider refunding of OTA that is tailored to fill demand gaps
- Consider how existing legislative branch providers can enhance or expand S&T support
- Apply best practices in institutional design
- Devise decision-making criteria
- Consider actions to enhance Congress' absorptive capacity

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 the following Table.

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 (prepared by Academy)

[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.

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. 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 for increasing congressional capacity and capabilities.

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. Every major committee should have at least one S&T advisor. 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.

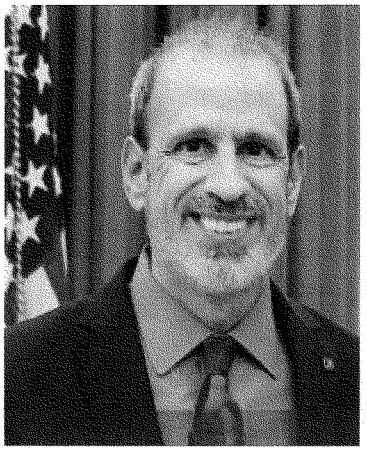
The Panel recommends that Congress conduct a thorough, independent, and nonpartisan review to evaluate the performance of the option. This review would take place 24 months after implementation. Congress should provide CRS and GAO resources and authority to build the capabilities needed to carry out 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. In addition to the four recommendations above that speak to the resources available to the Congress, 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 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 and congressional policy-making on the cutting-edge of S&T issues.

In summary, 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. The Panel's recommendation addresses these needs and calls for a timely review to ensure that any course corrections can be identified and actions taken in order to best harness and address the S&T developments proliferating around us. We commend the committee for holding this hearing and we look forward to working with you going forward, should you so desire, as you conduct oversight and prepare to legislate to move the Congress forward on this important issue.



Michael J. McCord

Mike McCord is the Director, Civil-Military Programs at the Stennis Center for Public Service Leadership, which is a legislative branch organization devoted to promoting public service and enhancing the leadership skills of congressional members and staff.

He also serves as an Adjunct Research Staff Member at the Institute for Defense Analyses, with a focus on management, cost, and acquisition issues. In addition, Mr. McCord is a Fellow of the National Academy of Public Administration and was a member of the Commission on the National Defense Strategy for the United States, which released its report *Providing for the Common Defense* in November 2018.

Previously, he served for eight years at the U.S. Department of Defense as the Under Secretary of Defense (Comptroller)/Chief Financial Officer and before that as the Principal Deputy Under Secretary of Defense (Comptroller) from January 2009 through January 2017. In these roles he advised Secretaries of Defense Gates, Panetta, Hagel and Carter on all budgetary and financial matters and was responsible for development and execution of annual defense budgets in excess of $500 billion.

Prior to his service at the Department of Defense, Mr. McCord served for 24 years in the legislative branch, including 21 years as a Professional Staff Member on the Senate Armed Services Committee for former Senators and Chairmen Sam Nunn and Carl Levin. As a member of the Senate staff his primary focus was on budget, fiscal policy, and military readiness and installation issues. He also served on the staff of the House Budget Committee, and began his career as a cost analyst at the Congressional Budget Office.

Mr. McCord has a B.A. in Economics from the Ohio State University and a Master of Arts in Public Policy from the University of Pennsylvania.

Chairwoman JOHNSON. Thank you, Mr. McCord. Ms. Laura Manley.

TESTIMONY OF MS. LAURA MANLEY,
DIRECTOR, TECHNOLOGY AND PUBLIC PURPOSE PROJECT,
BELFER CENTER FOR SCIENCE
AND INTERNATIONAL AFFAIRS,
HARVARD KENNEDY SCHOOL OF GOVERNMENT

Ms. MANLEY. Chairwoman Johnson, Ranking Member Lucas, and distinguished Members of the Committee, thank you for calling today's hearing and the opportunity to testify. My name is Laura Manley, and I'm the Director of the Technology and Public Purpose Project at the Harvard Kennedy School's Belfer Center for Science and International Affairs. Our mission is to ensure that emerging technologies are both developed and managed in ways that protect the public good. We conduct research on how to integrate societal impacts like privacy, safety, security, transparency, and inclusion at each step of new technology's development, production, and management.

One of the most critical opportunities to ensure new technologies are benefiting the public while harms are minimized is governance through the U.S. Congress. Eight out of 10 of the largest tech companies in the world are U.S.-based, giving Congress the unique position and power to create thoughtful legislation on these new technologies.

While you represent your constituents in this country, your decisions also have the power to affect billions of people around the world impacted by emerging tech. Therefore, over the past 18 months we've conducted research on how congressional personal offices and committees identify S&T needs, find relevant resources, absorb the salient points, and use that information in the policymaking process.

After consulting with over 140 current and former Members of Congress, staffers, support agency leaders, lobbyists, civil society experts, and academics, we've uncovered several issues. First, much of the debate around solutions to the S&T gap present a false choice between building external support agency expertise and internal capacity efforts. We find that both are needed in order to effectively address the gap for several reasons.

One, the S&T demands on Congress vary so widely neither a single centralized expertise body nor a bolstered staff would alone address all issues. Two, even with access to the smartest experts in the world on any given technical topic, personal offices and committees still need internal S&T talent to evaluate what they're told, especially when there are opposing views or opaqueness in how experts arrived at their conclusions.

By understanding the day-to-day experiences of Members of Congress and their staff, we believe that there are several steps that can be taken on two levels: long-term congressional workforce improvements and near-term actions to address immediate expertise gaps. Therefore, we have the following recommendations.

In terms of workforce improvements, Congress should increase budgets to allow both committees and offices to hire additional staff members and pay more competitive salaries, which will help retain

the staff they already have. This will ultimately save taxpayer dollars by giving offices and committees the expertise they need to thoughtfully evaluate the effectiveness of S&T spending or recommend other cost-saving actions.

Congress should also hire additional staff with STEM (science, technology, engineering, and mathematics) backgrounds to increase in-house expertise and capacity. As a current staffer noted, congressional offices often hire from within. Staffers typically start as interns who worked their way up over time. In other words, the traditional hiring process is not necessarily designed for subject-matter experts with years of scientific training.

For near-term actions to address immediate gaps Congress should strengthen legislative support agencies like the GAO or revive and revamp the OTA. A new or improved legislative support agency provides Congress with immediate benefits as it reevaluates its workforce. Given the time-sensitive nature of emerging tech that need effective legislation now, supporting an S&T expertise body will help provide timely information for a variety of congressional needs, specifically those that require a comprehensive evaluation of complex technical topics.

And last, Congress should connect with universities to build more robust pipelines for recruiting STEM talent to serve on Capitol Hill.

Improving S&T expertise within the policymaking community is not Congress' responsibility alone. Many STEM students aren't aware that they could be successful policy advisors on Capitol Hill or even what the jobs would entail. Academic institutions should educate STEM students in the policymaking process and roles within government.

In conclusion, to truly fix Congress' science and tech problem it needs to fix its staffing problem. More immediate actions like refunding the OTA or enhancing entities like GAO or CRS are extremely valuable pieces of the puzzle but do not complete the picture. Conversely, only increasing staff salaries and hiring additional STEM talent will not solve the independent expertise gap either. Both are critical supports for each other. They allow Congress to have independent rigorous assessments of emerging tech while also giving it the in-house expertise and capacity to evaluate requests, advice, and proposed legislation.

I acknowledge the challenges of some of these recommendations and the time it may take to make progress. However, to fully address the magnitude of the problems this country faces due to transformational technologies, we need an equally significant change to the way Congress recruits, retains, and absorbs expertise.

Thank you again for the opportunity to testify and for holding an important hearing on this topic. I welcome your questions.

[The prepared statement of Ms. Manley follows:]

CONGRESSIONAL TESTIMONY

Prepared Statement

by

Laura Manley
Director, Technology and Public Purpose Project
Belfer Center for Science and International Affairs
Harvard Kennedy School

Before the

United States House Committee on Space, Science, and Technology (HSST)

Hearing on

Experts Needed: Options for Improved Science and Technology Advice for Congress

December 5, 2019

Chairwoman Johnson, Ranking Member Lucas, and distinguished Members of the Committee, thank you for calling today's hearing on congressional Science and Technology (S&T) expertise and for the opportunity to testify. The views I express in this testimony are my own and should not be construed as representing any official position of the Belfer Center, Harvard Kennedy School, or Harvard University.

Congress's Role in Governing Emerging Technologies

We are at a pivotal moment in time. Emerging technologies are moving from research labs to store shelves faster than we've ever seen. In the past ten years, social media, smartphones, cloud computing, genetic editing, and other AI-fueled technologies have changed how humans live, work, eat, and interact with one another. Many of these technologies hold tremendous promise, but each has a downside, too. Protecting online privacy, combating climate change, and safeguarding elections from hacking are all examples of areas where science and technology expertise is needed by our policymakers to ensure society benefits from these new technologies while harms are minimized.

Driving much of this innovation are United States-based companies, scientists, and technologists. Eight of the ten largest tech companies in the world (including Apple, Microsoft, Alphabet, IBM, and Facebook) are American and out of the top 150 largest tech companies, the U.S. is home to

nearly half[1]. The U.S. is also a global leader in creating cellular therapies and other biotechnologies, according to Deloitte, and is in a race with China for 'biointelligence' supremacy by combining artificial intelligence and biotechnology capabilities.[2] And according to the World Intellectual Property Organization's ranking of innovative countries, in 2019 the U.S. ranked first in quality of innovation and market sophistication, with the most top science and technology innovation clusters in the world.[3]

Because of the country's position as a global innovation leader, the U.S. Congress, more than any other institution in the world, has the power to craft breakthrough legislation to help shape how our global society is impacted by emerging technologies. As the Congressional Research Service (CRS) wrote, "The federal government has played an important role in supporting R&D efforts which have led to scientific breakthroughs and new technologies, from jet aircraft and the internet to communications satellites and defenses against disease."[4]

From appropriating funding for basic and applied research--about $155 billion in FY2017, the most recent figure available[5]--to crafting smart regulations that promote fair competition and safe use, Congress plays a vital role in promoting and managing emerging technologies. Congress also acts as a key fail safe in managing emerging technologies that were ineffectively managed, and therefore pose societal risks. **By creating societal guardrails for technologies that have already become pervasive in society, like social media, Congress can promote public purpose in ways that other organizations cannot.**

Unfortunately, in recent years, Congress has missed opportunities to set the guiding principles and norms for many emerging technologies, ceding opportunities to other countries, states, or governments. For example, rather than make the U.S. a global leader in protecting user data privacy, the European Union set the standard with its General Data Protection Regulations (GDPR), with California's Consumer Privacy Act (CCPA) to soon follow. In the U.S., Congress has ceded the opportunity to set the norms and guidelines, leaving it up to individual states and localities to create a patchwork of data privacy and protection regulations--sometimes making it more difficult for consumers to understand how their data is used or secured. Other technologies with profound public impacts, like facial recognition, have been left to state and local governments to regulate.[6]

Aside from managing emerging technologies, Congress plays an important role in increasing American economic competitiveness. As Undersecretary of Commerce for Standards and

[1] Panciano, Jonathan. "The Largest Technology Companies In 2019: Apple Reigns As Smartphones Slip And Cloud Services Thrive." *Forbes*. May 15th, 2019. https://www.forbes.com/sites/jonathanponciano/2019/05/15/worlds-largest-tech-companies-2019/#14b5b18e73 1f
[2] "2019 Global Life Sciences Outlook." *Deloitte*. Page 13. https://www2.deloitte.com/global/en/pages/life-sciences-and-healthcare/articles/global-life-sciences-sector-outlook.html
[3] "Global Innovation Index 2019: United States of America." *World Intellectual Property Organization*. July 2019. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2019/us.pdf
[4] Gottron, Frank. "S&T Issues in the 116th Congress." Congressional Research Service. February 2019. Page 2. https://fas.org/sgp/crs/misc/R45491.pdf
[5] Ibid.
[6] "A Facial Recognition Ban is Coming to the US, says AI Policy Advisor." MIT Tech Review. September 2019. https://www.technologyreview.com/s/614362/a-facial-recognition-ban-is-coming-to-the-us-says-ai-policy-advisor/

Technology and NIST Director Walter G. Copan put it, "Removing roadblocks, enabling entrepreneurs, attracting private investment and getting inventions from the laboratory into the marketplace faster are essential to unleash American innovation and to strengthen U.S. economic competitiveness and national security."[7] Congress plays a role at each step.

Evaluating and Reframing the Dialogue on Congressional S&T Expertise

At the Technology and Public Purpose (TAPP) Project based at Harvard Kennedy School's Belfer Center for Science & International Affairs, we conduct research on how to ensure that emerging technologies are developed and managed in ways that serve the overall public good.

Given Congress's importance in this space, we wanted to better understand how equipped it is to reckon with emerging technologies. In interviews and much of the existing literature on Congress and its S&T expertise, we heard three consistent themes:

1. Congress does not have enough S&T experts on staff;
2. Congress is too slow to keep up with effectively governing new technologies; and
3. We need better institutions to address this problem: either refund the OTA or invest in support agencies' capabilities like GAO.

This is a simple story, and on its face, a correct one. However, the existing narrative left out vital foundational questions: what, specifically, do congressional personal offices and committees need science and technology information for (see Appendix 1, Figure 1)? Where do they get it from? What do they do with it? In other words: what causes members of Congress to demand S&T expertise, and where do they get their supply of it from? What gaps exist, and how can they be filled both internally and externally?

To make progress, we needed to reframe the dialogue around the lived experiences of members and their teams. **Without a more holistic understanding how congressional personal offices and committees identify S&T needs, find relevant sources, absorb the salient points, and use that information, improving S&T expertise by adding support capacity is likely to be ineffective.** Reframing the conversation around actual day-to-day use of S&T information provides a more accurate picture of the real gaps that members and their staff face and offers a clearer set of prescriptions to close those gaps.

Over the past 18 months, the TAPP Project consulted over 140 stakeholders--including current and former members of Congress, congressional staff, lobbyists, civil society experts, and academics--**to understand how Congress uses S&T expertise and how we bolster its capacity to ensure society benefits from advances in technology while harms are**

[7] "NIST Releases Findings on Increasing the Innovation Impacts of Federally Funded R&D." National Institute of Standards and Technology, Department of Commerce. April 24th, 2019. https://www.nist.gov/news-events/news/2019/04/nist-releases-findings-increasing-innovation-impacts-federally-funded-rd

minimized. We found that an existing narrative presented a false choice between strengthening legislative support agencies and internal capacity building efforts leaving out important distinctions between different types of S&T needs. We believe a new framing is needed to truly build a 21st century Congress capable of addressing the pressing societal dilemmas of emerging technologies.

Existing S&T Needs & Available Resources

Given the broad spectrum of today's S&T information needs, a one-size fits all solution or a centralized expert S&T body alone to address capacity gaps will be insufficient to improve Congress's S&T expertise. Congressional S&T expertise requests vary from simple one-off time-sensitive requests to expansive reports on the technical, social, and economic dimensions of a nascent or emerging technology; the level of expertise, time to complete, and outputs vary considerably based on the need.[8]

As a result, congressional offices seek out the information they need from a variety of sources, including committee staff, legislative support agency staff, academics and think tank staff, and lobbyists (see Appendix 1, Figure 2). Each source has its benefits and drawbacks; lobbyists are well informed but working on behalf of a client with a specific goal and their own data, while academics are experts on specific topics but often not used to offering policy-oriented, actionable resources.

Despite the depth and breadth of S&T resources available to it, Congress remains unable to fully absorb and use them to understand emerging technologies and their implications; it needs an embedded workforce better suited to do so. As noted in our report, "Congress has simply not given itself the human capacity and funding necessary to efficiently and effectively absorb new information—particularly for complex S&T topics."[9] Members of Congress and their staff can get expert opinions and advice from a number of credible external sources. However, without basic in-house STEM expertise, many offices struggle to choose which expert to consult and how to weigh and assess opposing recommendations.

Recommended Approaches for Increasing Congressional S&T Expertise

As noted, our research showed that there is no one-size fits all solution to congressional S&T capacity issues. By understanding the lived experience of members of Congress and their staff, though, we believe that there are several steps that Congress can take on two levels: (1) Long-Term Congressional Workforce Improvements, and (2) Near-Term Actions to Address S&T Expertise Gap.

[8] For more on this topic, see *Building a 21st Century Congress*, page 59.
[9] Ibid, page 60.

Some of the steps to improve S&T capacity require structural changes to how Congress funds itself and hires talent to work in personal offices and committees. These changes are politically difficult and will require sustained pressure over time to accomplish, both by internal champions and through external pressure. However, making the changes would significantly improve congressional S&T expertise and enable the legislative branch to more effectively craft legislation and conduct real-time oversight on emerging technology issues.

In the meantime, there are several immediate actions that Congress can take to both rapidly bolster its S&T expertise and simultaneously lay the groundwork for the structural improvements that will pay off later. **These actions will help Congress address some of the gaps but should not be expected to solve the broader S&T expertise gap.** Nevertheless, they are vital improvements that, with some effort, will have an immediate impact.

Long-Term Congressional Workforce Improvements

Based on our research, we believe that the S&T gap Congress faces is a product of structural forces that prevent Congress from absorbing the S&T information it needs to do its job effectively (see Appendix 1, Figure 3). Therefore, we recommend the following long-term approaches to improve in-house expertise:

1. **Increasing Congressional Resources to Create Staff Capacity**

   Congress does not give itself enough resources to do its job effectively, particularly on S&T issues. Congressional staffers are overworked and underpaid; Congress does not offer salaries on par with the executive branch[10] or the private sector.

   Congressional under-resourcing affects every issue area Congress is responsible for, of course, but makes the S&T capacity gap more acute, for two reasons. First, congressional staff often have liberal arts backgrounds, which makes S&T issues more difficult to immediately work on. Second, congressional staff is overstretched with extremely broad portfolios, which makes it more difficult to spend time learning about the S&T issues they may be responsible for covering. The result is a Congress that lacks S&T expertise and is unable to take the time to learn some of the basics relevant to S&T topics.

   The solution is, at a surface level, simple: "Congress should increase committee budgets to allow them to hire additional staff members and pay a more competitive salary, which will help them retain the staff they already have. Specific to the House of Representatives, Congress should raise members' personal office budgets, remove the cap on office personnel, and increase the staff pay ceiling."[11]

[10] "Tech Unit Stretches Federal Pay System to Recruit Cyber Talent." Nextgov. October 2016. https://www.nextgov.com/cybersecurity/2016/10/tech-unit-stretches-federal-pay-system-recruit-cyber-talent/132332/
[11] Ibid., 12

Politically, though, this is a heavy lift. There is bipartisan agreement that Congress should not appropriate itself additional funding, as it would be a politically difficult vote to justify to constituents.

2. **Hiring Scientists and Technologists to Increase Subject Matter Expertise**

   Relatedly, Congress does not hire enough scientists and technologists to serve on Capitol Hill. As our report notes, "There are structural challenges that make a S&T-focused career in Congress unusually difficult. Due to budget constraints and the nature of the role, staffers are usually generalists...Career progression in Congress also puts those with an S&T background— often with a PhD— at a disadvantage. As a current staffer noted, congressional offices often hire from within Congress; staffers typically start as interns who work their way up over time. In other words, the hiring process is not designed for subject matter experts with years of scientific training."[12]

   Because science and technology-relevant issues are a part of every member of Congress's portfolio, S&T expertise should not be centralized within a single entity or office on Capitol Hill—it should be suffused throughout personal offices and committees. From asking smart questions during hearings to conducting effective oversight and crafting responsive, valuable legislation, members increasingly need S&T expertise within their personal offices.

   Congress should hire more S&T talent, and to do so it will need to create pathways for individuals with S&T backgrounds to thrive on Capitol Hill.

A workforce development solution that increases funding and creates pathways for S&T talent will take time, effort, and political will; it is a long-term project that will need champions inside Congress.

Near-Term Actions to Address Congressional S&T Gap

In addition to long-term workforce improvements, we believe there are immediate opportunities for Congress to supplement its S&T expertise:

1. **Adding S&T expertise through a legislative support agency like the Government Accountability Office or a revamped Office of Technology Assessment.**

   A new or improved legislative support agency provides Congress with immediate benefits as they reevaluate their workforce. Given the time-sensitive nature of emerging

[12] Ibid, 65-66.

technologies that need effective legislation now, supporting a new or improved S&T expertise body will help provide timely information for a variety of congressional needs, from one-off information requests to long-term interdisciplinary studies of the next generation of emerging technologies.

OTA's original function of providing timely, independent, and decisive research on complex S&T topics must be restored whether that's through GAO, a new version of OTA, or another entity. It's a necessary, but not fully sufficient approach to address the broader S&T expertise gap.

2. **Working with universities, foundations, and others to begin creating robust pathways for recruiting S&T talent to serve on Capitol Hill.**

   Improving S&T expertise within the policymaking community is not Congress's responsibility alone. Many STEM students are not aware that they could be successful policy advisors on Capitol Hill, or even what the job would entail. Universities and colleges should educate STEM students on the policymaking process and roles within government and should more actively promote public service to these students. Non-profit organizations and foundations can help provide stipends or other funding for students, to help defray the cost of living in the expensive Washington, DC area, and to offer additional incentive for STEM students.

Conclusion

At the TAPP Project, our next research priority is to better understand current pathways for junior STEM talent to serve on Capitol Hill: which universities have created effective pathways, what strategies can scale to other universities, and what Congress needs to do to encourage more STEM talent to advise on and participate in emerging technology policy.

Reframing the debate about congressional S&T capacity away from narrow questions about the OTA or GAO and towards a more holistic understanding of congressional needs is an important step for this conversation to take, and we are pleased to see NAPA's recent study continuing this trend.

The United States will continue to lead in technology development and innovation; it should also lead in managing emerging technologies to best serve the public purpose. In order to do so, we need a Congress capable of engaging in the complex societal issues that emerging tech brings to the forefront. We are delighted that this committee is holding a hearing on this important topic, and we are excited to help build a 21st century Congress, together.

APPENDIX I: Referenced Figures

Figure 1: Congressional Demand for S&T Resources

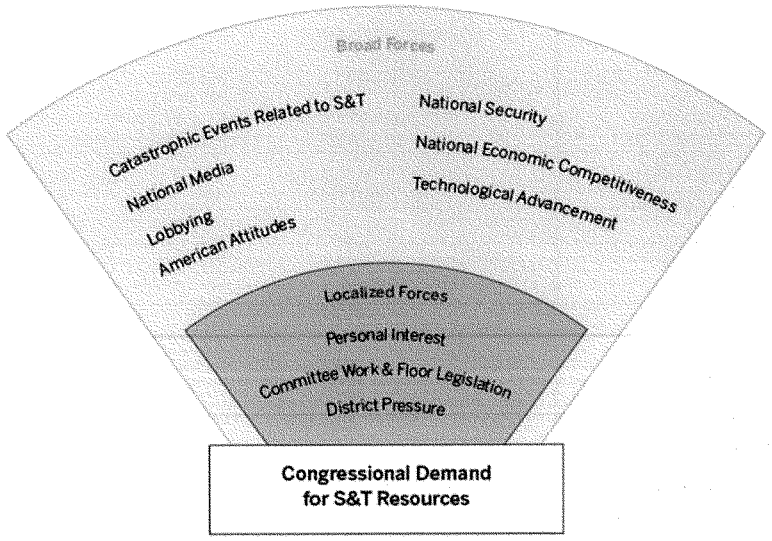


Figure 2: S&T Resources and Value-Add to Congressional Staff

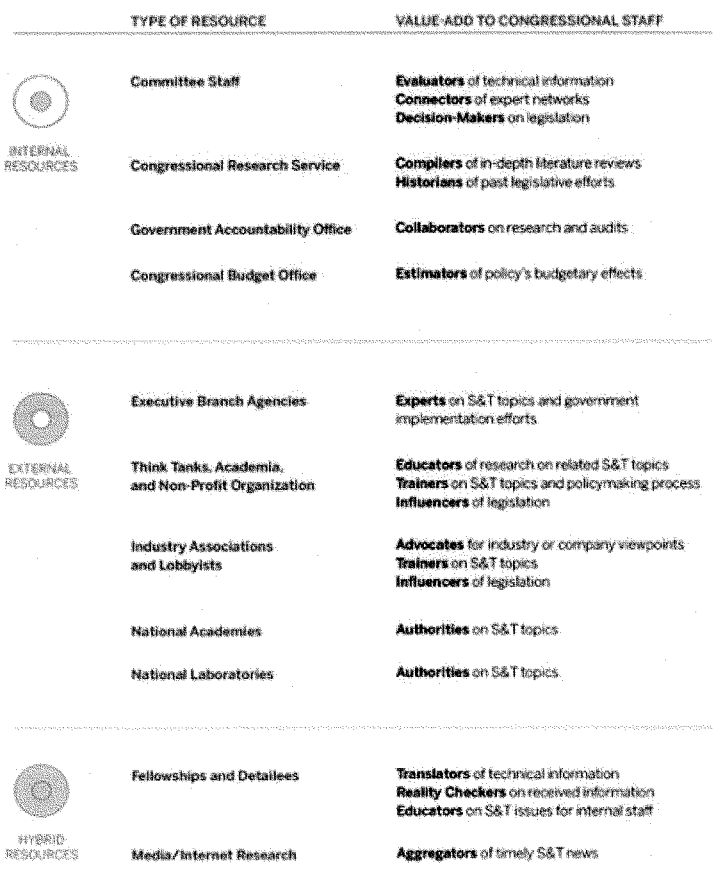
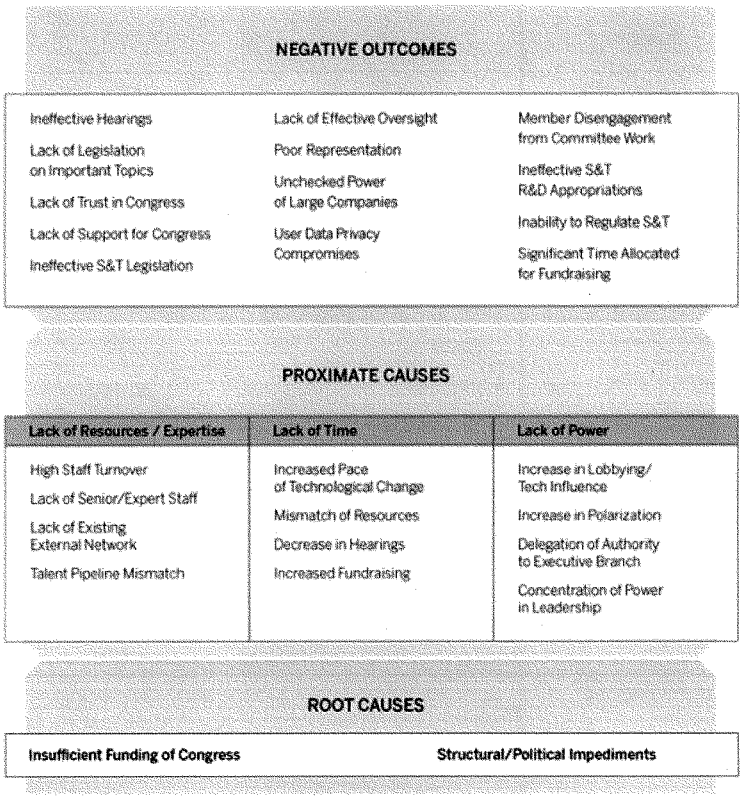


Figure 3: Root Causes of a Lack of Congressional S&T Expertise



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LAURA MANLEY

WITNESS BIOGRAPHY

Laura Manley is the inaugural Director of the Technology and Public Purpose Project at the Harvard Kennedy School Belfer Center for Science and International Affairs. Led by former U.S. Secretary of Defense Ash Carter, the project aims to steer rapid technology-driven change in directions that serve net, long-term public good. Laura is responsible for all project research and programs including societal due diligence assessments for tech investors, emerging tech briefing guides for policymakers, and strategies for increasing congressional S&T capacity.

Previously, Laura co-founded the Center for Open Data Enterprise (CODE) in Washington DC, which is a nonpartisan research organization that works with governments to leverage data for social and economic good. At CODE, she worked with over a dozen U.S. federal agencies on their data management strategies and with eight national governments on their digital economy policies and IT modernization efforts.

Laura is a Senior Consultant for the World Bank Group and the United Nations Department for Economic and Social Affairs. She also lectures at several institutions including NYU Wagner School of Public Policy, Columbia University School for Professional Studies, and Harvard University Extension School.

Chairwoman JOHNSON. Thank you, Ms. Manley.
Dr. Tim Persons.

**TESTIMONY OF DR. TIM PERSONS,
CHIEF SCIENTIST AND MANAGING DIRECTOR, SCIENCE, TECHNOLOGY ASSESSMENT, AND ANALYTICS,
U.S. GOVERNMENT ACCOUNTABILITY OFFICE**

Dr. PERSONS. Yes, Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee, thank you for the opportunity to discuss GAO's expanding S&T products and services to Congress.

As you are aware, rapid developments in S&T are transforming multiple sectors of society from medicine to communication to defense. Such disruptive innovations bring transformative opportunities but also the potential for unintended consequences. The ability of Congress to understand, evaluate, and prepare for such changes in an agile manner is critical if the U.S. is to remain secure, innovative, and globally competitive both now and for generations to come.

GAO is approaching a half-century of delivering high-quality content on S&T topics such as space systems, climate change, cybersecurity, and emerging infectious diseases. We ensure that this work is independent, fact-based, and nonpartisan by applying quality standards that help bring transparency, rigor, and authority to our work. We also apply congressional protocols that were jointly crafted with Congress to ensure that we understand legislative priorities and are responsive to congressional needs.

Since 2001, in direct response to congressional direction and priorities, GAO has expanded its S&T portfolio by adding technology assessments, best practices guides for engineering project controls, and our new science and tech spotlight series, which are the single-page printed explainers of emerging S&T issues that the Members have in their packet.

We also recently launched our Innovation Lab led by GAO's first Chief Data Scientist. This team will develop innovative analytic capabilities and explore algorithmic accountability in our era of machine learning. Together, these capabilities support Members of Congress and their staffs to carry out their article 1 constitutional responsibilities, that is, oversight of Federal S&T enterprise, insight into key S&T topics, and foresight on the potential opportunities and challenges for S&T advances.

Now, foresight means spotting trends before they become front-page news. Our technology assessments provide in-depth critical analysis of emerging technologies and how they might shape society, the environment, and the economy. We've covered many high-profile issues, some in support of this Committee, including AI (artificial intelligence), sustainable chemistry, and nano manufacturing.

This year, we added a policy options to our technology assessments, most recently in our work on irrigated agriculture, to further enhance the usefulness of these products to our congressional clients. And we are increasing the volume and speed of this work with upcoming products on 5G wireless technology, AI in drug discovery and development, deepfake videos, and gene editing. We are

also pursuing a content-centric strategy for our S&T work so that we can provide such information to Members proactively, as well as on-demand.

We also know that our in-house expertise is crucial to successfully producing high-quality fact-based technical work. Our S&T team has now reached over 70 staff, and we plan to grow to 140. Over 90 percent of our staff have advanced degrees, and these in-house experts include physical, life, and computational scientists; engineers of the major disciplines; and other specialists. In addition, we employ staff with expertise in public policy, social science, economics, and law. The diversity of our staff makes GAO uniquely suited to perform effective S&T work for Congress.

Finally, for the purpose of rigorous external input and review we have a network of external experts who help us develop and independently review our S&T work from a cross-sectoral perspective. Since 2001 we have maintained a standing contract with the National Academies to help us identify and convene experts for in-depth discussion as part of our technical work. We are also enhancing our relationship with universities and scientific organizations so that we can tap external talent on short notice to meet congressional needs.

As S&T increasingly dominates and transforms our lives, Congress' need for timely, independent, and fact-based S&T information is our team's paramount priority. The NAPA panel recommended that GAO further develop its S&T capabilities to help meet congressional needs. Under the leadership of the Comptroller General we already are doing so and will continue to do so. With our unique access to Federal information, our extensive internal and external expertise, and our rigorous quality standards, we can and will rise to the challenge of seeking to meet the S&T needs of the 21st-century Congress.

Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee, this concludes my prepared statement. Thank you for your attention to these issues and the opportunity to speak here today. I'd be happy to respond to any questions when you are ready.

[The prepared statement of Dr. Persons follows:]

United States Government Accountability Office

GAO

Testimony
Before the Committee on Science, Space, and Technology, House of Representatives

For Release on Delivery
Expected at 10:00 a.m. ET
Thursday, December 5, 2019

SCIENCE AND TECHNOLOGY

Overview of GAO's Enhanced Capabilities to Provide Oversight, Insight, and Foresight

Statement of Dr. Timothy M. Persons,
Chief Scientist, GAO, and Managing Director,
Science, Technology Assessment, and Analytics

GAO Highlights

Highlights of GAO-20-306T, a testimony before the Committee on Science, Space, and Technology, House of Representatives

Background

Rapid developments in S&T are transforming multiple sectors of society, including medicine, transportation, communication, defense, and even culture. Like all technological change, each of these developments brings opportunities and potential unintended consequences. The ability of Congress to understand and evaluate such changes will be critical for the United States to remain safe, innovative, and globally competitive.

GAO's mission is to support Congress in meeting its constitutional responsibilities and to help improve the performance and ensure the accountability of the federal government for the benefit of the American people. The 2019 Legislative Branch Appropriations Bill Conference Report encouraged GAO to reorganize its S&T function by creating a new office. In January 2019, GAO created the STAA team to build on and expand its decades-long work providing Congress with science and technology analysis.

This statement discusses (1) GAO's S&T products and services for Congress; (2) how GAO is structured to provide S&T advice to the Congress; and (3) GAO's plan to continuously improve its S&T advising capabilities.

View GAO-20-306T. For more information, contact Timothy M. Persons, Ph.D., Chief Scientist, GAO, and Managing Director, Science, Technology Assessment, and Analytics, at (202) 512-6888 or personst@gao.gov.

December 5, 2019

SCIENCE AND TECHNOLOGY

Overview of GAO's Enhanced Capabilities to Provide Oversight, Insight, and Foresight

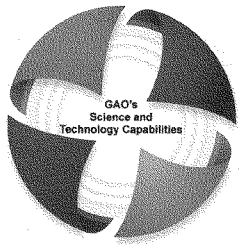
GAO provides a variety of science and technology (S&T) products and services to Congress. Over the decades, GAO has grown its S&T portfolio by adding technology assessments, engineering/project controls best practices guides, and, most recently, the Science & Tech Spotlight series. Together, these products are designed to address key congressional interests on S&T issues by providing foresight on the consequences of advances in S&T, oversight of the federal S&T enterprise and S&T-centric programs and projects, and insight into emerging issues and topics of congressional interest.

GAO has the expertise, independence, and access to data to provide authoritative, nonpartisan advice to Congress in a manner that complements other sources of S&T advice.

- **Expertise:** GAO's new Science, Technology Assessment, and Analytics (STAA) team has 59 staff members with masters' degrees and/or doctorates, as of November 2019. Fifty-six staff members have at least one degree in a science, technology, engineering, and mathematics field. GAO's technology assessments are informed by appropriate S&T expertise, including external experts across academia, think tanks, and industry. GAO integrates subject and policy knowledge from across its 15 mission teams to develop rigorous methodological approaches to expertly analyze quantitative and qualitative data.
- **Independence:** GAO has a robust quality assurance framework to help ensure its independence and has congressional protocols to help ensure GAO is responsive to Congress in a nonpartisan manner.
- **Access to data:** GAO's legal authorities grant it unique access to an extensive range of agency information and data, including classified information and other information that is not available to the public.

GAO will continue to build its capacity to respond to congressional demand. STAA's current staff level is about one-half of what was outlined in the April 2019 plan submitted to Congress. GAO's key S&T activities are shown in the figure below.

Key Science and Technology Activities in GAO



Technology Assessment
Provides foresight on key technologies and the policy implications for the federal government.

Evaluations
Oversight of research programs, cybersecurity, defense, intellectual property protection, health care, and all other science and technology functions of government.

Innovation Lab
Explores, pilots, and deploys advanced analytics, information assurance auditing, and emerging technologies to improve auditing practices.

Engineering Sciences
Provides best practices, including for cost, schedule, earned value, and technology readiness assessment.

Source: GAO. | GAO-20-306T

Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee:

Thank you for the opportunity to discuss GAO's science and technology (S&T) support to Congress. As you are aware, rapid developments in S&T are transforming multiple sectors of society, including medicine, transportation, communication, defense, commerce, and even culture itself. Like all technological change, each of these developments brings both opportunities—for economic growth and improved quality of life, for example—and the potential for unintended consequences. The ability of Congress to understand, evaluate, and prepare for such changes will be critical for the United States to remain safe, secure, innovative, and globally competitive.

We at GAO provide Members of Congress and their staffs with an array of professional services in the domains of oversight, insight, and foresight to help them carry out their Article I constitutional responsibilities as they relate to the nation's science and technology enterprise. Our expertise, research, and analyses help address a number of specific congressional needs, including:

- Evaluation of the impacts of science, technology, and innovation—including programmatic and/or policy implications
- Development of policy options concerning science, technology, and innovation issues in the context of actual or hypothesized congressional policy goals
- Proactive and/or on-demand, "just-in-time" scientific/technical assistance on science, technology, and innovation issues

The 2019 Legislative Branch Appropriations Bill Conference Report encouraged GAO to reorganize and enhance its S&T function by creating a new office. In January 2019, the Comptroller General directed the creation of the Science, Technology Assessment, and Analytics (STAA) team to build on and expand our decades-long work providing Congress with S&T analysis. GAO also enhanced its Information Technology and Cybersecurity team's existing capabilities with the hiring of 32 additional information technology (IT) and cybersecurity experts during fiscal year 2019. In addition, last year GAO inaugurated its Center for Strategic Foresight to identify and explore major emerging issues affecting government and society—including areas involving science and technology—such as personal identity and privacy, space policy, deepfake video, and other emerging technologies.

In my testimony today, I will discuss (1) our S&T products and services for Congress; (2) how we are structured to provide S&T advice to Congress; and (3) our plan to continuously improve our S&T advising capabilities.

GAO Provides Congress a Variety of S&T Products and Services

GAO has been successfully conducting science and technology-related work for close to 50 years—including technology assessments for almost two decades—providing Members of Congress and their staffs with a variety of products and services on S&T topics. This work addresses key congressional interests on S&T issues by providing foresight on the consequences of S&T advancement; oversight of the federal S&T enterprise; and insight into specific challenges and topics of congressional interest. Recent examples of these are included in table 1. Our products include traditional GAO reports such as S&T-related performance evaluations and testimonies. Over the decades, however, we have grown our portfolio of S&T products to include technology assessments (TAs), best practices guides, and most recently, our Science & Tech Spotlight series—the latter being designed to provide a brief overview of an emerging technology area and its possible implications for policy (see app. I for a list of technology assessments and related products, app. II for Spotlights, and app. III for a broader list of selected S&T products).

Table 1: Examples of GAO Products and Services that Provide Science and Technology Foresight, Oversight, or Insight

Category	Products and Services	Approx. Time frame	Examples
FORESIGHT 	Science & Tech Spotlights	4 to 6 weeks	*Science & Tech Spotlight: Hypersonic Weapons*, GAO-19-705SP *Science & Tech Spotlight: Opioid Vaccines*, GAO-19-706SP
	Evaluations and Testimonies	2 weeks to 2 years	*Biodefense: The Nation Faces Long-Standing Challenges Related to Defending Against Biological Threats*, GAO-19-635T *Science and Technology: Considerations for Maintaining U.S. Competitiveness in Quantum Computing, Synthetic Biology, and Other Potentially Transformational Research Areas.* GAO-18-656
	Technology Assessments	8 to 16 months	*Irrigated Agriculture: Technologies, Practices, and Implications for Water Scarcity*, GAO-20-128SP *Technology Assessment: Artificial Intelligence: Emerging Opportunities, Challenges, and Implications*, GAO-18-142SP
	S&T Horizon Scanning	Continuous	GAO's Center for Strategic Foresight, in partnership with STAA, is doing work on Deep Fakes, Deep Space, 5G and Cellular Agriculture.
OVERSIGHT 	Briefings and Technical Assistance	Days to weeks	In April 2019, we briefed congressional staff on National Institute of Standards and Technology's measurement services and standards development activities.
	Evaluations and Testimonies	2 weeks to 2 years	*Sexual Harassment in STEM Research: Preliminary Observations on Policies for University Grantees and Information Sharing among Selected Agencies.* GAO-19-583T
	Cross-cutting and Domain-specific Reporting	2 weeks to 2 years	*Critical Infrastructure Protection: Actions Needed to Address Significant Cybersecurity Risks Facing the Electric Grid.* GAO-19-332 *Nuclear Waste: Opportunities Exist to Reduce Risks and Costs by Evaluating Different Waste Treatment Approaches at Hanford.* GAO-17-306
INSIGHT 	Briefings and Technical Assistance	Days to weeks	In October 2019, our Chief Scientist participated as a subject matter expert in a Data Roundtable for the House Veterans' Affairs Committee to discuss data portability, use of electronic health records, and privacy and security concerns, among other things.
	Guides and Related Evaluations	5 months to 2 years	*GAO Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects, forthcoming. Exposure draft available at:* GAO-16-410G *Columbia Class Submarine: Overly Optimistic Cost Estimate Will Likely Lead to Budget Increases*, GAO-19-497
	S&T Issue Tracking	Continuous	Gene Editing; AI and Automation; Quantum Information Science; Brain/Augmented Reality; Cryptocurrencies

Source: GAO | GAO-20-306T

Note: Time needed is dependent on the scope and methodologies chosen. We are continuously working to decrease the amount of time taken to issue GAO reports and TAs.

In addition to written products, we provide S&T-related services to Members and their staffs, including briefings on our products or on our areas of expertise, and short-term analyses and reviews. Each product and service requires a different level of effort and time, tailored to the current and anticipated needs and interests of the requesters. Significant to STAA's long-term, sustainable service to the Congress is the shift in our strategic posture from a product-centered to an agile, content-centered operation in order to capitalize on newer information channels (e.g., podcasts, interactive/visualized data, mobile platforms) and in a manner that fits today's legislative operational tempo.

Foresight of Scientific and Technological Advancement

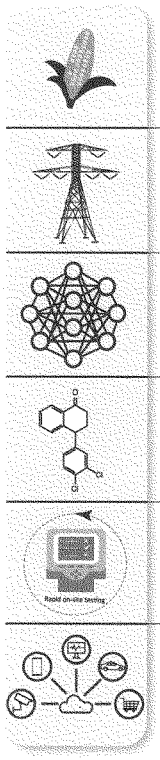
Members and their staffs need to understand how new technologies will shape our world. We provide foresight into technological opportunities and risks with thorough and balanced assessments of critical innovations that affect society, the environment, and the economy. GAO foresight products include TAs, Science & Tech Spotlights, and S&T-related evaluations and testimonies, while foresight services include S&T horizon-scanning and issue tracking in partnership with GAO's Center for Strategic Foresight. Having multiple product types and services allows us to respond in an appropriate time frame with the information Congress needs.

Technology assessments. Our TAs analyze the latest developments in science and technology, draw attention to implications of technological change, and make core concepts accessible to policymakers. The content of TAs varies. They may:

- Highlight potential short-, medium-, and long-term impacts of scientific advancement and/or technological development
- Elaborate on and communicate the risks and benefits associated with a technology, including early insights into the potential impacts of technology
- Highlight the status, viability, and relative maturity of a given technology—especially in the context of a complex acquisition program
- Describe federal investments in S&T
- Present policy options designed to inform decision makers on potential courses of action and the opportunities and challenges associated with each option.

TA time frames depend on their scope, but they can be completed within several months. Figure 1 highlights some recent TAs, and appendix I shows a full list of our TAs and related products.

Figure 1: Highlights of Selected GAO Technology Assessments



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

Provides an overview of irrigation technologies and practices that could reduce water usage. Also discusses factors that influence the adoption of efficient irrigation technology and how efficient irrigation technologies impact water conservation. Provides policy options in the area.

Critical Infrastructure Protection:
Protecting the Electric Grid from Geomagnetic Disturbances
GAO-19-98

Reports on the potential effects of geomagnetic disturbances on the U.S. electric grid, and technologies to prevent or mitigate a disturbance. Also discusses factors that could affect the development and implementation of these technologies.

Artificial Intelligence:
Emerging Opportunities, Challenges, and Implications
GAO-18-142SP

Discusses how artificial intelligence (AI) has evolved over time, the opportunities and future promise, as well as the principal challenges and risks. Report includes the policy implications and research priorities resulting from advances in AI.

Chemical Innovation:
Technologies to Make Processes and Products More Sustainable
GAO-18-307

Assesses selected technologies that are available or in development to make chemical processes and products more sustainable. Describes the contributions of the federal government, industry, and others to the development and use of such technologies.

Medical Devices:
Capabilities and Challenges of Technologies to Enable Rapid Diagnoses of Infectious Diseases
GAO-17-347

For multiplex point-of-care technologies, describes performance and costs. Discusses challenges and potential benefits of these technologies.

Internet of Things:
Status and Implications of an Increasingly Connected World
GAO-17-75

Describes the state of the Internet of Things, the purposes and uses of the technologies, along with potential implications.

Source: GAO. | GAO-20-306T

Science & Tech Spotlights. We also provide Congress with foresight through our Science & Tech Spotlights. Launched in 2019, Spotlights are two-page overviews for policymakers and the public. Each describes an emerging S&T development, the opportunities and challenges it brings, and the relevant policy context. Spotlights are designed to inform Congress of key developments in a timely and efficient manner, generally before congressional requests for deeper inquiries. Spotlights are completed in a few to several weeks. Our first four Spotlights, included in appendix II, address blockchain, hypersonic weapons, opioid vaccines, and probabilistic genotyping software—with the latter topic now requested as part of a full technology assessment project.

Evaluations and testimonies. Some GAO evaluations identify key technologies and their risks and opportunities, and provide policy options to decision makers. For example, in a series of reports from December 2009 through March 2019, we identified options for policy or structural changes that could help the Department of Homeland Security better fulfill its biosurveillance integration mission. More generally, since 2013, we have released 13 reports that included identification and assessment of policy options in a variety of technical and non-technical contexts. In addition, we addressed a range of S&T topics in testimonies before Congress. For example, in June 2019 we testified before the House Committee on Oversight and Reform on biological threats and biodefense efforts. In June 2019, we testified in front of the House Committee on Oversight and Reform on the privacy and accuracy of FBI's use of facial recognition. We also testified on a range of information technology and cybersecurity topics in fiscal year 2019, such as IT challenges at the Department of Veterans Affairs, systems development and cybersecurity efforts in preparation for the 2020 Census, and federal cybersecurity workforce issues.

S&T horizon scanning and issue tracking. In addition to working on specific foresight-related products, our staff continually perform horizon-scanning to support Congress. Further, awareness and evaluation of trends in S&T are part of our ongoing strategic planning efforts. In GAO's 2018-2023 Strategic Plan for Serving Congress and the Nation, we outline a number of technologies and scientific advances that will potentially transform society, among them genome editing, artificial intelligence and automation, quantum information science, brain-computer interfaces and augmented reality, and cryptocurrencies and

blockchain (see app. IV).[1] Our staff track advancements in these areas to inform our current and future products and services. The issues we focus on will change over time as our horizon-scanning identifies new priority issues.

Oversight of the Federal S&T Enterprise and S&T-centric Programs and Projects

Members and their staffs need trusted, nonpartisan information on the performance of federal programs and their outcomes for Americans. This work has increasingly focused on S&T as it has become more important to the efficient and effective performance of federal programs. GAO provides oversight through products, such as performance evaluations, and through technical assistance services, such as briefings on our prior work or short-term analysis of agency programs or activities.

Cross-cutting evaluations of S&T. We conduct cross-cutting work that evaluates the management and coordination of research and development across the federal government. This work addresses issues related to topics such as basic science, innovation, manufacturing, and S&T's role in economic competitiveness. For example, in fiscal year 2019 we issued products on advanced manufacturing, scientific integrity, and sexual harassment in Science, Technology, Engineering, and Mathematics (STEM) research.

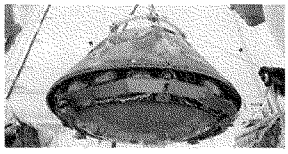
Domain-specific performance evaluations. In addition, we evaluate a number of domains where S&T is critical, including defense, space, energy and the environment, nuclear, health care, and IT, as is shown in figure 2. The development of S&T-intensive systems, delivery of technology-dependent services, and development and application of technologies to solve problems are just some of the topics addressed in this work. Recent work in this area has examined topics such as synthetic biology, environmental cleanup technologies, critical infrastructure cybersecurity, and quantum computing. Time frames for this work, including testimonies and evaluations, typically average less than a year, but may range from 2 weeks to 2 years, depending on the scope of the work and congressional needs.

[1]GAO, *Strategic Plan 2018-2023: Trends Affecting Government and Society*, GAO-18-396SP (Washington, D.C.: Feb. 22, 2018).

Figure 2: GAO Examines Science and Technology in Many Domains

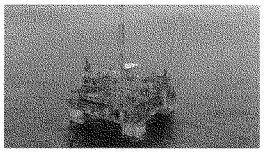
Defense and homeland security

We evaluate technology readiness and risks for complex weapons and homeland security systems, such as missiles, radar, ships, and border security systems.



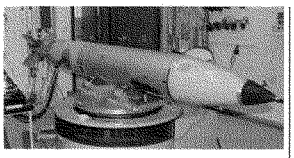
Space

We assess federal military and civilian space programs and efforts to support and oversee telecommunications in the public interest.



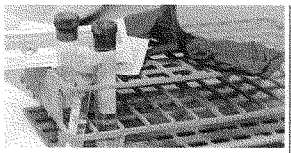
Energy and the environment

We evaluate developing and deployed technologies in a range of activities, including environmental monitoring, renewable energy, cleanup of hazardous sites, and civilian nuclear power.



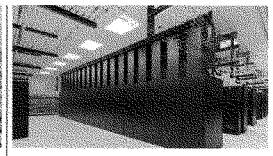
Nuclear

We evaluate programs, infrastructure, technology readiness, and operations for the maintenance and management of nuclear weapons, as well as the aircraft and submarines designed to carry and deliver them.



Health care

We assess new technologies for emerging infectious diseases, such as technologies that can simultaneously test for multiple infectious diseases at or near the site of patient care, and the impacts of new technology on human health, disease prevention, and the delivery of health care.



Information technology and cybersecurity

We evaluate the management and operation of the government's substantial IT investments and assess efforts to protect federal systems, emerging technologies, critical infrastructure, and individual privacy from cyber threats.

Sources (top left to right): DoD, NASA/Kennedy, and GAO; (bottom left to right) GAO, GAO, and Social Security Administration. | GAO-20-306T

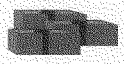
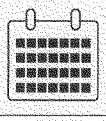
Series of performance evaluations. A third area in which we support congressional S&T oversight is long-term monitoring of agency operations and factors that could affect these operations. For example, GAO first designated federal information security as a government wide high risk area almost 22 years ago in 1997 and our cybersecurity work has been critical to informing and assisting Congress. Our work informed Congress as it considered major legislation on information security, such as the Federal Information Security Management Act of 2002 (FISMA), its successor, the Federal Information Security Modernization Act of 2014, and the Cybersecurity and Infrastructure Security Agency Act of 2018. We have also undertaken a series of reports evaluating the planning, design, and construction of large facilities sponsored by the National Science Foundation, such as telescopes and research vessels, and a series of reports on oversight of high-containment laboratories.

We also regularly provide services to Congress related to our oversight work, including briefings on past and ongoing work or technical assistance to provide additional data or context to our work. For example, informed by our bodies of work, we have provided overview briefings to committees, such as "Defense Space Systems 101" and "NIST 101."

Insight into Priority Issues

Members and their staffs need partners to help ensure efficiency and accountability in government. We provide guidance to federal managers and employees to help S&T-intensive programs operate at their best. We developed a series of best practices guides that lay out proven and effective approaches and decision-making tools for federal managers. We developed these guides to respond to persistent challenges in managing the cost, schedule, and performance of the federal government's significant investments in research and development and complex technical acquisition programs. Our guides currently cover cost, schedule, and technology readiness, with an additional guide planned for Agile software development. Our cost, schedule, and technology readiness assessment guides have improved project management practices across the federal government and spurred congressional action on technology risks. We have also used our expertise in these areas to review federal programs and identify targeted interventions to improve federal acquisitions, such as our December 2017 and April 2019 reports concerning, respectively, the technology readiness and cost estimate of the Navy's Columbia class submarine. These guides are described in figure 3.

Figure 3: GAO Best Practice Guides

	Title	Summary
	**Cost Estimating and Assessment Guide** *Currently being updated* Best Practices for Developing and Managing Capital Program Costs GAO-09-3SP, Mar. 2, 2009	• Provides 12-step process to develop high-quality, reliable program cost estimates applicable across government and industry. • Provides a detailed link between cost estimating and earned value management (EVM).
	**Schedule Assessment Guide** Best Practices for Project Schedules GAO-16-89G, Dec. 22, 2015	• Provides 10 best practices to help managers and auditors ensure that a program schedule is reliable. • Develops standard criteria to determine the extent to which agency programs and projects meet industry scheduling standards.
	**Technology Readiness Assessment Guide** *Update forthcoming* Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects GAO-16-410G, Aug. 11, 2016	• Provides six-step outline of a reliable technology readiness assessment process and associated best practices to evaluate technology maturity across the federal government. • Provides a framework for better understanding technology maturity, conducting credible technology readiness assessments, and developing plans for technology maturation efforts.
	**Agile Guide** Upcoming June 2020	• Provides nine adoption best practices sorted into team activities, program processes, and agency environment. • Relates program control best practices established in the Cost Guide and Schedule Guide to Agile Software Guide processes and artifacts.

Source: GAO. | GAO-20-306T

We also provide Members and their staffs immediate access to a trusted source of nonpartisan information to gain insight into S&T topics and programs, ranging from answering technical questions by phone, to providing a comprehensive written and oral briefing on a complex issue. Depending on the need and topic, turnaround time can range from days to a few weeks. Some of our methods for providing technical assistance to Congress include:

- We frequently provide informal briefings and other assistance to Members of Congress and congressional staff on a very short time frame based on our expertise, prior work, and analysis. We have provided numerous technical briefings on request, such as on biodetection systems, big data, artificial intelligence, IT, and cybersecurity issues, among others. Our technical assistance also supports hearings. For example, we provided information on fentanyl and fentanyl analogs for a hearing on the opioid crisis. We developed a briefing on sustainable chemistry for a committee.
- We have briefed new committee staff on topics or agencies within their portfolios, highlighting our recent reporting and our understanding of the major issues involved.
- We also draw on our in-house expertise and prior reporting to provide context and issues to consider regarding draft legislation.

Our ongoing work develops S&T content across a mixture of product types, key topics, and for a variety of congressional committees. Figure 4 shows selected current work in S&T.

Figure 4: Selected Ongoing GAO Science and Technology (S&T) Work

	Topic (Product Type)	Congressional Clients
	CRISPR gene editing and surrounding policy context (Science & Tech Spotlight)	Biomedical, Agriculture, and National/Homeland security-related committees and caucuses
	Information on deepfake video technology (Science & Tech Spotlight)	Technology-related committees and caucuses
	Nuclear microreactors technology (Science & Tech Spotlight)	Energy-related committees and caucuses
	Artificial intelligence in drug development (Technology Assessment)	Senate Committee on Health, Education, Labor, and Pensions, and House Committee on Energy and Commerce
	Performance, usage, and challenges of 5G wireless networks (Science & Tech Spotlight and Technology Assessment)	House Committee on Armed Services, House Permanent Select Committee on Intelligence, House Committee on Science, Space, and Technology, and Senate Select Committee on Intelligence
	Artificial intelligence in the delivery of health care services (Technology Assessment)	Senate Committee on Health, Education, Labor, and Pensions, and House Committee on Energy and Commerce
	Algorithms used in forensics, including DNA fingerprints and facial recognition (Technology Assessment)	Security and technology-related committees and caucuses
	Infectious disease modeling as it relates to public health decisions (Performance Evaluation)	House Committee on Energy and Commerce
	Federal efforts to address antibiotic resistance (Performance Evaluation)	Senate Committee on Health, Education, Labor, and Pensions, and House Committee on Energy and Commerce
	The National Science Foundation's large facilities construction (Performance Evaluation)	House Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies
	The Department of Veterans Affairs research into veterans' health care needs (Performance Evaluation)	House Committee on Veterans' Affairs
	Intellectual property assistance for small businesses (Performance Evaluation)	House Committee on Small Business
	Department of Homeland Security's new biodetection technology system (Technology Assessment and/or Performance Evaluation)	Senate Committee on Homeland Security and Governmental Affairs, House Committee on Energy and Commerce, House Committee on Homeland Security, House Committee on Science, Space, and Technology
	Identify and describe Agile software development best practices (Best Practice Guide)	Appropriations, Budget, and technology-related committees and caucuses
	An update to GAO's 2009 Cost Estimating and Assessment Guide (Best Practice Guide)	Appropriations, Budget, and oversight-related committees and caucuses

Source: GAO. | GAO-20-306T

GAO Has the Expertise, Independence, and Access to Data to Provide Authoritative, Nonpartisan Advice to Congress

GAO is uniquely positioned to provide fact-based, non-ideological, nonpartisan and authoritative S&T advice to Congress in a manner that complements advice provided by the National Academies of Sciences, Engineering, and Medicine (National Academies) and the Congressional Research Service. Authoritative S&T advice requires distilling technical and policy expertise into clear, concise, and independent descriptions and recommendations. GAO has the in-house talent, access to external expertise, and employs the methodological rigor to do so, although we are not yet staffed up as intended in our April 2019 STAA plan. GAO has a strong reputation for independent, high-quality, nonpartisan analysis. In addition, we have unique access to expertise and information in the federal government, as well as significant access to external expertise, be it through our standing relationship with the National Academies or through our own convening and access to academic, nonprofit, and private-sector expertise.

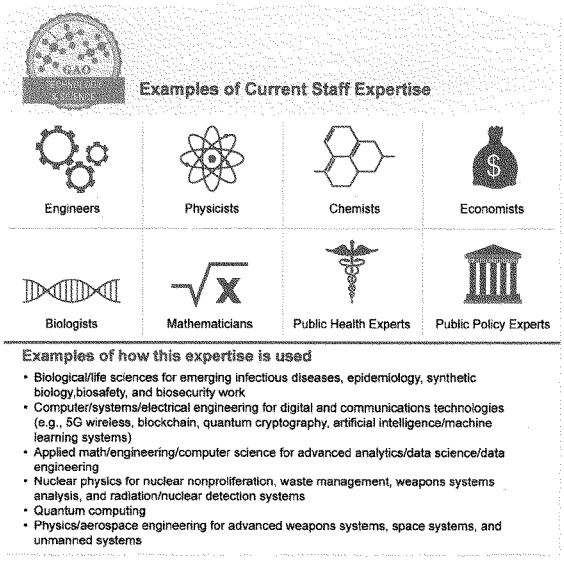
GAO Staff Are Well Qualified to Provide Congress a Variety of S&T Products and Services

Although we have expanded our technical expertise substantially over the past year, we have not yet fully staffed up as intended in our April 2019 STAA plan. Nevertheless, we have a well-trained and diverse talent pool. Our STAA team now has 59 staff members with masters' degrees and/or doctorates. Fifty-six staff members have at least one degree in a STEM field. The team currently includes engineers (e.g., biomedical, electrical and electronics, systems, petroleum, aerospace), chemists (e.g., analytical, environmental, inorganic, organic, theoretical), biologists, and physical scientists (e.g., nuclear physics, environmental science, geology), and others. STAA also has operations research analysts/project controls engineers who specialize in lifecycle cost estimating, scheduling, earned value management, technology readiness assessment, and Agile software development. In addition to these fields, STAA team members also hold advanced degrees in public policy, rounding out the team to expertly advise on the nexus of technology and policy. In October 2019, we hired our first Chief Data Scientist to lead innovative data analytics efforts for all of GAO. A team of attorneys within GAO's Office of the General Counsel provides support to STAA as well.

STAA staff also benefit from collaboration with GAO's broader workforce of subject-area policy analysts, economists, social scientists, methodologists, and attorneys across our 14 other mission teams. Some of the other mission teams that address S&T topics typically have their own dedicated, in-house S&T expertise on topics related to their missions. Examples include expertise in engineering, chemistry, biology,

physics and cybersecurity. Figure 5 shows a representation of S&T expertise within STAA and GAO more broadly.

Figure 5: GAO Has Extensive Science and Technology Expertise



Source: GAO. | GAO-20-306T

Our Information Technology and Cybersecurity (ITC) team, for example, has extensive knowledge of key IT domains, including IT and cybersecurity risk management, software development, system administration, and computer networking. Many ITC team members have one or more specialized certifications, such as Certified Information Systems Security Professional (CISSP), Certified Information Privacy Professional (CIPP), and Certified Ethical Hacker (CEH).

Furthermore, we have 11 field offices across the country, giving us deeper links throughout the federal community, access to talent from different regions, and connecting us with a diverse set of universities, research institutions, and industries. This access to a well-trained and diverse talent pool brings a powerful and sophisticated perspective to our work as we conduct TAs and analyze the policy implications of a range of technical and scientific topics for Members and their staffs.

GAO Work Is Fact-Based and Undergoes a Rigorous Technical Review Process

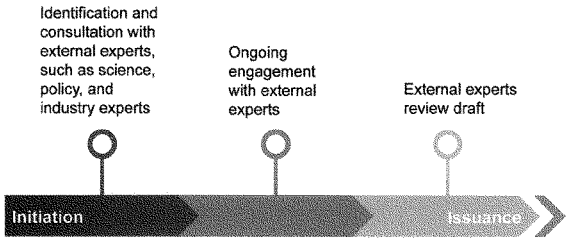
We employ rigorous methods to produce fact-based information, ensuring that all statements presented in our products are based on sufficient and credible evidence. Further, we integrate a wealth of knowledge from across GAO's 14 other mission teams to develop rigorous methodological approaches for expertly analyzing quantitative and qualitative data. We also tailor our methodologies to suit particular products and meet congressional needs.

We have designed our TA process to ensure that our work is informed by appropriate S&T expertise, including external experts across academia, think tanks, and industry.[2] We involve experts throughout our studies. To do so, we draw expertise from scientists, engineers, and physicians through routine engagement with the National Academies of Sciences, Engineering, and Medicine. Since 2001, we have maintained a standing contract that allows National Academies personnel to help GAO identify experts and assist with convening expert meetings for GAO. Once we have selected a group of experts that represents the needed cross-sector expertise (e.g., government, university, industry, and nonprofit), we traditionally convene a meeting of these experts to highlight and discuss the latest research in the field. We use an experienced moderator to encourage discussion that can result in new thoughts and ideas. We then contact the experts over the course of our work to gain additional input as needed. Once we have developed a draft report, the experts who participated in our meeting of experts then review our TAs for technical and scientific accuracy to ensure the assessments are of the highest quality. Involvement of these experts throughout the process is reflected in figure 6 and in more detail in appendix V. As described in our April 2019 STAA Plan, our TA portfolio is based on our well-established quality

[2]GAO, *Technology Assessment Design Handbook*. GAO-20-246G. (Washington, D.C.: Dec. 5, 2019).

assurance framework and is at times above and beyond how it is applied to our evaluation work.

Figure 6: GAO Involves Experts Throughout Its Technology Assessments



Source: GAO | GAO-20-306T

We collaborate with many other S&T entities as well. For example, we engage with federally funded research and development centers, such as the MITRE Corporation, the Institute for Defense Analyses, and the Carnegie-Mellon Software Engineering Institute. We are also building key academic partnerships with universities that have specialized programs in science, technology, and public policy, such as Arizona State University, Carnegie-Mellon University, the Georgia Institute of Technology, the Massachusetts Institute of Technology, and University of Maryland College Park, among others. By maintaining a diverse network, we are able to connect Members and their staffs with other relevant experts when needed.

GAO Responds to Congressional Priorities

Our work directly supports congressional interests. In fiscal year 2019, we devoted 96 percent of our engagement resources to work requested directly by Members and committees or required by Congress in statute. Prioritization of this work is guided by our congressional protocols, which we designed in consultation with Congress and which provide a sequence of internal controls that allows us to efficiently and effectively receive, prioritize, and respond to congressional requests. These protocols help ensure we work constructively with Congress and conduct our work in accordance with congressional priorities to meet the needs of both parties. These protocols also ensure that we are consistent in dealing with all committees and individual members. Although we prioritize

mandates and requests from Chairs and Ranking Members of congressional committees over individual member requests, we may also provide technical assistance and briefings in response to individual member requests.

In addition, we may undertake work that is not directly tied to requests.[3] This can be useful for topics that are of broad interest in Congress, generally longer-range, crosscutting, and transformational issues. The ability to conduct such work under "Comptroller General Authority," is also beneficial because it allows us to bring to Congress's attention important emerging S&T issues that may affect the nation's future. For example, we developed our Science & Tech Spotlights under this authority to quickly inform Congress of S&T topics of broad interest. Examples of some of our ongoing work—including requests and Comptroller General Authority work—were previously shown in figure 4.

Examples of our more recent S&T work to support Congress include our July 2019 testimony before the Subcommittee on Research and Technology on the technologies for making chemical products and processes more sustainable.[4] Also in July 2019, before the Subcommittee on Research and Technology and the Subcommittee on Investigations and Oversight, we testified on federal research, and strengthening scientific integrity policies. This hearing helped inform Members of the subcommittees as they considered the *Scientific Integrity Act.* In October 2019, our Chief Scientist participated as a subject matter expert in a Data Roundtable for the House Veterans' Affairs Committee to discuss data portability, use of electronic health records, and privacy and security concerns, among other things. Also, we provided a briefing of 5G technologies to Members and their staffs from the House Science, Space, and Technology Committee and staff from the House Armed Services Committee.

[3]31 U.S.C. § 717(b)(1) grants the authority to evaluate the "results of a program or activity" of the Government on the initiative of the Comptroller General. This work, conducted under "Comptroller General Authority," can be beneficial as we identify emerging S&T issues.

[4]*Chemical Innovation: Technologies for Making Products and Processes More Sustainable,* GAO-19-660T (Washington, D.C.: July 25, 2019)

GAO Work Is Independent and Nonpartisan by Design

We ensure our independence both in our work and as an independent agency that works for Congress. We are careful to ensure that our opinions, findings, conclusions, judgments, and recommendations will be impartial and will be viewed as such by third parties. GAO has a robust quality assurance framework and systems to help ensure our independence. For example, GAO employees must disclose their personal financial holdings and other interests annually. In addition, employees must certify every two weeks that they remain independent with respect to their work. If any conflict or concern arises, supervisors, in conjunction with our Office of Ethics, take immediate and appropriate action.

As an agency, we efficiently use available resources to maximize our ability to meet the Congress's needs and consistently exercise the independence necessary to ensure that our products and work conform to professional standards and our core values of accountability, integrity, and reliability. While we work closely with Congress to understand their needs and to conduct work that will address those needs, we do so in a manner that enables us to demonstrate our independence throughout all aspects of our work to ensure credibility. For example, we make the final determination of the specific questions our work will address, the scope of those questions, and the methods we will use to answer them.

GAO Has Unique Access to Federal Agency Data

We are also well-positioned to address Congress's S&T needs because our legal authorities grant us unique access to an extensive range of agency information and data, including classified information and other information that is not available to the public. This gives us a unique ability to provide well-informed, high-quality S&T advice. For example, in the technology assessment *Irrigated Agriculture: Technologies, Practices, and Implications for Water Scarcity*, we used nonpublic data from the U.S. Department of Agriculture to create an econometric model examining the effects irrigation technology had on how much water farms were using.[5] We found that use of efficient irrigation technologies alone may not conserve water, and provided two policy options designed to address that concern.

[5]*Irrigated Agriculture: Technologies, Practices, and Implications for Water Scarcity*, GAO-20-128SP (Washington, D.C.: Nov. 12, 2019)

GAO Plans to Continue to Expand Its S&T Capacity to Respond to Congressional Demand

In January 2019, we created the STAA team and since then have dramatically enhanced our ability to provide Congress with thorough and balanced analyses of technological and scientific developments that affect society, the environment, and the economy. Since that time, we have built significant capacity to produce S&T products and services, but more needs to be done. We will work to continuously enhance our products and services by exploring additional product types, and expanding our staff by attracting additional world-class talent.

Future Content-Centric Plans to Meet Congressional S&T Needs

Using a content-centric strategy, we are implementing a number of steps that take into account the unique requirements of TAs and related S&T work to meet the needs of Members of Congress and their staffs. As we build on our existing capabilities and grow the new STAA team, we will:

- Develop and refine content development and delivery formats designed to issue clear and concise communication on technical topics in accordance with the current and projected congressional operational tempo
- Develop additional methods and standards that are appropriate to TAs and separate from those covering our evaluation work
- Designate staff whose primary focus will be TAs and the provision of direct technical assistance to the Congress
- Continue engaging with external experts and advisory boards, as appropriate

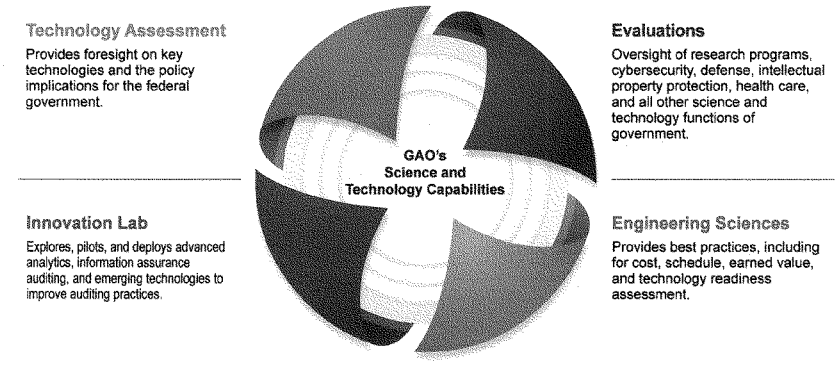
We are exploring and anticipate making future changes. While still in the exploratory phase, these may include preparing an annual horizon scanning report and establishing an S&T advisory board.[6]

Future Staffing Plans to Enhance S&T Work

To ensure Members and their staffs continue to receive high-quality, independent, and nonpartisan advice and analysis on technological and scientific topics, we organized our S&T activities into four key groups, as is shown in Figure 7. We plan to continue to build capacity in those areas to respond to greater congressional demand.

[6]Though not finalized yet, the S&T advisory board may consist of external S&T policy experts from industry, academia, nonprofits, and former senior government officials.

Figure 7: Key Science and Technology Activities



Across our work we aim to augment our core products with a range of timely, high-value technical assistance services for our congressional clients.

Source: GAO. | GAO-20-306T

STAA's current staff level is about one-half of what was outlined in the plan submitted to Congress, so we will grow our current S&T workforce over the next few years. Depending on congressional priorities through the normal authorization and appropriations process, we aspirationally plan to grow STAA to 140 full-time equivalent total staff as we adapt to meet future congressional demand. We anticipate that at least half of STAA staff will have advanced degrees across the physical, life, and computational sciences as well as most variants of engineering. We will continually assess optimum staffing levels for the team based on congressional needs and product demand. As we continue to assess anticipated future work and S&T issues that will be of interest to the Congress, we have hired and plan to continue hiring to add expertise in areas such as:

- Biological/life sciences for emerging infectious diseases, epidemiology, synthetic biology, biosafety, and biosecurity work

- Computer/systems/electrical engineering for digital and communications technologies (e.g., 5G wireless, blockchain, quantum cryptography, artificial intelligence/machine learning systems)
- Applied math/engineering/computer science for advanced analytics/data science/data engineering
- Nuclear physics for nuclear nonproliferation, waste management, weapons systems analysis, and radiation/nuclear detection systems
- Quantum computing
- Physics/aerospace engineering for advanced weapons systems, space systems, and unmanned systems

In addition to permanent staff, we are exploring actively recruiting temporary or limited-term staff to meet project-specific needs, particularly around the latest S&T advances. Such staff could include experts from the National Academies or Intergovernmental Personnel Act detailees.[7] The exact number of such staff will vary based on our hiring authority, project needs, and congressional demand for our work. We will seek additional authorities if necessary to obtain needed expertise. As discussed during meetings with external stakeholders, there is a strong interest within the S&T community in opportunities to participate in and contribute to analysis of S&T issues on behalf of the Congress, and to enhance their own work on S&T issues through an understanding of the broader policy context.

Thank you, Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee, this concludes my prepared statement. I would be pleased to answer any questions.

[7]The Intergovernmental Personnel Act Mobility Program provides for the temporary assignment of personnel between the federal government and state and local governments, colleges and universities, Indian tribal governments, federally funded research and development centers, and other eligible organizations. Assignment agreements can be made for up to two years, and may be intermittent, part-time, or full-time.

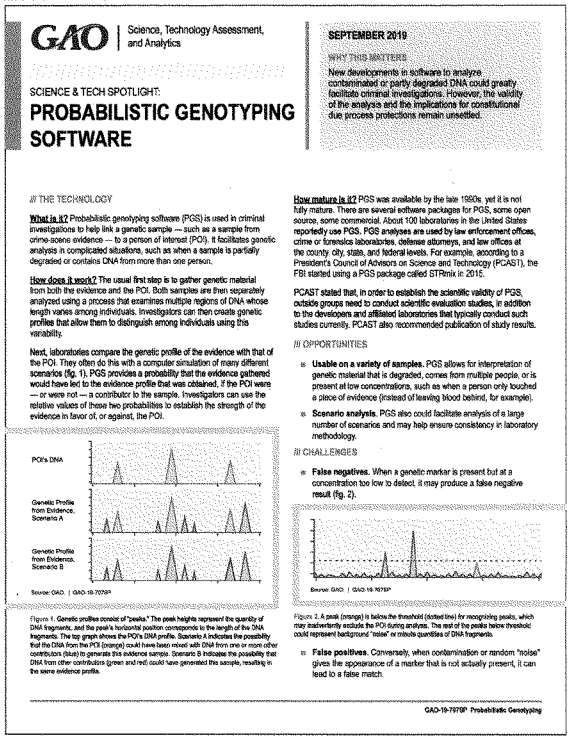
For further information on this testimony, please contact Timothy Persons, Chief Scientist, GAO, and Managing Director, Science, Technology Assessment, and Analytics who may be reached at (202) 512-6888. Contact points for our Congressional Relations and Public Affairs offices may be found on the last page of this statement. Other individuals making key contributions to this work include: Karen Howard (Director), Laura Holliday (Assistant Director), Jenn Beddor (Analyst-in-Charge), Will Bauder, Anika McMillon, Jon Menaster, Tind Shepper Ryen, and Ben Shouse.

Appendix I: List of GAO Technology Assessments and Science Forum Highlights

Irrigated Agriculture: Technologies, Practices, and Implications for Water Scarcity, GAO-20-128SP (Nov. 12, 2019)	*Highlights of a Forum: 3D Printing: Opportunities, Challenges, and Policy Implications of Additive Manufacturing*, GAO-15-505SP (June 24, 2015)
Critical Infrastructure Protection: Protecting the Electric Grid from Geomagnetic Disturbances, GAO-19-98 (Dec. 19, 2018)	*A Capsule Version of Nanomanufacturing—Emergence and Implications for U.S. Competitiveness, the Environment, and Human Health*, GAO-14-406SP (May 19, 2014)
Technology Assessment: Artificial Intelligence: Emerging Opportunities, Challenges, and Implications, GAO-18-142SP (Mar. 28, 2018)	*Nanomanufacturing: Emergence and Implications for U.S. Competitiveness, the Environment, and Human Health* GAO-14-181SP (Jan. 31, 2014)
Chemical Innovation: Technologies to Make Processes and Products More Sustainable, GAO-18-307 (Feb. 8, 2018)	*Technology Assessment: Neutron Detectors: Alternatives to Using Helium-3, GAO-11-753 (Sept. 29, 2011)*
Medical Devices: Capabilities and Challenges of Technologies to Enable Rapid Diagnoses of Infectious Diseases, GAO-17-347 (Aug. 14, 2017)	*Technology Assessment: Climate Engineering: Technical Status, Future Directions, and Potential Responses*, GAO-11-71 (July 28, 2011)
Internet of Things: Status and Implications of an Increasingly Connected World, GAO-17-75 (May 15, 2017)	*Technology Assessment: Explosives Detection Technologies to Protect Passenger Rail*, GAO-10-898 (July 28, 2010)
Highlights of a Forum: Data and Analytics Innovation—Emerging Opportunities and Challenges, GAO-16-659SP (Sept. 20, 2016)	*Securing the Transport of Cargo Containers*, GAO-06-68SU (Jan. 25, 2006)
Technology Assessment: Municipal Freshwater Scarcity: Using Technology to Improve Distribution System Efficiency and Tap Nontraditonal Water Sources, GAO-16-474 (Apr. 29, 2016)	*Technology Assessment: Protecting Structures and Improving Communications during Wildland Fires*, GAO-05-380 (Apr. 26, 2005)
Technology Assessment: Municipal Freshwater Scarcity: Survey of Technology Adoption by Municipal Water Utilities (GAO-16-588SP, Apr. 29, 2016), an e-supplement to GAO-16-474	*Technology Assessment: Cybersecurity for Critical Infrastructure Protection*, GAO-04-321 (May 28, 2004)
Technology Assessment: Water in the Energy Sector: Reducing Freshwater Use in Hydraulic Fracturing and Thermoelectric Power Plant Cooling, GAO-15-545 (Aug. 7, 2015)	*Technology Assessment: Using Biometrics for Border Security*, GAO-03-174 (Nov. 15, 2002)
Technology Assessment: Nuclear Reactors: Status and Challenges in Development and Deployment of New Commercial Concepts, GAO-15-652 (July 28, 2015)	

Source: GAO | GAO-20-306T

Appendix II: Examples of GAO Science and Technology Spotlight Series



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SCIENCE & TECH SPOTLIGHT:

PROBABILISTIC GENOTYPING SOFTWARE

SEPTEMBER 2019

WHY THIS MATTERS

New developments in software to analyze contaminated or partly degraded DNA could greatly facilitate criminal investigations. However, the validity of the analysis and the implications for constitutional due process protections remain unsettled.

/// THE TECHNOLOGY

What is it? Probabilistic genotyping software (PGS) is used in criminal investigations to help link a genetic sample — such as a sample from crime-scene evidence — to a person of interest (POI). It facilitates genetic analysis in complicated situations, such as when a sample is partially degraded or contains DNA from more than one person.

How does it work? The usual first step is to gather genetic material from both the evidence and the POI. Both samples are then separately analyzed using a process that examines multiple regions of DNA whose length varies among individuals. Investigators can then create genetic profiles that allow them to distinguish among individuals using this variability.

Next, laboratories compare the genetic profile of the evidence with that of the POI. They often do this with a computer simulation of many different scenarios (fig. 1). PGS provides a probability that the evidence gathered would have led to the evidence profile that was obtained, if the POI were — or were not — a contributor to the sample. Investigators can use the relative values of these two probabilities to establish the strength of the evidence in favor of, or against, the POI.

Figure 1. Genetic profiles consist of "peaks." The peak heights represent the quantity of DNA fragments, and the peak's horizontal position corresponds to the length of the DNA fragments. The top graph shows the POI's DNA profile. Scenario A indicates the possibility that the DNA from the POI (orange) could have been mixed with DNA from one or more other contributors (blue) to generate this evidence sample. Scenario B indicates the possibility that DNA from other contributors (green and red) could have generated this sample, resulting in the same evidence profile.

How mature is it? PGS was available by the late 1990s, yet it is not fully mature. There are several software packages for PGS, some open source, some commercial. About 100 laboratories in the United States reportedly use PGS. PGS analyses are used by law enforcement offices, crime or forensics laboratories, defense attorneys, and law offices at the county, city, state, and federal levels. For example, according to a President's Council of Advisors on Science and Technology (PCAST), the FBI started using a PGS package called STRmix in 2015.

PCAST stated that, in order to establish the scientific validity of PGS, outside groups need to conduct scientific evaluation studies, in addition to the developers and affiliated laboratories that typically conduct such studies currently. PCAST also recommended publication of study results.

/// OPPORTUNITIES

- **Usable on a variety of samples.** PGS allows for interpretation of genetic material that is degraded, comes from multiple people, or is present at low concentrations, such as when a person only touched a piece of evidence (instead of leaving blood behind, for example).
- **Scenario analysis.** PGS also could facilitate analysis of a large number of scenarios and may help ensure consistency in laboratory methodology.

/// CHALLENGES

- **False negatives.** When a genetic marker is present but at a concentration too low to detect, it may produce a false negative result (fig. 2).

Source: GAO. | GAO-19-707SP

Figure 2. A peak (orange) is below the threshold (dotted line) for recognizing peaks, which may inadvertently exclude the POI during analysis. The rest of the peaks below threshold could represent background "noise" or minute quantities of DNA fragments.

- **False positives.** Conversely, when contamination or random "noise" gives the appearance of a marker that is not actually present, it can lead to a false match.

GAO-19-707SP Probabilistic Genotyping

Source: GAO. | GAO-20-306T

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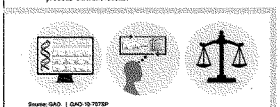
- **Limited information content.** PGS cannot attribute a DNA sample to a particular event. For example, a high likelihood of matching the POI does not mean the POI handled the object at a particular time or during a particular incident.
- **Lack of clarity.** It can be challenging to present results in a way that is meaningful to a lay audience. For example, if the test shows that the POI match is 500,000 times more likely than a match to a random person, how a non-specialist would interpret this statistic is unclear.
- **Lack of consistency.** Different software packages may yield different results from the same sample. In some cases, even the same software package can yield varying results, although this may not invalidate the results. One of the causes for lack of consistency is the lack of standards for using and interpreting PGS results.
- **Lack of validation.** It is challenging to validate PGS for certain scenarios, such as when a sample contains DNA from more than three people, or if the amount or quality of DNA decreases. If outside parties cannot validate the methods or examine how validation was conducted, legal questions could arise. For example, one news report suggested that results from a single PGS were used as the sole physical evidence in a trial that ended in conviction. However, the defense argued that the software company did not make its source code available for examination. Additionally, without validation, one may not know specifically why different methods produce different results.



Source: GAO. | GAO-19-707SP

Figure 3. Lack of clarity, standards, and validation studies may raise legal concerns about the use of PGS results.

/// POLICY CONTEXT AND QUESTIONS

PGS use in forensic analyses is increasing, but PGS results reportedly can be used with only limited confidence under certain circumstances. Some key questions for consideration include:

- In what situations is PGS useful, and when should it be avoided or used with caution?
- What are the gaps in empirical evidence that need to be filled to increase confidence in PGS results for use in criminal or civil trials, and what is the cost and feasibility of addressing these gaps?
- How are federal agencies evaluating and using PGS, and what should the federal role be?
- What additional validation work is needed to expand use of PGS?

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- DNA Evidence: DOJ Should Improve Performance Measurement and Property Design Controls for Nationwide Grant Program, GAO-16-216
- DNA Evidence: Preliminary Observations on DOJ's DNA Capacity Enhancement and Backlog Reduction Grant Program, GAO-16-661T
- Technology Assessment: Artificial Intelligence: Emerging Opportunities, Challenges, and Implications, GAO-18-142SP

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GAO SUPPORT:

GAO meets congressional information needs in several ways, including by providing oversight, insight, and foresight on science and technology issues. GAO staff are available to brief on completed bodies of work or specific reports and answer follow-up questions. GAO also provides targeted assistance on specific science and technology topics to support congressional oversight activities and provide advice on legislative proposals.

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Staff Acknowledgments: Sushil Sharma (Assistant Director), Hayden Huang (Analyst-in-Charge), Anika McMillon, Ben Shouse, and Jessica Smith.

Source: GAO. | GAO-20-306T Part 2 of 2

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SCIENCE & TECH SPOTLIGHT:

OPIOID VACCINES

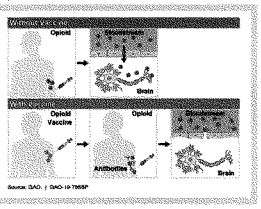
SEPTEMBER 2019

WHY THIS MATTERS

The ongoing opioid epidemic in the United States impacts lives on both a personal and national level. More than 10 million people abused opioids in 2017, with more than 47,000 opioid-related deaths — a nearly six-fold increase since 1999. Opioid vaccines could offer advantages over current treatment options.

/// THE TECHNOLOGY

What is it? Opioid vaccines are medical therapies designed to block opioids, such as heroin and fentanyl, from entering the brain or spinal cord, thus preventing addiction and other negative effects. While none are approved for use yet, they could be useful for at-risk individuals, patients in drug recovery programs, or first responders who might accidentally come into contact with deadly opioids that can be absorbed through the skin. This approach offers advantages over some current treatment methods, including requiring minimal medical supervision and no potential for abuse.



Source: GAO. | GAO-19-706SP

Figure 1: When an opioid enters the bloodstream (top), it crosses into the brain, where it can act on the target receptor to cause psychotropic effects, addiction, and overdose. Opioid vaccines (bottom) trigger the body to create antibodies that bind to opioid molecules and prevent them from entering the central nervous system, thus preventing negative effects.

How does it work? When opioid molecules bind to receptors in the central nervous system (the brain and spinal cord), they can cause psychotropic effects (e.g., hallucination, euphoria), addiction, and overdose. Opioid molecules have specific chemical structures. Opioid vaccines are designed to trigger an immune response to those structures when injected into a patient. Similar to vaccines for infectious diseases, such as polio or measles, when a patient is treated with an opioid vaccine, their immune system learns to identify the targeted opioid as a dangerous foreign substance so it can respond if that opioid enters the bloodstream in the future.

After the body has learned to target an opioid molecule, it naturally forms antibodies that can bind to it. These opioid-specific antibodies stick to opioid molecules in the bloodstream, forming a unit that is too large to enter the central nervous system.

Without entering the central nervous system, the molecule is not able to produce the negative effects associated with opioids. The antibody-bound opioid will eventually be excreted via urine without harming the exposed individual.

How mature is it? As of 2019, the Food and Drug Administration (FDA) has not approved any opioid vaccines for use. While opioid vaccine studies were initially proposed as early as the 1970s, clinical trials have thus far been unsuccessful. Currently, at least three early-stage clinical trials of potential opioid vaccines are underway, including one that the Walter Reed Army Institute of Research is conducting on a heroin vaccine.

Recently the National Institutes of Health and the National Institute of Allergy and Infectious Diseases released a broad agency announcement to fund the development of opioid vaccines against heroin and fentanyl. This funding is set to begin in August 2020. Other academic researchers continue to publish studies focusing on development and preclinical testing of opioid vaccines.

/// OPPORTUNITIES

- **Treat at-risk patients.** Unlike some current treatment options, opioid vaccines do not carry the risk of abuse. This could allow for more effective treatment of patients at high risk of abusing another medication, such as methadone.
- **Medical advantages.** The vaccines have a long duration (months to years) of action and require limited medical supervision.
- **Compatible with other therapies.** Vaccines currently in development are targeted to illicit use of opioids such as heroin and fentanyl, and therefore do not interfere with most drug treatment or pain management therapies.
- **Protection against accidental exposure.** Vaccines could be administered prophylactically to individuals at risk of accidental exposure to opioids, such as law enforcement, military, and first responders.

/// CHALLENGES

- **Lack of broad-based effect.** Current opioid vaccines are designed against the specific chemical structure of each opioid; therefore, multiple vaccines would be needed to provide broad-spectrum

Source: GAO. | GAO-20-306T

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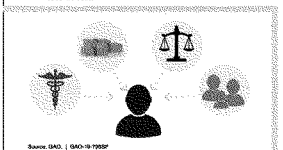
immunity. In addition, opioids such as fentanyl can be easily altered into a series of similar molecules called analogs, further complicating vaccine development.

- **Less effective in immune-compromised patients.** Patients with opioid use disorders often have other infections and altered immune responses that may limit the effectiveness of vaccines.
- **Mechanism not well understood.** The current biological mechanism of opioid vaccines is not as well understood as that of vaccines for infectious diseases.
- **Patient consent.** Consent issues could arise for people who might receive an opioid vaccine. For example, some might question a parent's right to compel their child to take a vaccine against a non-infectious agent, or an addicted person's ability to understand potential long-term effects of an opioid vaccine.
- **Interference with medical care.** If vaccines were developed against legal opioids that are used for pain management, vaccinated individuals would have a reduced risk of addiction but would also be unable to use those medications as effective treatments.
- **Insurance and payment.** Recent refusals to provide insurance to individuals who carry naloxone, used to counter opioid overdose, highlight the insurance issues surrounding opioid-related treatments. Would insurance cover an opioid vaccine? What might be the baseline costs?



Source: GAO. | GAO-19-706SP

Figure 2. Opioid vaccines will likely have a wide range of social and economic effects that could impact the individual.

POLICY CONTEXT AND QUESTIONS

- What means are available to facilitate the development of successful commercial opioid vaccines?
- What standards and validations should the FDA set for clinical trials of an opioid vaccine?
- When and to whom should an opioid vaccine be administered?
- What insurance coverage options are there for opioid vaccines?

SELECTED GAO WORK

- Drug Policy: Assessing Treatment Expansion Efforts and Drug Control Strategies and Programs, GAO-19-526T
- Opioid Crisis: Status of Public Health Emergency Authorities, GAO-18-689R
- Opioid Use Disorders: HHS Needs Measures to Assess the Effectiveness of Efforts to Expand Access to Medication-Assisted Treatment, GAO-18-44
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Staff Acknowledgments: Karen Howard (Assistant Director), Eliot Fletcher (Analyst-in-Charge), Anika McMillan, Ben Bolduc, and Jessica Smith.

GAO-19-706SP Opioid Vaccines

Source: GAO. | GAO-20-306T

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GAO | Science, Technology Assessment, and Analytics

SCIENCE & TECH SPOTLIGHT:

HYPERSONIC WEAPONS

SEPTEMBER 2019

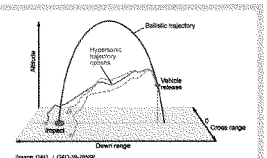
WHY THIS MATTERS

Hypersonic weapons, once developed, would fly faster than 3,800 mph and be extremely difficult to defend against. Advances in hypersonic technologies have significant implications for national security, as well as for transportation and space systems. Research and development of offensive and defensive capabilities in hypersonics is and will remain critically important.

THE TECHNOLOGY

What is it? Hypersonic weapons fly at least Mach 5 – five times the speed of sound, or approximately 3,800 mph. Unlike ballistic missiles, which can reach similar speeds but have a relatively fixed flight path, hypersonic weapons, once developed, would fly at lower altitudes, be highly maneuverable, and may be able to change targets during flight. This will make them extremely difficult to defend against.

How does it work? Most hypersonic weapons fall into two categories, hypersonic glide vehicles (HGVs) and hypersonic cruise missiles (HCMs).



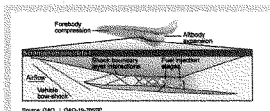
Source: GAO. | GAO-19-705SP

Figure 1. Ballistic Reentry Vehicle (RV) Versus HGV Trajectories. An RV follows a parabolic trajectory determined mainly by its launch characteristics, its target, and gravity. An HGV can take a variety of trajectories and leave its final destination ambiguous.

HGVs are unpowered and glide to their targets from a high altitude after initial launch by a rocket. They are expected to fly at altitudes between 25 and 60 miles.

HCMs are powered by high-speed engines during their entire flight. They are expected to fly at altitudes between 12 and 19 miles.

For most HCMs, a rocket would accelerate the missile to Mach 3 or 4, and then the HCM's own ramjet or supersonic combustion ramjet (scramjet) engine would take over. A ramjet uses the speed of the vehicle to "ram" and compress air with fuel, which is burned to produce thrust. A scramjet is similar, with air moving at supersonic speed.



Source: GAO. | GAO-19-705SP

Figure 2. Scramjet Engine. The air enters the inlet at a speed greater than Mach 1. It is then compressed by the engine geometry, and combustion occurs at supersonic speeds.

How mature is it? According to a U.S. Air Force Scientific Advisory Board report, domestically, the core technologies needed for the development of a tactical range HGV have reached Technology Readiness Level (TRL) 5 out of 9. The board expected the remaining subsystems for such a weapon to reach TRL 6 or higher by 2020. According to GAO best practices, TRL 7 is the level of technology maturity that constitutes a low risk for starting system development. It indicates that a technology has achieved form, fit, and function, and has been demonstrated in an operational environment.

OPPORTUNITIES

- **Penetrate defenses.** Hypersonic weapons would likely enable U.S. warfighters to penetrate existing adversary anti-aircraft and anti-missile systems because of their speed, maneuverability, and altitude (above typical anti-aircraft defenses and below interception points for ballistic reentry vehicles).
- **Strike fleeting targets.** The speed of hypersonic weapons would allow them to hit targets that are only vulnerable for a limited time, such as mobile, high-value military targets and adversary weapons systems.
- **Agile targeting.** A traditional missile needs to be launched with a target in mind, but a hypersonic weapon could be maneuvered later in flight. This could provide U.S. decision-makers more time and make it extremely difficult for adversaries to prepare.
- **High travel speeds.** Piloted hypersonic vehicles would allow for very short travel times and may have commercial applications. Such vehicles have essentially been limited to certain spacecraft reentering the atmosphere and experimental aircraft.

GAO-19-705SP Hypersonic Weapons

Source: GAO. | GAO-20-306T

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/// CHALLENGES

- **Heat-tolerant materials.** At hypersonic speeds, the exterior temperature of a hypersonic vehicle or weapon can exceed 2,000°F, necessitating advanced materials that will protect interior electronics. Such materials also need to be mechanically strong and efficient.
- **Propulsion technology.** Refinement of engine technology is needed for HCMs. This includes increasing the reliability and efficiency of scramjet engines. New types of engines that allow for propulsion from standstill to hypersonic speeds are also being developed, which would eliminate the need for rockets to provide the initial launch.
- **Weapon tracking.** Defense against a hypersonic weapon would involve tracking and intercepting it, but current radar and satellite systems are inadequate for this task.
- **Limited testing resources.** There are limited places to perform ground tests and flight tests of hypersonic weapons and vehicles in the United States. Currently, there are limited wind tunnel facilities in the country capable of running propulsion tests of hypersonic weapons and vehicles.
- **Safety and control.** Hypersonic velocities require additional improvements of aircraft control and guidance to help ensure the accuracy of hypersonic weapons and to avoid in-flight accidents or loss of control of hypersonic vehicles.

/// POLICY CONTEXT AND QUESTIONS

Within the Department of Defense (DOD), multiple programs by the Defense Advanced Research Projects Agency (DARPA), the Air Force, the Navy, and the Army are leading research or developing hypersonic weapons for a variety of applications and launch methods.

NASA also conducts work related to hypersonics for vehicles and spacecraft reentry into the atmosphere, both for NASA programs and in support of DOD. This includes research to safety control and guide hypersonic vehicles.

With U.S. investment in hypersonics increasing, and key technologies not yet mature, some questions for consideration include:

- What is the status of U.S. efforts to advance the science and technology needed to develop hypersonic weapons and vehicles?
- What measures are needed to ensure timely and efficient development?
- Are the development goals realistic given the current status of key technologies?
- Which federal agencies are investing in hypersonic weapons, vehicles, and related technologies, and how are these efforts coordinated?
- What are the implications of the proliferation of hypersonic weapons? What are the implications of the commercialization of hypersonic technologies and vehicles?

/// SELECTED GAO WORK

- DOD Acquisition Reform: Leadership Attention Needed to Effectively Implement Changes to Acquisition Oversight, GAO-19-439
- National Security: Long-Range Emerging Threats Facing the United States As Identified by Federal Agencies, GAO-19-204SP
- Technology Readiness Assessment Guide, GAO-16-410G

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Source: GAO. | GAO-20-306T

Part 2 of 2

GAO | Science, Technology Assessment, and Analytics

SEPTEMBER 2019

WHY THIS MATTERS

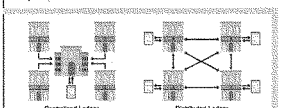
Distributed ledger technology (e.g. blockchain) allows users to carry out digital transactions without the need for a centralized authority. It could fundamentally change the way government and industry conduct business, but questions remain about how to mitigate fraud, money laundering, and excessive energy use.

SCIENCE & TECH SPOTLIGHT:

BLOCKCHAIN & DISTRIBUTED LEDGER TECHNOLOGIES

THE TECHNOLOGY

What is it? Distributed ledger technologies (DLT) like blockchain are a secure way of conducting and recording transfers of digital assets without the need for a central authority. DLT is "distributed" because multiple participants in a computer network (individuals, businesses, etc.), share and synchronize copies of the ledger. New transactions are added in a manner that is cryptographically secured, permanent, and visible to all participants in near real time.



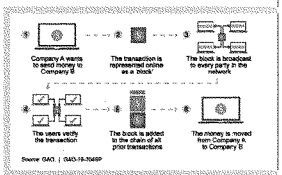
Source: GAO. | GAO-19-7045P

Figure 1. Difference between centralized and distributed ledgers.

How does it work? Distributed ledgers do not need a central, trusted authority because as transactions are added, they are verified using what is known as a consensus protocol. Blockchain, for example, ensures the ledger is valid because each "block" of transactions is cryptographically linked to the previous block so that any change would alert all other users. With an agreement on that history, users may then conduct a new transaction with a shared understanding of who has which resource.

Distributed ledgers can be either "permissioned" or "unpermissioned." With unpermissioned ledgers, which are generally public, any participant can conduct a transaction. Permissioned ledgers may or may not be public, but only trusted users can conduct transactions.

How mature is it? Businesses have been using ledgers to record transactions for thousands of years, and a defining characteristic of such ledgers was their reliance on central management. Furthermore, DLT is not a new technology, but an innovative way of using existing, mature technologies. In October 2008, an unknown author using the name Satoshi Nakamoto published a white paper called "Bitcoin – A Peer-to-Peer Electronic Cash System", which is credited as the first theoretical framework of a DLT. In January 2009 the service the paper described was launched.



Source: GAO. | GAO-19-7045P

Figure 2. How blockchain, a form of distributed ledger technology, acts as a means of payment for cryptocurrencies.

Cryptocurrencies like Bitcoin are a digital representation of value and represent the best-known use case for DLT. The regulatory and legal frameworks surrounding cryptocurrencies remain fragmented across countries, with some implicitly or explicitly banning them, and others allowing them.

In addition to cryptocurrencies, there are a number of other efforts underway to make use of DLT. For example, Hyperledger Fabric is a permissioned and private blockchain framework created by the Hyperledger consortium to help develop DLT for a variety of business applications. The consortium is made up of companies such as Airbus, Cisco, American Express, IBM, and Intel.

OPPORTUNITIES

- **Transparency.** Because any user can view the ledger, DLT may result in benefits such as reduced corruption.
- **Reduced labor costs.** DLT reduces or eliminates the need for human workers to track data.
- **Data quality and reliability.** Transaction information is automatically generated by a computer, which may reduce errors.
- **Wide applicability.** DLT is being explored for use across many sectors, including supply chain and logistics, news, energy, healthcare, and government. For example, Target built a system now known as ConsenSource to verify products are sourced sustainably.

GAO-19-7045P Blockchain & Distributed Ledger Technologies

Source: GAO. | GAO-20-306T

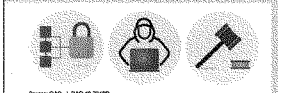
Part 1 of 2

GAO | Science, Technology Assessment, and Analytics

The New York Times created the News Provenance Project to explore a blockchain-based system for recording and sharing information published by news organizations.

/// CHALLENGES

- **Excessive energy usage.** Some uses of DLT can be costly to operate. For example, cryptocurrencies using "proof-of-work" consensus protocols (also known as "mining") require large amounts of computing power and energy to generate new units of currency.
- **Collusion.** Security of the network relies on the consensus protocol that maintains the ledger, and research has shown that users who collude could gain enough influence to manipulate the ledger to their benefit and gradually disrupt the protocol.
- **Security.** Entities using DLT will need to ensure data stored on a permissioned distributed ledger is not accessible to outside actors. Additionally, holders of cryptocurrency can have their digital wallets hacked and their currency stolen.
- **Permanence.** While the permanence of transactions may be a core strength of DLT, it can also be a weakness should an entry find that it needs to regularly correct errors in its ledger, as it would be unable to easily do so with DLT.
- **Lack of transparency.** Because DLT can be used without a central authority, governments may feel uncomfortable allowing cryptocurrencies (or other DLT) to be used as a method of exchange or contracting, since they cannot easily be tracked and could be used to facilitate illicit activity (such as tax evasion and money laundering).



Source: GAO. | GAO-19-704SP

Figure 3. Permanence and lack of transparency and regulation raise concerns about adoptability.

- **Lack of regulation.** Businesses may express concern about making investments in DLT because of uncertainties surrounding how such technologies might be regulated. While there have been initial efforts to regulate cryptocurrencies such as Bitcoin, much less has been done around other DLT use cases.

/// POLICY CONTEXT AND QUESTIONS

DLT use across many sectors is increasing, but challenges remain to widespread adoption. Some key questions for consideration include:

- In what situations is DLT useful, and when should it be avoided or used with caution?
- To what extent can DLT be used to facilitate illegal activities, and how might policymakers mitigate such use?
- How are federal agencies evaluating and using DLT.

/// SELECTED GAO WORK

- Financial Technology: Additional Steps by Regulators Could Better Protect Consumers and Aid Regulatory Oversight, GAO-18-254
- Trends Affecting Government and Society: United States Government Accountability Office Strategic Plan 2018-2023, GAO-18-396SP
- Financial Technology: Information on Subsectors and Regulatory Oversight, GAO-17-361
- Virtual Currencies: Emerging Regulatory, Law Enforcement, and Consumer Protection Challenges, GAO-14-496

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Timothy M. Persons, Ph.D., Chief Scientist, personst@gao.gov

Staff Acknowledgments: William Carrigg (Assistant Director), Jon Menaster (Analyst-in-Charge), Anika McMillon, Ben Shouse, and Jessica Smith.

Source: GAO. | GAO-20-306T Part 2 of 2

Appendix III: Selected GAO Science and Technology Products, Fiscal Years 2018 and 2019

Defense and Space

Army Modernization: Army Futures Command Should Take Steps to Improve Small Business Engagement for Research and Development. GAO-19-511. Washington, D.C.: Jul 17, 2019	*Defense Science and Technology: Actions Needed to Enhance Use of Laboratory Initiated Research Authority.* GAO-19-64. Washington, D.C.: Dec 20, 2018.
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Source: GAO. | GAO-20-306T

Biology and Medicine

Biological Select Agents and Toxins: Actions Needed to Improve Management of DOD's Biosafety and Biosecurity Program. GAO-18-422. Washington, D.C.: Sep. 20, 2018.	*Illicit Opioids: While Greater Attention Given to Synthetic Opioids, Agencies Need to Better Assess Their Efforts.* GAO-18-205. Washington, D.C.: Mar. 29, 2018.
Generic Drugs: FDA Should Make Public Its Plans to Issue and Revise Guidance on Nonbiological Complex Drugs. GAO-18-80. Washington, D.C.: Dec. 14, 2017.	*High-Containment Laboratories: Coordinated Actions Needed to Enhance the Select Agent Program's Oversight of Hazardous Pathogens.* GAO-18-145. Washington, D.C.: Oct. 19, 2017.

Source: GAO. | GAO-20-306T

Physical Sciences and Engineering

Advanced Manufacturing: Innovation Institutes Have Demonstrated Initial Accomplishments, but Challenges Remain in Measuring Performance and Ensuring Sustainability. GAO-19-409. Washington, D.C.: May 23, 2019.	*Chemical Innovation: Technologies for Making Products and Processes More Sustainable.* GAO-19-660T. Washington, D.C.: Jul 25, 2019
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Plutonium Disposition: Observations on DOE and Army Corps Assessments of the Mixed Oxide Fuel Fabrication Facility Contract. GAO-18-122R. Washington, D.C.: Nov. 15, 2017.	*Low-Dose Radiation: Interagency Collaboration on Planning Research Could Improve Information on Health Effects.* GAO-18-184T. Washington, D.C.: Nov. 01, 2017.

Source: GAO. | GAO-20-306T

Fundamental Research and Innovation

Federal Research: Agency Actions Could Strengthen Scientific Integrity Policies. GAO-19-674T. Washington, D.C.: Jul 17, 2019.	*Sexual Harassment in STEM Research: Preliminary Observations on Policies for University Grantees and Information Sharing among Selected Agencies.* GAO-19-583T. Washington D.C.: Jun. 12, 2019.
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Source: GAO. I GAO-20-306T

Environmental Science and Agriculture

Climate Change Adaptation: DOD Needs to Better Incorporate Adaptation into Planning and Collaboration At Overseas Installations. GAO-18-265C. Washington, D.C.: Apr. 02, 2018.	*Food Safety: USDA Should Take Further Action to Reduce Pathogens in Meat and Poultry Products.* GAO-18-272. Washington, D.C.: Mar. 19, 2018.
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Source: GAO. I GAO-20-306T

Cybersecurity

Critical Infrastructure Protection: Actions Needed to Address Significant Cybersecurity Risks Facing the Electric Grid. GAO-19-332. Washington, D.C.: Sep. 25, 2019.	*Future Warfare: Army Is Preparing for Cyber and Electronic Warfare Threats, but Needs to Fully Assess the Staffing, Equipping, and Training of New Organizations.* GAO-19-570. Washington, D.C.: Aug. 15, 2019.
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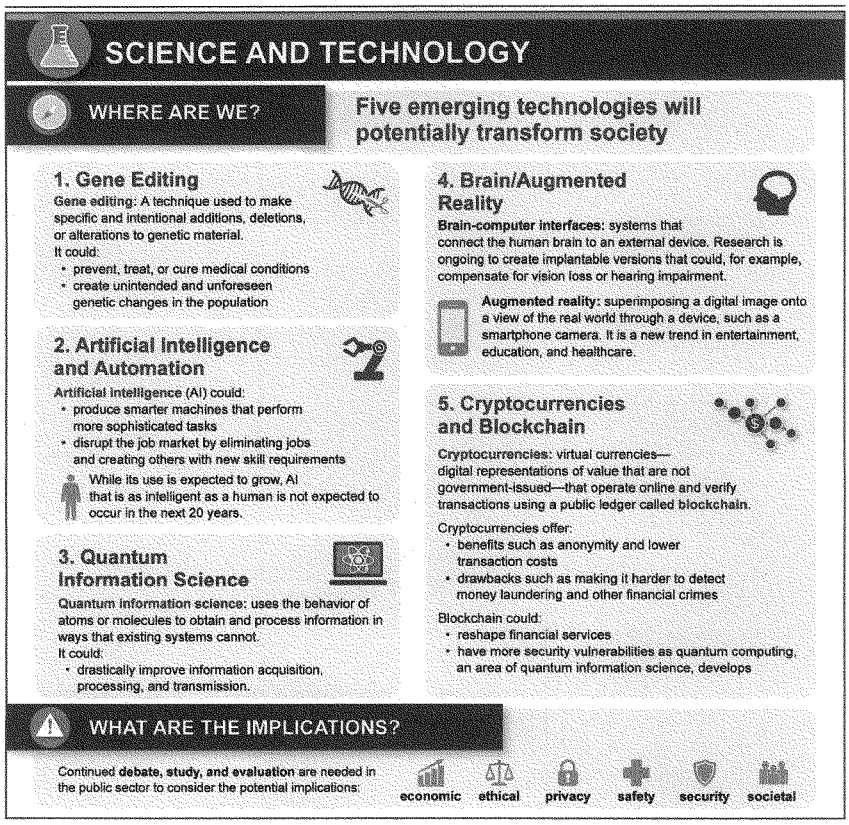
Weapon Systems Cybersecurity: DOD Just Beginning to Grapple with Scale of Vulnerabilities. GAO-19-128. Washington, D.C.: Oct. 9, 2018.	*High-Risk Series: Urgent Actions Are Needed to Address Cybersecurity Challenges Facing the Nation.* GAO-18-622. Washington, D.C.: Sep. 6, 2018.

Source: GAO. I GAO-20-306T

Computer Science and Data	
Face Recognition Technology: DOJ and FBI Have Taken Some Actions in Response to GAO Recommendations to Ensure Privacy and Accuracy, But Additional Work Remains. GAO-19-579T. Washington D.C.: Jun. 4, 2019.	*Workforce Automation: Better Data Needed to Assess and Plan for Effects of Advanced Technologies on Jobs.* GAO-19-257. Washington, D.C.: Mar. 7, 2019.
Artificial Intelligence: Emerging Opportunities, Challenges, and Implications for Policy and Research. GAO-18-644T. Washington, D.C.: June 26, 2018.	*Artificial Intelligence: Emerging Opportunities, Challenges, and Implications.* GAO-18-142SP. Washington, D.C.: Mar. 28, 2018.
Financial Technology: Additional Steps by Regulators Could Better Protect Consumers and Aid Regulatory Oversight. GAO-18-254. Washington, D.C.: Mar. 22, 2018.	*Internet of Things: FCC Should Track Growth to Ensure Sufficient Spectrum Remains Available.* GAO-18-71. Washington, D.C.: Nov. 16, 2017.

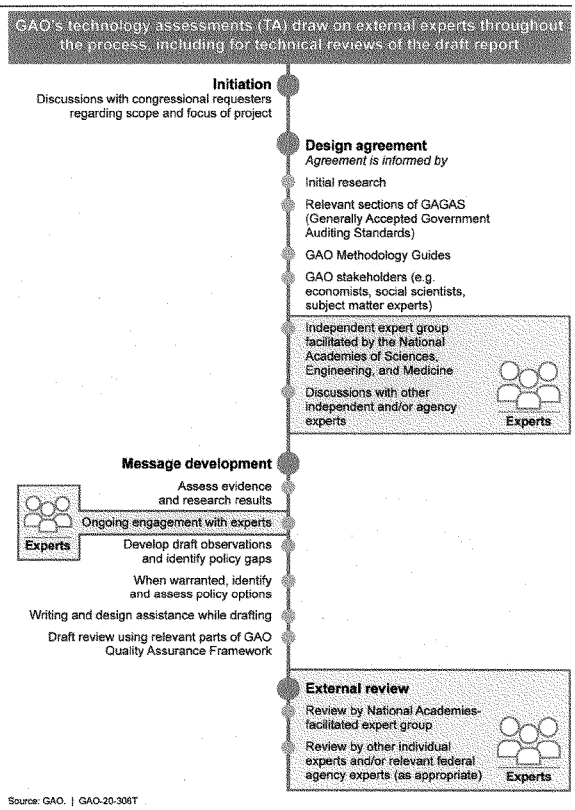
Source: GAO. | GAO-20-306T

Appendix IV: Science and Technology Trends from GAO's 2018-2023 Strategic Plan



Source: GAO. | GAO-20-306T

Appendix V: For Technical Reviews, GAO Involves External Experts Throughout the Engagement Process



Source: GAO. | GAO-20-306T

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Biography

Dr. Timothy M. Persons is the Chief Scientist and Managing Director of the Science, Technology Assessment, and Analytics team of the United States Government Accountability Office (GAO - the oversight, insight, and foresight entity of the U.S. Congress). Dr. Persons is the founder of GAO's Innovation Lab and in this role he leads advanced data analytic activities as well as the exploration of emerging technologies such as machine learning systems, blockchain, and cloud cybersecurity research at GAO. He also directs GAO's science, technology, and engineering portfolio – including technology assessment, technical assistance, and engineering in support of the Congress and GAO. In these roles he has led a large interdisciplinary technical team which has advised Congress and informed legislation on topics ranging from artificial intelligence, advanced data analytics, sustainable chemistry, biosafety and biosecurity, 3D printing, nanomanufacturing, homeland security systems, and freshwater conservation technologies, among others. He also directed the production and release of GAO's Best Practices Guides – Cost, Schedule, Technology Readiness Assessment, and Agile Software Development. Prior to joining GAO, Dr. Persons served as the Technical Director for the Intelligence Advanced Research Projects Activity (IARPA) as well as the technical lead for Quantum Information Sciences and Biometrics research groups for the Information Assurance Directorate at the National Security Agency.

Dr. Persons is a recipient of a 2016 James Madison University (JMU) Distinguished Alumnus Award, a 2014 recipient of a GAO Distinguished Service Award, a 2012 recipient of the Arthur S. Flemming award in recognition of sustained outstanding and meritorious achievement within the U.S. federal government; and a 2012 and 2010 recipient of GAO's Big Picture Award for significant project achievement involving the ability to look longer, broader, and more strategically at key national or global issues. He has also received numerous GAO Results through Teamwork awards for key accomplishments in high risk and high value transformative work for the Comptroller General.

In 2007, Dr. Persons was awarded a Director of National Intelligence Science and Technology Fellowship focusing on computational imaging systems research. He was also selected as the JMU Physics Alumnus of 2007. He has also served as a radiation physicist with the University of North Carolina at Chapel Hill. He received his B.Sc. (Physics) from JMU, a M.Sc. (Nuclear Physics) from Emory University, and a M.Sc. (Computer Science) and Ph.D. (Biomedical Engineering) degrees from Wake Forest University. He is a senior member of the Institute for Electrical and Electronic Engineers (IEEE), a council member (*ex officio*) of the National Academy of Sciences, Engineering and Medicine's (NASEM) Government-University-Industry Research Roundtable (GUIRR), a member (*ex officio*) of the National Academy of Medicine's Committee on Emerging Science, Technology, and Innovation, and a member of the Virginia Tech-Wake Forest University Biomedical Engineering and Mechanics (BEAM) Advisory Board.

Chairwoman JOHNSON. Thank you, Dr. Persons.
Dr. Peter Blair.

**TESTIMONY OF DR. PETER BLAIR,
EXECUTIVE DIRECTOR, DIVISION ON ENGINEERING AND PHYSICAL SCIENCES, THE NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE**

Dr. BLAIR. Good morning, Madam Chair, Ranking Member Lucas, Members of the Committee. Today's subject is a long-standing one with me, shaped both by my current post at the Academies and my earlier role at the former OTA. So the views I express today are my own based on that experience and not necessarily those of the Academies per se since we haven't addressed the topic in a long time, actually since the 1960s, although that may be something for you to keep in mind.

Let me say at the outset the prospect of reinvesting in a dedicated technology assessment capability for Congress has come before you from time to time in recent years, but it should be abundantly clear that such investment in a variety of ways, as both the reports you've heard about recommend, is now long overdue.

Today, Congress draws on many sources of advice, but it created for itself four options historically that have been used most frequently for science and technology-related issues: The National Research Council (NRC), the operating arm of the Academies, the CRS, the still-authorized but unfunded OTA, and, more recently, adding to the mission of GAO.

Now, Congress created each option for a specific purpose, but in the wake of the OTA's suspension of operations in 1995, the others assumed some of OTA's function. But to date that assumption has occurred only to a modest degree even after nearly a quarter of a century. And to illustrate this I give you three observations.

First, following OTA's closure, congressional requests for Academies studies doubled but then the next year fell back to its historical trend most likely because most NRC studies currently are carried out at a different level of policy extraction context than the efforts that the Congress traditionally commissioned to the OTA.

Second, CRS' timely off-the-shelf information remains an essential resource, but it hasn't filled and never aspired to fill the analysis gap left by OTA's closure.

And finally, as Dr. Persons mentioned, GAO began in 2002 ever so slowly to develop a technology assessment capability. It remains a work in progress, and there are important challenges to mature that capacity.

So the salient question is at this point, how best to improve Congress' capacity overall in a way that is authoritative, independent, objective, timely, and tuned specifically to Congress' needs as distinct from executive agency needs.

The current needs are compelling enough that that investment need not be either/or among the options. Rather, the result would be more effective overall as a hybrid, that is, to deploy each organization building on its design strengths and realize additional economies from effective collaboration among them rather than attempting to reinvent the wheel in any one of them.

The historical OTA experience, in producing hundreds of assessments over its 23 years, has some important lessons applicable even today. By the way, you can see all of the 750 assessments just by Googling "OTA legacy" or in better bookstores in the Washington area the CD collection is around. It's a fascinating read even today.

But let me recap the three lessons. First, OTA drew extensively and broadly on the Nation's authoritative technology and other relevant expertise through its panels, contractors, consultants, and through participation in many workshops for each assessment. Also, OTA relied on staff expertise recruited specifically to match the technical and policy needs of each assessment undertaken individually.

So far, GAO's assessment involvement of external experts has been modest by comparison, so they have some work to do. But overall, the lesson is in order to be unassailably credible, it is essential to engage the Nation's vast reservoir of authoritative technology and other relevant expertise formally in generating science and technology advice.

The second lesson, like the Academies, OTA relied on the crucial quality assurance step of rigorous external review of its work, again, from authoritative experts and stakeholders across the Nation. So far, GAO's review remains dominated by the internal processes with some limited external review. So again, it's on the to-do list for GAO. But the lesson overall is extensive and fully accountable external review is essential to demonstrating credibility that the advice delivered is independent, objective, authoritative, and current.

And finally, the third illustrative lesson is OTA's statutory technology assessment board of House and Senate Members, informed again by a standing council of external experts, commissioned assessments in response to bipartisan leadership requests from committees of jurisdiction most often from both chambers. Most of the GAO assessments so far have not been undertaken in response to formal requests from the committees of jurisdiction and none so far in response to the bipartisan requests from such committees in both chambers. So there are protocols for the balance of GAO's work that when applied directly to technology assessment need some augmentation.

I didn't mean to pick on GAO solely. All the options need modernization. GAO's initiative going forward, as you heard from Dr. Persons, promises features tuned to today's context and in the direction of the OTA standards I just described, although after 17 years, they have some catching up to do.

The NRC also is undergoing a major transformation internally that may yield some important ways of providing authoritative S&T advice to the Congress. But since progress toward replicating key features of OTA has been slow, Congress needs to redouble its efforts to develop effective advisory capabilities wherever it resides both in modernizing a dedicated OTA-like organization, as well as enhancing the capacity of existing mechanisms.

Moreover, going forward, both reports mention a broader portfolio of activities, products, closer connections with other organizations, enhanced communications capacity, and more collaboration

across the agencies. The collaboration feature is particularly important. I think, for example, GAO's well-developed performance audits augmented by its developing S&T capability could be much more effective than an OTA assessment alone in evaluating the management performance of executive agency programs.

There are other examples, but they all underscore my principal conclusion as I noted at the outset, that the overall goal should be to deploy each organization in line with its design strengths and to achieve economies and collaboration across the cylinders of excellence rather than try to reinvent the wheel in any one of them.

[The prepared statement of Dr. Blair follows:]

EFFECTIVE SCIENCE AND TECHNOLOGY ADVICE FOR CONGRESS: COMPARING OPTIONS

Statement of

Peter D. Blair, Ph.D.
Executive Director, Engineering and Physical Sciences
National Academies of Sciences, Engineering, and Medicine

before the

Committee on Science, Space and Technology
U.S. House of Representative

December 5, 2019

Madam Chair and Ranking Member Lucas,

Thank you for the invitation to participate today. Today's subject is of longstanding interest to me. My perspective is shaped not only by my current post at the National Academies but also by my earlier roles at the former Office of Technology Assessment and at Sigma Xi, the scientific research society. So, the views I express today are my own, based on that perspective and not necessarily those of the Academies or an Academies report, since we haven't addressed this topic recently in an Academies study, although that may be something for you to keep in mind.

The prospect of reinvesting in an effective technology assessment (TA) capacity for Congress has come before you from time to time in recent years, but it should be clear at this point that a renewed investment in Congress's capacity to be better informed about science and technology (S&T) is long overdue. It is essential that you, our elected representatives, can make fully-informed decisions, and S&T issues increasingly complicate many of the decisions you face across the full agenda of Congress and the jurisdictions of your committees. Also, more prominent than ever today are the sweeping implications of the rapid pace of technology change. Artificial intelligence, blockchain technology, the internet of things, quantum computing, autonomous vehicles, data encryption, big data mining, hypersonic weapons, hydraulic fracturing, deep fakes, and gene editing technology are but a few recent examples. Finally, Congress faces many more issues for which the S&T dimension, while often not the dominant concern, is often still a very significant one that, if misunderstood, could lead to poor legislative decisions and oversight, some touching the very heart of our democracy such as elections or information security and privacy. Still others involve massive government investments in S&T related facilities, regulations, and infrastructure, such as preparing for 5G cellular network deployment, securing the nation's food supply, research and development security, and scores of others.

The salient question then is how best to improve Congress's capacity for acquiring S&T information and advice that is authoritative, independent, objective, relevant, timely and tuned specifically to Congress's current needs. Moreover, the needs are compelling enough that investment in expanding Congress's S&T capacity need not be either/or among options being considered. Rather, the objective could be more effective overall to deploy each organization building on its design strengths rather than attempting to reinvent the wheel in any or only one of them and realizing additional economies from effective collaboration among all of them.

Congress draws on many sources of S&T advice though its committee and personal staffs, often supplemented with expertise from universities, professional societies, industry or executive agencies, constituents, and many other interests, all with strengths and weaknesses with respect to serving the needs of Congress. S&T advice delivered to Congress must be both *credible* and *suitable* to congressional needs, more specific measures of which I will address later. In facing this challenge previously, Congress created four traditional options that stand out as having been used most frequently overall in providing advice matching its needs. In chronological order of their assumption of roles in providing S&T advice to Congress, they are:

- First, the **National Research Council** (NRC), the principal operating arm of the National Academies of Sciences Engineering and Medicine, is a private, independent, non-government organization operating under the 1863 congressional charter creating the National Academy of Sciences to "investigate, examine, experiment, and report upon any subject of science whenever called upon to do so by any department of the government." (*NAS Act*, 1863)
- Second, the **Congressional Research Service** (CRS), created in 1914 by Congress to operate within the Library of Congress, which includes S&T as one component of its broad portfolio, "to serve

Congress and, in particular, individual members of Congress, throughout the legislative process by providing broad-ranging legislative research and analysis." (*Legislative Reorganization Act of 1970*)

- Third, the former **Office of Technology Assessment** (OTA), created in 1972 as an agency of Congress (operating though 1995) to provide Congress with independent, objective and authoritative analysis of the complex scientific and technical issues. The intent was for Congress to "equip itself with new and effective means for securing competent, unbiased information concerning the physical, biological, economic, social, and political effects of such [technology] applications." (*OTA Act*, P.L. 92-484, 1972)
- Fourth, the **Government Accountability Office** (GAO), created by Congress in 1921 as an independent auditing agency for Congress to "investigate … matters relating to the receipt, disbursement, and application of public funds, and shall make to the President … and to Congress … reports [and] recommendations looking to greater economy or efficiency in public expenditures" (*Budget and Accounting Act*, 1921), began in 2002, in the wake of OTA's closure, to develop an approach to technology assessment within its portfolio.

I can submit for the record soon an as-yet-unpublished working paper, *Effective Science Advice for Congress: Comparing Options*, which evaluates the strengths and weaknesses of these options in detail in today's circumstances, a few highlights of which I include in my testimony today.

A main conclusion of the paper is, as I indicated at the outset, that the time for reinvesting in an effective TA advice capability for Congress is at this point long overdue, but, also as noted earlier, in order to be effective, the advice delivered must be both widely recognized as both credible and tailored to the needs, context, and language of Congress. The paper elaborates on measures of *credibility* of advice from the perspective of those who will use the advice, which in sum are that it must be (1) **authoritative**, (2) **objective**, and (3) **independent**. As measures of *suitability*, it must be (4) **relevant**,

(5) **useful**, and (6) **timely**. The table attached summarizes and compares the four options noted earlier against these six criteria.

Filling the Gap Left with OTA's Closure

Congress created each of the four most-often-used options just noted for a specific purpose, although all evolved significantly since their creation. Regarding S&T advice specifically, the NRC, CRS, and GAO each assumed some of the former OTA's function in the wake of the OTA's closure in 1995, but that assumption has occurred only to a modest degree so far, even after nearly a quarter of a century. The following are three illustrations of this:

- First, following OTA's closure, congressional requests for National Academies or NRC studies doubled but then the next year fell back to the historical trend, at least in part because most NRC studies currently are carried out at a different level of policy context than the kinds of efforts that Congress traditionally commissioned to the former OTA.
- A second observation is that CRS's delivery of timely "off the shelf" S&T information remains an excellent resource for the Congress for that purpose and has improved with new technology and experience, including becoming publicly accessible, but it hasn't filled and never really aspired to fill the analysis gap left by OTA's closure.
- And, finally, in 2002, GAO began to develop a TA capacity, but progress has been very slow towards adopting key features for providing effective TA for Congress, at least to the standard set by the former OTA.

To elaborate on the last illustration, I highlight three features reflective of the OTA experience. Over OTA's 23-year history the office delivered hundreds of technology assessments that (1) drew extensively and broadly on the nation's authoritative S&T expertise through its advisory panels, as

contractors, as consultants, and though participation in information gathering workshops and in rigorous peer review of its products; (2) relied on experienced and highly qualified staff expertise recruited specifically for the technical and policy needs of each assessment undertaken; and (3) focused on topics matched to clearly articulated needs of congressional committees of jurisdiction as judged by the agency's statutory Technology Assessment Board of House and Senate Members and informed by the Technology Assessment Advisory Council of external experts, also a statutory group.

By comparison, for these 3 illustrative features, during the 17 years that the GAO TA function has been active (2002-2019), GAO issued 15 efforts listed as TAs issued, but so far developing a TA model including features commensurate with the OTA experience has progressed very slowly. As three examples to illustrate: (1) early GAO TA efforts (2002-2010) rarely involved in any formal way the nation's broad reservoir of S&T expertise and, even in more recent efforts (2011-2019), one-time Academies-organized expert meetings have provided the only prominent degree of formal access to external expertise; (2) over the same period, GAO TA internal agency mechanisms dominated review of draft reports; only recently has there been incremental movement toward comprehensive external review by inviting review comments on draft reports from some Academies technical expert meeting participants; and (3) GAO has yet to initiate a TA with bipartisan requests from the relevant committees of jurisdiction in both congressional chambers and most efforts to date carried no formal request expressed by the committees of jurisdiction over the TA topics undertaken.

Modernizing Options

Going forward, the developing design of GAO's Science, Technology Assessment and Analytics Team promises features tuned to today's context and in the direction of the OTA standard, although GAO has much to do to rise to that standard, as illustrated above, as well as with other examples. Also, going forward, the NRC is undergoing an internal transformation process that may yield new ways of

providing S&T advice to Congress. For any of the four options, developments to adapt capabilities to today's congressional needs are certainly possible and I elaborate on those possibilities in detail in the working paper.

However, even with prospective changes to the NRC, GAO, and the former OTA, some structural limitations with each of them may limit the degree to which substantial change is possible. The following are three examples related to: (1) access to authoritative expertise, (2) quality assurance with external review, and (3) decision-making about selection of assessments tuned to congressional needs.

1. **Access to Expertise.** The NRC typically provides authoritative analysis and advice from widely recognized experts serving as pro bono volunteers on an appointed NRC study committee that provides specific evidence-based recommendations on a course of action. It is a widely valued resource, but the topics addressed most often are subjects tailored to executive agency needs, which comprise the bulk of the NRC's work portfolio. For policy analysis, the NRC's consensus study process limits the range of perspectives participating in the committee deliberation, both due to the necessity of excluding conflicts of interest as well as limiting the degree to which deep ideological differences can be reconciled in achieving a consensus view. Such challenges are not at all insurmountable, however, and finding new ways to address value-laden policy issues is a task for the ongoing internal NRC transformation. By contrast, OTA's objective was solely to inform the policy debate, including consideration of the broader social, economic, and political context and proffering alternative policy options and analyzing their consequences but not providing specific recommendations. As noted earlier, OTA assessments were carried out by professional staff whose expertise was carefully tuned to the topic of the assessment. Assessments were also informed and guided by an advisory panel of external experts like that of an NRC committee but including a broad range of experts and stakeholder interests relevant to the topic. The main point, however, is that both

the NRC and OTA models draw extensively and broadly on the nation's S&T expertise. GAO's STAA has a similar advisory objective to OTA's but to date has developed relatively weak mechanisms for acquiring the best external expertise possible or tuning available staff expertise to the needs of current assessments. *Going forward, it is certainly possible for the NRC to build the staff capabilities to fully support an "OTA-like" approach, i.e., that focuses on articulating the broad implications of policy options tuned to congressional needs, and such features could well be an outcome of the NRC's ongoing internal transformation. Similarly, it may be a stretch for GAO to build strong mechanisms to access extensive authoritative external and staff technical expertise tuned to the needs of current assessments, but it is essential to include such a feature as the STAA's approach develops.*

2. **Quality Assurance through External Review.** As another example, both the NRC and OTA have/had strong and highly structured external review mechanisms for draft reports. This helps ensure quality and accountability to standards of evidence as judged by experts. The review processes differed in that the NRC stresses the independence of the external review through a formal appointment process for reviewers and a very structured response-to-review process accountable to an independently appointed report monitor who judges the adequacy of the study committee's response to reviewer comments. The OTA process sought to involve all stakeholder interests in its external review process, which often expanded the review to include many more individuals (sometimes involving a hundred reviewers) with the adequacy of the response-to-review judged by the office of OTA's Director. That is, both the NRC and OTA models involve extensive and accountable external review mechanisms. GAO's process traditionally has been dominated by the agency's internal review process, but more recently has involved some degree of external review, at least of the technical features of the assessment, by inviting comments from some participants from a

group of technical experts recruited for a one-time "meeting of experts" by the Academies to help inform the assessment, inclusion of which has become more common in recent GAO TA activities. *Generally, though, GAO would benefit from strengthening its external review process, adopting more extensive accountable review procedures like those of the NRC or OTA.*

3. **Setting Priorities**. As a final example, the mechanisms for ensuring that assessments undertaken are tuned to high priority needs of the Congress vary considerably by option. Congressionally mandated studies commissioned to the Academies typically require passage of legislation, which, by definition, denotes a high congressional priority since the legislation requires passage by both chambers and the signature of the President. Further, the resources to carry out the work are committed in appropriations language or by agreement of executive agencies. The drawback is that this is a lengthy process and may preclude many worthy efforts since it takes so long to commission a study. Reconciling congressional intent with the terms of reference defined by federal agencies sponsoring the study can add delay. Both OTA and GAO were/are allocated an annual appropriation from which the resources to carry out an assessment were/are committed. In OTA's case, the Technology Assessment Board (noted earlier), which convened monthly, weighed the relative priority of prospective assessments against congressional needs judged by the nature of the requests from committees of jurisdiction (with a strong preference for endorsement of both majority and minority committee leadership) and the legislative agenda before authorizing an assessment to proceed. GAO relies on the internal "congressional protocol" developed for its performance audits to process requests, the current version of which does not mention TA. This protocol has not resulted in TAs to date commissioned in response to a bipartisan request from the relevant committees of jurisdiction in both congressional chambers. *Developing new mechanisms for commissioning NRC studies more quickly is certainly possible and GAO could significantly strengthen its procedure for*

determining the priority of requested assessments relative to directly expressed congressional needs and the jurisdiction of committees requesting the assessment.

Comparing Options

Since progress towards replicating the key features of OTA has been so slow over nearly a quarter of a century, reconstructing an OTA with many of the original agency's features beckons as one viable option, although it could take years for a new entity to mature and involves start-up costs relative to trying to build and strengthen TA capacity in existing agencies of Congress. It may be worthwhile, however, and there is nothing to preclude a longer-range risk-adjusted strategy of pursuing multiple options simultaneously. In addition, circumstances are changing rapidly and developing any or all the options to include more OTA-like features, even restoring an OTA-like organization, would need to include new features as well to match today's needs. Such features include: (1) a broader portfolio of activities and products including, some related to shorter term needs of individual Members as opposed to exclusively those of congressional committees, (2) closer connections with other organizations to more efficiently gather the most recent and comprehensive information, (3) enhanced communications capacity for considerably expanded and timely information gathering and delivery of information to the Congress and the public; and (4) collaboration across congressional support agencies where topical areas overlap and strengths are complementary.

To illustrate this last feature, as an example, even with a restored OTA, the developing GAO STAA team approach, building on their traditional approach to performance audits, would likely be better suited than an OTA TA in many cases to evaluating the management performance of agency programs engaged in the nation's now massive federal S&T enterprise. The current example of NRC-organized expert meetings to support a GAO TA is another example. That is, as I noted at the outset, investment in expanding Congress's S&T capacity need not be either/or among options. Rather, the

objective could be more effective to deploy each organization building on its design strengths rather than attempting to reinvent the wheel in any or only one of them and realizing additional economies from collaboration among all of them.

Let me end where I started. The time for reinvesting in new effective approaches S&T advice to support Congress is now long overdue. I very much urge you to get on with it, including restoring and modernizing an OTA-like agency as well as fashioning ways to make sure that the existing entities, such as the NRC, CRS, and GAO, can move much more effectively to both fill the rapidly accelerating gap left in the wake of OTA's closure now nearly a quarter of a century ago and Congress's growing needs. Developing a more collaborative environment to draw on all their collective strengths would yield important benefits. Thank you for your attention.

Table 1. Strengths & Weaknesses of Selected Sources of S&T Assessment Advice for Congress

	Dimensions of Effectiveness	CONGRESSIONAL AGENCY--DIRECTLY ACCOUNTABLE TO CONGRESS						OUTSIDE GOVERNMENT	
		Former OTA		GAO		CRS*		NASEM	
QUALITY	**Authoritative**	4	Expert advisory panels; dedicated staff;rotational staff	1	Assigned staff--may have relevant expertise	2	Dedicated issue area staff	5	Expert, often world-class committees; dedicated staff; consultants
	Informed	5	Panel review of perspectives included; focused workshops; staff research; consultants	1	Staff research; expert meetings	1	Independent staff research	4	Committee meetings; workshops; staff research; consultants; scope controlled by contract
	Independent	5	Scope approved by board; COI procedures for staff; all perspectives included and verified by advisory panel; articulate options; extensive external review	2	No governance group oversight; no expert committee or advisory panel; limited external review	3	Institutional procedures and policies	5	Elaborate COI procedures for committee and staff; rigorous external review
	All perspectives	5	Advisory panel & workshops; research by dedicated staff, contractors and consultants	2	Expert meetings to inform staff	2	Literature and individual research by experienced staff	3	Elaborate appointment of consensus committee; workshops; staff research
	Peer Review	4	Extensive external review	1	Institutional review; some external review	1	Institutional review	5	Independent external review
CONGRESSIONAL CONTEXT	**Relevant**	5	Requests from committees of jurisdiction and priorties set by Technology Assessment Board	1	Agency selection based on requests	5	All requests by design	5	Legislation and contract
	Presentation	5	Written to be tuned to congressional context	5	Written to be tuned to congressional context	5	Written to be tuned to congressional context	3	Usually tuned better to executive agency needs
	Useful	5	Requests from committees of jurisdiction and priorties set by Technology Assessment Board	3	Sometimes commissioned by committees of jurisdiction	5	For "off the shelf" analysis	5	Comissioned by law and contract
	Report/follow-up	5	Staff and panel members briefings and hearings	3	Staff briefings, hearings	4	Staff briefings, occasionally hearings	5	Committee members and staff
	Shared Staff	5	Project director and staff called upon for follow-up and analysis	0	Assessment staff available for limited follow-up	4	Expert staff available for follow-up	0	Very limited follow-up beyond initial briefings
	Timely	3	Detailed, evidence-based, peer reviewed reports with no recommendations	4	Detailed reports with supporting evidence; limited peer review	5	Summary reports	3	Detailed, evidence-based, peer reviewed reports with recommendations; contract required
	Other products		--background papers		--forum highlights		--now publicly available		--workshop reports
			--interim reports		--updates				--interim reports
			--issue papers		--podcasts				--letter reports
			--shared staff follow-up						--phased reports
									--release workshops

*CRS seldom produces major reports.

Strong<----------->Weak

5 4 3 2 1 0

BIOSKETCH:

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Peter D. Blair joined the National Academies in 2001 as the first Executive Director of the Division for Engineering and Physical Sciences, responsible for the Academies' portfolio in national security, energy and environmental systems, information and telecommunications, physics, astronomy, mathematics and operations research, aeronautics, space science and engineering, materials, manufacturing and engineering design, and civil engineering infrastructure.

Prior to his current position, Dr. Blair was executive director and CEO of Sigma Xi, the Scientific Research Society and publisher of *American Scientist* (1997–2001) as well as adjunct professor of public policy analysis at the University of North Carolina at Chapel Hill.

From 1983-1996 Dr. Blair served in several capacities at the Congressional Office of Technology Assessment (OTA), concluding as Assistant Director of the agency and Director of the Industry, Commerce and International Security Division where he was responsible for the agency's research programs on energy, transportation, infrastructure, international security, space, industry, commerce, and telecommunications. He received the OTA's distinguished service award in 1991.

In 1979 Dr. Blair was cofounder and principal of Technecon Analytic Research, Inc., a Philadelphia-based engineering-economic consulting and project development firm specializing in investment decision analysis of energy projects and in developing, financing, and managing independent power generation projects. Technecon was acquired by the Reading Energy Corporation in 1985. In the 1970s and '80s he served on the faculty of the University of Pennsylvania with appointments in the graduate groups of energy engineering and management, regional science, and public policy.

Dr. Blair is the author, coauthor, or co-editor five books: *Multiobjective Regional Energy Planning* (1978), *Geothermal Investment Decision Analysis* (1982), and *Input-Output Analysis: Foundations and Extensions* (1985; 3rd ed., forthcoming), and *Congress's Own Think Tank: Learning from the Legacy of the Congressional Office of Technology Assessment, 1972–1995* (2013); and he co-edited *Trends in Industrial Innovation: Industry Perspectives & Policy Implications* (1997). He has authored over a hundred technical articles on energy and environmental policy, electric power systems, operations research, economics and regional science, and science and technology policy.

Dr. Blair is a fellow of the American Association for the Advancement of Science (AAAS) and previously chaired its section on Societal Impacts of Science and Engineering. He currently serves on the National Renewable Energy Technology Analysis Advisory Committee. He is a past co-chair of the National Science Foundation's Business and Operations Advisory Committee and a former member of the Board of Directors for the National Institute for the Statistical Sciences and advisory or visiting committees for Carnegie Mellon University's Engineering and Public Policy Department, the Colorado School of Mines, Electric Power Research Institute, Gas Research Institute, Lawrence Livermore Laboratory's Energy and Environment Division, Lawrence Berkeley Laboratory's Energy Division, New York Energy Research and Development Authority, Houston Applied Research Center, and many others. He served on the editorial board of IEEE Spectrum and as an associate editor of the Journal of Regional Science, and currently as an area editor of the Proceedings of the National Academy of Sciences.

Dr. Blair holds a BS in engineering from Swarthmore College, and graduate degrees from the University of Pennsylvania: an MSE in systems engineering, and MS and PhD in energy management and policy.

Chairwoman JOHNSON. Thank you, Dr. Blair.

Dr. BLAIR. Thank you.

Chairwoman JOHNSON. At this point we will begin our first round of questions, and the Chair will recognize herself for 5 minutes.

We all agree that Congress is not sufficiently equipped to address the many complex S&T issues affecting society today, and I'd like to go down the line and hear from each of you about the consequences of this deficiency, what is the one issue that Congress has failed to adequately address either through legislation or oversight and because of its lack of science and technology capacity. And why should the American public care? So I will start with our first witness, Mr. McCord.

Mr. MCCORD. Thank you, Chairwoman. The consequences, as a number of panelists have said, is if the Congress is failing to be proactive, then the private sector, others, are setting the agenda for you or other nations. So I think that that remark was very apropos.

I would personally rank probably climate change as the biggest issue out there in science and technology space, although there are many others from quantum computing to artificial intelligence. I think that climate change probably would be my number one.

Chairwoman JOHNSON. Thank you.

Ms. MANLEY. Thank you. I think speaking for myself I would say one of the most pressing concerns is our lack of legislation on any kind of real data privacy rights. I think that's related to how we're addressing some of the social media platforms that are interfering with our elections and that are taking advantage of a lot of people that aren't quite aware of what they're viewing and what they're looking at.

Chairwoman JOHNSON. Thank you very much. Mr. Persons.

Dr. PERSONS. Thank you, Madam Chairwoman. Right behind you, Proverbs 29:18 says, "No vision, the people perish," and a lack of vision is one of the key challenges. It leads to errors of omission strategically that result in, I would say, not optimized economic competitiveness, safety, security of the U.S., and so on. And so I think that's the—sort of the consequences of insufficiency I think often would fall in that regard.

I would add to the macro issues I think that we're behind on legislatively could involve cybersecurity. It's just such a hard, tough cross-sectoral issue. Even if we have perfect performance from our Federal Government, which we need on this, it still needs our best-thinking university, industry, and so on to solve that hard problem. And it's only getting worse with the proliferation of Internet of Things and 5G wireless and so on. So that's just one.

I would say that there's certainly a lot of things to do, and that's exactly why we actually have a sister team at GAO working on IT and cybersecurity all by itself. Thank you.

Chairwoman JOHNSON. Thank you. Dr. Blair.

Dr. BLAIR. I'd say the role of science, technology, and innovation as a driver to economic growth and prosperity is where we've fallen short. The structure of the U.S. economy is changing quickly, and the opportunities for growth and investment in science and technology have to be strategically considered. And I think that Congress can and has to play an important role in that and to have

the capacity to look at the landscape and decide where those investments can be most effective, where regulation can be altered, where all kinds of issues associated with empowering that dimension should be considered. That's my vote.

Chairwoman JOHNSON. Well, thank you very much. Ms. Manley, Congress has a constitutional responsibility to provide a check on the executive branch. However, one of the major consequences of Congress' lack of science and technology capacity is an increased reliance on the expert staff working at executive branch agencies and at the Office of Science and Technology Policy.

I want to try to make myself clear. We have very great respect for scientists, engineers, and other expert civil servants working across government and value their expertise, but our reliance on them also creates an imbalance that could impede our ability to fully carry out our responsibilities of the legislative branch. Can you talk about this and why you think that it was important to address this in your report?

Ms. MANLEY. So we identified three types of resources that Congress relies on for S&T expertise, and internal resources like committee staff, CRS, GAO, CBO (Congressional Budget Office) but also external resources and then hybrid resources like fellowships, detailees, and then the media. Within external resources, we do reference the executive branch. And while we do believe that it's very important to reach out to experts in other parts of the government, we also think that nothing is necessarily free if that's the common phrase that people use. So being able to have independent reviewed analysis from each committee and each personal office, it's really important for you to be able to evaluate the priorities based on your offices or your committees. So I think relying on these sources is inherently OK. It's problematic if it's the only source that you're relying on.

Chairwoman JOHNSON. Thank you very much. My time is expired. Mr. Lucas.

Mr. LUCAS. Thank you, Madam Chair.

Dr. McCord, in your testimony you state that GAO needs to make appropriate changes in its organization operating policies to accommodate the distinctive features of technology assessments and other foresight projects. Can you highlight the key things that NAPA thinks GAO needs to do to be successful?

Mr. MCCORD. Yes, thank you for that question. A couple parts to that. First, our perception from the people that we interviewed that the panel and the staff interviewed was that there may be not full awareness of GAO's capability given that the STAA office is fairly new. The technology assessment effort is older, but the new office, so there may just be some lack of awareness on the customer side of what GAO is able to do as the capability develops.

But we clearly got as we talked to people the concern that the overall mission of GAO is as a performance evaluator, as an auditor. It looks backward but this function looks forward, the function we're talking about today, so there was a concern about whether those two cultures can fit perfectly well and so our recommendation is to try and separate this office a bit from the overall backward-looking evaluating, auditing function partly because of perception of people that you are working with that do I want to fully share

everything that I'm doing with someone who might come back in an audit later and criticize that based on that conversation?

That may be fair or unfair to GAO, and I'm sure Dr. Persons might want to comment on that. But there is certainly the perception that the kind of openness that you want in scientific endeavors might be somewhat of a bad mix with, you know, the people that are going to come and audit that same issue so that a separation would be beneficial in our view.

Mr. LUCAS. What about that, Dr. Persons? Can you address how GAO can focus on those kind of recommendations?

Dr. PERSONS. Yes, sir, happy to do so, and thanks for the question. I think the NAPA panel and Mr. McCord was pointing to the issue essentially goes to organizational change and growth. I'll just point to the fact that GAO really started performance auditing in this program evaluation context really in the 1970s. So it's been decades since that time that is now our dominant product line if you will of work. We were started of course as a financial accounting and financial auditing and things, but we have greatly expanded our professional services for the Congress. As our former comptroller general said, we are a world-class professional services organization just happens to work for the Congress.

And so the technology assessment is a function that adds in and can fit well to our long-standing—again, as I mentioned in my opening remarks, almost half a century of work starting in social science work and so on but moving forward with the evolution especially led by this Committee on things in the space program or nuclear issues or what have you. We've built up expertise and not just only recently as well, and we believe we can——

Mr. LUCAS. So you're comfortable with the question of whether an institution or the history being a review group can also be a forward-focused entity?

Dr. PERSONS. Yes, sir. So like Mr. McCord was saying, essentially we are ex-post in one sense the training in terms of looking at something that's—we have to be fact-based and so on, and we're not about predicting the future as a rule. However, the ex ante work, we've been doing technology assessment, as was noted, for almost 2 decades now, and we also have a sister institution or entity within GAO now called the Center for Strategic Foresight. And that's just because they're not all just in the tech assessment because although all tech assessment is foresight, not all foresight is technology and science necessarily, although it's increasingly moving in that way. So there is a recognition of ex ante work and working toward and doing policy analysis in that particular dimension offering up options to Congress that are balanced that we believe we can do.

Mr. LUCAS. Dr. McCord, your study committee looked at the option of reinstating OTA or something similar and ultimately didn't recommend that option. What were the downsides of trying to bring back the OTA?

Mr. MCCORD. Thank you for that question. We did not recommend it. It would be, I think, incorrect to say that we oppose it and the Academy would think it was a terrible idea if Congress did that, but you can't help but notice that for 25 years Congress has chosen not to do that, so the question whether the support is

there to go that route and sustain it, you know, that's a serious question for us, the viability of doing something that you've consistently chosen not to do.

So that's why we believe that if you follow our approach, first of all, you could go that route eventually. Remember, we talk about creating an advisory office which is much smaller in the sort of scope and capability than OTA was, giving GAO and CRS a chance to do more, come back and evaluate that. You could always move in that direction if you needed to, but, again, you look at the fact that Congress has consistently not found a consensus around reinstating OTA. That kind of viability question is part of the equation that we talk about, as well as what is desirable. What is desirable would probably be to have, you know, 500 or 1,000 people dedicated solely to this, but are you willing to pay that, you know, to support that financially and otherwise in Congress? It seems that so far the answer has been no, so that bore on our thinking as well.

Mr. LUCAS. Understood. Yield back, Madam Chair.

Chairwoman JOHNSON. Thank you very much. Ms. Bonamici.

Ms. BONAMICI. Thank you very much, and thank you to our witnesses for bringing your expertise here today.

I've served on this Committee on Science, Space, and Technology since I joined Congress in early 2012. I, like most Members of Congress, do not have a background in science, although now that we have Dr. Foster, Dr. McNerney, and of course Mr. Casten with his science background, they enlighten us—yes, and Mr. Baird of course, Dr. Baird.

All of us know that the people we represent and our policies and our planet will all benefit when we engage the scientific community in our decisionmaking. We're glad to have so much expertise here on the dais, but among all of us we need that assistance. We know our world is facing the consequences of climate change, as Mr. McCord mentioned, extreme weather patterns. We had a hearing yesterday. We know that toxic substances continue to impede access to clean air and clean water, emerging technologies, as Ms. Manley and others mentioned, shifting entire sections of our economy, creating challenges. We know that peer-reviewed, evidence-based science can help inform our decisions. And for more than 2 decades, the independent, nonpartisan Office of Technology Assessment provided Congress with that unbiased advice and information. But today, we're facing the consequences of efforts to defund this important resource.

I am cosponsoring Congressman Takano's *Office of Technology Assessment Improvement and Enhancement Act* to reinstate the OTA and to make it more responsive to the needs of Congress. We won't be able to solve our Nation's most challenging problems without the expertise of scientists, so I'm glad we're having this hearing today.

And I wanted to follow up on Ranking Member Lucas' question. Mr. McCord, you mentioned in your testimony that Congress directed the Congressional Research Service to engage with the National Academy of Public Administration to produce a report to study science and technology policy resources for the legislative branch. And specifically, the conference report stated that the study should assess the potential need within the legislative

branch to create a separate entity charged with the mission of providing nonpartisan advice on the issues of science and technology. And as you indicated, the NAPA report suggests that Congress should provide CRS and GAO with the resources and authority to address the gaps in science and technology advice, which is inconsistent with the directive to assess the potential to create a separate entity.

Now, it's my understanding that in conversations with our Committee staff the NAPA study team disclosed that it did not give full consideration to the need for a renewed Office of Technology Assessment and instead assumed that the GAO would perform those activities. Is that your understanding as well?

Mr. MCCORD. Congresswoman, I would not say we didn't assess it. I would say it's difficult to assess something that hasn't existed for 25 years and compare it to things like Dr. Persons' unit that exists today. That I would agree is a challenge. We did look at both options and, as I said, we recommended that we start with building off of the things that exist today. It's a quicker way to get there in our view.

You could ultimately—as I said to Mr. Lucas, you could ultimately move in the direction of going to a full OTA if you found that our approach was insufficient. I think it's easier to start with our approach and build that way if you feel you need to than to try to build the grand structure and possibly struggle and, you know, for several years and maybe not get there.

Ms. BONAMICI. And I appreciate that it was difficult, but I know you're up to the task. In your opinion does the NAPA report provide Congress with a comprehensive analysis of the options for independent scientific advice if it does not address the renewal of OTA?

Mr. MCCORD. Well, again, I think we did assess that topic as well, but our mission from the report was to look at the questions Congress posed, as you said, and so it was not quite the clean sheet of paper that some of the other panelists here might have. So I wouldn't be surprised if we have different conclusions. To me, the salient point is that everybody on this panel I think agrees that we need to do better, that Congress needs more capabilities.

But also, a big point with NAPA was that we felt that creating a lot more capability only works if you have time to absorb it. So the one thing that nobody on this panel, no organization can do is create more time in your day so——

Ms. BONAMICI. Which we would very much appreciate.

Mr. MCCORD. Something has to change on your end as well——

Ms. BONAMICI. Understood.

Mr. MCCORD [continuing]. Rather than just build something that you don't have time to read.

Ms. BONAMICI. And, Dr. Blair, in your testimony you discuss how the NRC, CRS, and GAO have assumed functions of the OTA. Sorry for all the acronyms but I know you're with me. They've assumed functions of the OTA since 1995. In light of the limited resources, these entities currently have and given that GAO has not fully implemented its technology assessment plan, do you agree with the NAPA study team's decision to assume that the GAO would perform all of the technology assessment work? And what

value could a reinstated OTA bring to Congress if the structure were more responsive to our policymaking needs?

Dr. BLAIR. Well, I think there are several paths to the future. I think that, as I mentioned, the best path is to use the template that existed for OTA that is as an independent, dedicated technology assessment organization. As I mentioned at the outset, it is still authorized, and all of the work practices were there. They have to be modernized just like all of the options that we've discussed today, but I'm not sure I would dismiss it because it hasn't been addressed in so long. The OTA experiment went on for 23 years, and it had a pretty good track record. And I think it's worthy of a serious consideration for a complete look at that.

Ms. BONAMICI. Thank you. And I see my time is expired. I yield back. Thank you, Madam Chair.

Chairwoman JOHNSON. Thank you very much. Mr. Posey.

Mr. POSEY. Thank you very much, Madam Chair, for holding this hearing and the options to improve science and technology advice for Congress.

From 1972 to 1995, Congress had an agency called the Office of Technology Assessment, the OTA for purposes of our hearing here. Its objective was to provide Congress with objective and authoritative analysis of scientific and technical issues. But as we've heard discussed, it was abolished because it was duplicative and a wasteful useful use of taxpayer dollars.

It also strayed from its nonpartisan origins, I understand, and published biased studies. The OTA published a background paper in 1984 on our Nation's missile-defense system in space, and in a Heritage Foundation report entitled, "Reassessing the Office of Technology," it stated, "Regarding the missile-defense paper that there are reasonable grounds to conclude that the OTA background paper compromised the national security by revealing information relating to the national defense." Due to the OTA being a congressional entity, as the Ranking Member previously pointed out, it was nearly impossible to hold them accountable. The OTA's lack of accountability, partisanship, and national security concerns led to its demise.

And so we're here today because some Members of Congress have demonstrated a propensity to leak sensitive information, and the history of the OTA in dealing with national security issues makes many wonder about the reasonableness of reestablishing it.

You know, does the GAO have a secure structure in place for handling sensitive or classified information? And has the sensitive information ever been compromised as with the OTA paper on missile-defense in space? And the question is for Mr. Persons.

Dr. PERSONS. Short answer, yes, sir, we do. We have all our apparatus to handle classified information even up to the top secret and SCI level. Thank you.

Mr. POSEY. Do you see any way that the OTA would help your agency with information?

Dr. PERSONS. I'm sorry, the question is would a hypothesized revived OTA help GAO?

Mr. POSEY. Yes. Yes, would it be of any value to the GAO?

Dr. PERSONS. Well, I think it would be—if a revived OTA were in place, it would be one of our sister agencies that we would co-

ordinate with so that we don't duplicate work. I think one thing that I think all parties are agreeable here—I'm not going out on a limb—is that there's a lot of science and technology work to do. And so I think we would coordinate with them in the same way that GAO's protocols at the start of every study interact or check with CRS and CBO at the moment if an OTA were back. And we did this decades ago when OTA was there. We would coordinate with them on that.

Mr. POSEY. Do you think money would be better spent bolstering the GAO or reinstating an OTA?

Dr. PERSONS. Sir, our policy—if the Congress wills, we already are growing into—as I mentioned, our aspirational target number is 140 FTEs (full-time equivalents). That is comparable to what OTA's FTE count was at its shuttering as far as we understand it. It depends, sir, if it's a zero-sum game. If you pay this entity versus GAO, that's the delicate issue. We do think, again, there's plenty of work to do even with an OTA, and it's GAO's official policy that we would help support and coordinate with any hypothesized standup of OTA. However, if the question is whether or not we are willing, able to do this, I think the short answer is yes.

Mr. POSEY. It takes a pretty compelling argument to get most of the people in my district to think it's a good idea to start another government agency which failed before and is doing a job done by other government agencies presently. But I thank you for your comments, and I see my time is about to expire, and I yield back. Thank you.

Chairwoman JOHNSON. Thank you very much. Mr. Foster.

Mr. FOSTER. Thank you, Madam Chair. And thank you to our Ranking Member Lucas and the panelists.

First off, I want to thank the Committee leadership for holding this hearing today on this important topic. I've long been a champion of bolstering the science and technology capacity of Congress from both Members and staff. I've been a longtime advocate of the reinstatement of the OTA as a bipartisan, independent source of sound technical and scientific analysis. And I've raised this issue, as many of my colleagues know, many times in this Committee.

I'm proud that we successfully pushed for $6-million funding to restore the OTA in the House FY 2020 legislative branch appropriations bill. And while we've been waiting on a final appropriations agreement, I, alongside with my colleagues, Representative Takano in the House and Senators Tillis and Hirono in the Senate, introduced the bipartisan and bicameral *OTA Improvement and Enhancement Act* to strengthen the office's ability to serve the growing need for technology expertise in Congress.

This Act modernizes and strengthens the OTA by enabling any Member to request a technology assessment to be considered by the technology advisory board; adding a Congressional Research Service-style deliverables to the office's function, and duties such as providing briefings and formal conversations, and technical assistance to Members on science and technology issues without the need for board review requiring preliminary findings of ongoing technology assessments, in addition to completed analysis; also requiring final reports to be made publicly available whenever possible and introducing a rotator program to hire experts from academia

and industry modeled after the rotator program at the National Science Foundation; and finally, directing the office to be as open and transparent with Members about the request review process as possible.

I have tremendous respect for the work that's done at the GAO, but it is a common source of frustration among Members with not a lot of seniority in this operation that you have to, because of the manpower restrictions, prioritize. And very often that means requests by Members without seniority, you unfortunately have to prioritize off the list of things you actually work on. Because, you know, the good ideas in this body come from Members of all different levels of seniority, and unfortunately, you're not able to respond more to that.

One of the reasons I believe that restoring and enhancing the OTA is important is that this problem is so important that we need an all-of-the-above approach frankly on this thing.

I share Mr. McCord's worries about the political viability of this. It was sort of a sad situation, you know, back I guess in the 1980s when, for the first time, you saw scientific fact become a partisan issue. I think there's probably no clearer example than the one that was raised earlier with the Star Wars, Ronald Reagan's dream of an impervious missile defense. Somewhere on those pile of CDs is the OTA report.

It escaped a lot of Members' notice, but we quietly this summer killed the EKV, the enhanced kill vehicle, the latest incarnation of Ronald Reagan's unworkable dream of having an impervious missile-defense system. And if Congress had been paying attention, even reading that ancient CD from almost 40 years ago now, we would have saved tens of billions of dollars. We've now spent more in absolute dollars on the missile-defense program than we've spent in absolute dollars on the Apollo program. And we've gotten a system that we've had to cancel again and again and again despite claims that it's—and so this is the problem that scientific reality is that these kind of systems, midcourse interceptors, just cannot work for fundamental physics reasons, and if you make that correct scientific point, it is interpreted as a partisan political point. You get into similar discussions with climate change.

And so this is one of the reasons why Mr. McCord is right. We have to be very careful that this is going to be politically viable because there are real risks that one party or the other will get very angry when it's pointed out that their dreams are not reality. And that's the value of this.

You know, if you think if Congress had paid attention to what the OTA said back then, you know, what that $25 billion could have done in science policy, you know, over the course of the last 40 years, it's sort of breathtaking. And there are other examples of the OTA's output.

Anyway, I'd like to also enter into the record here a report of an evaluation of the NAPA report, a reaction to it. That really, you know, points out I think things that have already been pointed out. And so without objection, I'd like to enter that into the record.

Chairwoman JOHNSON. Without objection.

Mr. FOSTER. That really, I think, you know, highlights. You were given a charge which didn't give you the clear chalkboard to come up with a complete plan.

Anyway, I just want to thank the Chair and all the witnesses for their engagement in this. And I'll close with one last thing. The Belfer Center, I was very, very pleased—Ash Carter invited me to go to a workshop or discussion on this very issue at the Belfer Center. And the level of engagement of that organization toward what they see is a key shortcoming of Congress is something I just want to applaud, so thank you all.

Chairwoman JOHNSON. Thank you. Mr. Baird.

Mr. BAIRD. Thank you, Madam Chair. And thank all the witnesses for being here today. We appreciate you sharing your expertise with us.

But, Mr. McCord, when your study committee was looking back at the Office of Technology Assessment, were you able to interview folks to find out how the office did or did not serve the needs of the Members? And then in that same vein can you share some of those findings and what the lessons learned were that influenced the decision not to reinstate the OTA?

Mr. MCCORD. Congressman, yes, we interviewed I believe it was about 127 people, including those, you know, familiar with the old OTA. But our task was not to evaluate whether OTA when it existed was as good as it should have been, should be brought back exactly as it was. We were operating, you know, in here and now. So although looking back at OTA was part of what we did, it was not the focus I guess of our task from the appropriations conference. So I would not to want to represent our report as authoritative on whether OTA succeeded or failed in its time. That's really not what we were looking at. We were just trying to look at what would happen—you know, what are the options before us today and again trying to make some judgments partly on what is this body and the other body willing to do given the history of relative inaction on this subject.

Mr. BAIRD. So, Dr. Blair, Dr. Persons testified that GAO uses the National Academies as a resource. Can you talk about how the GAO and the National Academies are coordinating and how you think the GAO could better utilize the Academies as it expands its science and technology work?

Dr. BLAIR. I don't remember when the contract started. It was quite a while ago.

Dr. PERSONS. 2001.

Dr. BLAIR. 2001. It was an illustration, I think, of the collaboration that is essential for success in the future of how this family of organizations can get more out of the collection than just the sum of the parts. That particular contract is to use the Academies' Rolodex if you will to identify the best and brightest minds, technical minds principally, associated with an assessment on the table, and that that group of experts then can be used both to inform the assessment ongoing at GAO and to be a source of some degree of external review as the assessment goes forward.

Mr. BAIRD. Sorry, I have one more question for you then along that same vein. The National Academies of Science were created in 1863 by a congressional charter.

Dr. BLAIR. Yes.

Mr. BAIRD. That was approved by President Lincoln. And they were tasked with serving as an advisor to the Federal Government on science and technology. Do you have any recommendations for how Congress can better utilize the National Academies? And do you have any recommendations for how the National Academies can better serve Congress?

Dr. BLAIR. That's a very good question. I think I might mention that right now the Academies is undergoing a transformation. The National Research Council, the operating arm, is undergoing a transformation to examine better ways that it can advise both the executive branch and the Congress. I think many of the things that are addressed in both of the reports such as producing shorter, more timely reports, being able to provide information while an Academies study is ongoing, and all kinds of different modalities for being able to advise the Congress are certainly being considered as we go along. At the same time, Congress needs to be a receptor to the advice provided by the Academies to figure out where it best fits. And I think continued conversations like we're having with this Committee will very much provide opportunities for improving that impedance match going forward.

Mr. BAIRD. Madam Chair, I'm out of time, but I think Dr. Persons would like to say something. Is that OK if we go on?

Chairwoman JOHNSON. Yes.

Dr. PERSONS. Just a quick response just from the GAO answer to how we're coordinating with the National Academies, as Dr. Blair noted. In 2001, we started our standing contract. We use it on a broad array of technical work.

By the way, it's important that GAO has precisely defined technology assessment in a particular product line way, right, whereas I believe there's an apples-orange risk here where essentially everything OTA did is really science and technology policy when you really think about it from an oversight, insight, foresight process.

So on many of our reports, including our oversight things when they are particularly technical like our antibiotic resistance report or superbug that's about to come out, emerging infectious disease work, that sort of thing, we routinely engage with them early on through the design and lifecycle process and review toward the end.

Second, what we're doing is also now doing partnered work. We're about to issue a jointly branded report with the National Academy of Medicine on artificial intelligence and health care for drug discovery and development. And so that's one of a series. There'll be others that are coming on, diagnostic medicine, as well as delivery of care, but that's that piece.

And then third, based upon the sustainable chemistry work that we did for this Committee and that informed the SCRD, the *Sustainable Chemistry Research Development Act* out of this Committee, we are also looking at and building a partnership with a different board of the National Academies on how to estimate or compute the economic impact or GDP on chemistry on the whole economy, which has not been done yet. So we're proud to be partnered where we are. They've been a key partnership with us, and we do extensive work with them. Thank you.

Mr. BAIRD. Thank you, and I yield back.

Chairwoman JOHNSON. Thank you very much. Mr. Beyer.

Mr. BEYER. Thank you, Madam Chair, very much.

Ms. Manley, I really appreciate your addressing the elephant in the room, which is the need for additional congressional resources for staff capacity. I underlined in your report congressional staffers are overworked and underpaid, they tend to come from liberal arts backgrounds, extremely broad portfolios. Even in our small office I'm trying to figure out when the portfolios are so broad, you know, who's going to do what.

And I would argue that we have to have a dualfold approach, and one of them is a lot more resources for the congressional offices. So I was really glad to see the Belfer Center report address this. And this is due to the low MRAs, the resources that we have, and the fact that so often our folks are interns. I think virtually everyone in my office except the chief started as an intern. The wonderful young woman behind me was our best intern, so we hired her and on you go.

And as a result we look and see that, you know, we've had no COLA (cost of living allowances) for 15 years, there's no housing allowance, so some significant percentage of Members of Congress sleep on their couches in their own office. So you say it's a simple solution to raise Members' personal office budgets, remove the cap on office personnel, and increase the staff pay ceiling.

So I want to get to the simple part of that. You know, we're the politicians up here, and we've not been able to figure out how to do that. What's the perspective from the Belfer Center?

Ms. MANLEY. I don't think we have a special formula for doing that, and we do acknowledge that this would take a long time and it's a politically difficult task. But a lot of this conversation even in today's hearing has been about either reinstating the OTA or bolstering other agencies like CRS and GAO. And frankly, I personally think that both of these options are good things. But even if we reinstate the OTA and we continue on building up GAO, if we don't have better staff in offices, you might not be able to absorb the information in the first place.

So, again, I don't have a silver-bullet answer on how to address making this possible, but I think making the case that even if you do move forward with these other options, if you don't address the root problems, then it really won't make a difference in the long run.

Mr. BEYER. Yes. One of the other things, I'm used to running a business where everyone stays for 25 years, and it's been really difficult to understand that the wonderful young people with beautiful educations that I hire I can count on for maybe 18 months because they're so underpaid they have to go do something else. They've got to go to law school or Kennedy School or the like. But there is a Committee on Modernization. We need to continue to take this to them. They've come out on a bipartisan way and said we need a new OTA, but we also need to really invest in our own people.

I also think some of the great breakthroughs in my office has had when we had scientists from the EPA (Environmental Protection Agency) 2 different years, so we actually had scientists that we

weren't paying for that helped us really advance causes and develop good legislation.

Dr. Blair, you recommended that Congress enact new authorizing legislation, blah, blah, blah, but also to provide for deliberative hearing process and congressional debate. How do you see that different from what we have right now? What would that enhancement be? And I say this with the perspective of floor time is so desperately scarce in this place right now.

Dr. BLAIR. I'm not sure I fully—you mean the broader scope of technology assessment as it—to inform the decisionmaking process? Or do you mean replacing hearings? I'm not quite following you.

Mr. BEYER. I'm not sure. This was in the panel recommendation.

Dr. BLAIR. Oh, no, that——

Mr. BEYER. Maybe I'm addressing it to the wrong person.

Dr. BLAIR. That's probably the NAPA report.

Mr. BEYER. Oh, the NAPA report. So, Mr. McCord, did you have a different idea, though, about a deliberative hearing process and congressional floor debate?

Mr. MCCORD. Well, I think——

Mr. BEYER. As it affects science and——

Mr. MCCORD. Thank you, Mr. Beyer. First of all, I would say I would agree completely with what Professor Manley's report said about the problems, and your observations about staff being overworked, underpaid, and not having—you do have to put more money against this, and all the options on the table. As I think Professor Manley observed, all the options are going to cost money somewhere, whether you enhance OTA, add any more billets at GAO. But without your ability to absorb more, yes, I think that that would be an issue that you're going to underperform on your investments in creating supply of new capability if you don't increase your ability to absorb it.

So we agree with a lot of the diagnosis that the Belfer Center has in its report about how we got to this place and to the comments you've made, too, about basically a self-imposed salary cap. For understandable reasons, staff can't make more than you do. You know, Members have not raised their own pay. So that is clearly part of the issue.

But, as I said also in response to a previous question, no amount of financial resources create more time for you, and you observed a hearing time, floor time, you know, could be a challenge, and floor time is not under any one committee's control. But if no more time is devoted to these issues, then it's hard to see how you're going to advance the public interest in the way that I think everybody in the room would like to see.

So Members have to find time in their day to understand these issues. You have to be able to afford staff that can get you this quality information. So, yes, that's what I will call the supply of your time and your resources, as well as—is very important in this matter.

Mr. BEYER. Great, thank you very much. Madam Chair, I yield back.

Chairwoman JOHNSON. Thank you very much. Mr. Babin.

Mr. BABIN. Yes, ma'am. Thank you, Madam Chair. Thank you, expert witnesses, for being here.

Dr. Persons, I'd like to ask you a couple of questions if you don't mind. I want to thank you very much for your service and thank you for GAO's excellent service, do a fantastic job. We really appreciate that.

As we've heard today, the National Academy of Public Administration report recommends that Congress should not stand up an OTA-like entity within the legislative branch but instead should provide the Government Accountability Office and the Congressional Research Service with the authority and resources to build their science and technology capacity. Do you agree that this would be a better use of taxpayer money in our country? And are there any authorities that GAO is currently lacking that is impeding it from building up its science and technology capacity?

Dr. PERSONS. Thank you. First of all, let me return the thanks. Thanks, Mr. Babin, for the question——

Mr. BABIN. You're welcome.

Dr. PERSONS [continuing]. For the compliment as well. We have an extraordinary staff that we've built and doing very important work, so appreciate that.

In terms of our view on the capabilities or the capacity, we don't have an official position on whether or not we can do everything that's at, but we do believe we can do a good deal of the oversight, insight, foresight umbrella of work that we believe Congress has. We believe we're uniquely positioned to be able to just—the burden for Congress is but ask the questions that may pertain to science and technology and then we can work inversely to solve that and provide that in that case.

Mr. BABIN. Absolutely.

Dr. PERSONS. I think it's significant, sir, that you have both Belfer and NAPA independently came from this from absorptive conclusion as well. I thought that was a very important—I was impressed with the studies in terms of the quality and what they were doing, and I think when you look at where they came out, that particular piece is important because it's one—in addition to Dr. Blair, I have other senior former OTA officials, some of which said, you know, the U.S. Congress is the most advised body in the world. So having more input is not necessarily I think the key challenge, although we always want quality of input in filtering and selecting.

Mr. BABIN. OK.

Dr. PERSONS. So I think that's where we are on that.

Mr. BABIN. Great. And then what I most appreciate about GAO is the trusted nonpartisan information that it provides on the performance of Federal programs. And so I would ask you this. How does GAO ensure that it produces fact-based information that meets those rigorous standards?

Dr. PERSONS. Yes, sir. So you can't get a report out of GAO if it's not all about the facts and what's provable, what's documented, and so on. We have the Government Auditing Standards that have been around for decades. We literally wrote the book. We're nearly a century old as an institution having done that. A lot of that, what we call the yellow book is essentially the scientific method in ac-

countancy language. Did you get the right data, is it fact-based, are you getting balance in your inputs? Do you have an independent quality check? Are you communicating the results properly, and so on? And so in that case it's ideal, it really is a lot of it in the scientific method.

Then we're also doing the—as we mentioned already, the National Academies partnership particularly when it's technical work to help expand and reach out to. And then, as I mentioned in my opening remarks, we're building those networks into universities and scientific organizations to be able to get the best and brightest.

On tech assessment (TA), we just yesterday issued a Design Handbook to go out for a year of review and comment to help us with large public input to be accountable to what is good TA, what are the outcomes of TA, which I think is what the conversation needs to be about in terms of fitting in the absorptive side of things, and how do we vouch for quality TA——

Mr. BABIN. OK.

Dr. PERSONS [continuing]. Which this is an augmentation of or an apparatus to help work under our quality assurance framework to guarantee, sir, what the Congress needs.

Mr. BABIN. Yes, sir. Thank you. Just how many Member-of-Congress requests for information does GAO get?

Dr. PERSONS. Well, we issue hundreds of reports a year, and then—so I would say we at least get as many of those, whether it's phone calls, tableside briefings. I recently did a roundtable with a different House committee just on electronic health records and what blockchain or digital ledger technology may mean for that, in addition to hearings and so on.

Mr. BABIN. So extensive?

Dr. PERSONS. It's extensive.

Mr. BABIN. OK.

Dr. PERSONS. And I do want to just—Dr. Blair is a friend of mine. He's been keeping us accountable ourselves. It is our middle name on this. But we do disagree with the idea that we are not relevant to committees. On page 13 of my testimony statement, we have nearly a dozen different committees, including House Science, in this case that request our work and that are absorbing and things like that. So we are tied in intimately through our congressional protocols to a broad array of Members and committees and staff and so on. So we are in the position to be in an on-demand, on-call if you just need to ask a question even as a quick can you tell me what 5G is all about, for example, then we're happy to come and do that.

Mr. BABIN. And that is a very good information, and I really appreciate that. I just think we need to make sure that Congress is always getting trusted, nonpartisan information that is being requested.

So I yield back, Madam Chair.

Chairwoman JOHNSON. Thank you very much. Mr. McNerney.

Mr. MCNERNEY. Well, I thank the Chair, and I thank the witnesses for your work. I really do appreciate it and see the need for it.

Dr. Persons, how much would it cost for the GAO to grow its STAA team to 140 staff, as laid out in the GAO plan?

Dr. PERSONS. Yes, sir, thank you, Mr. McNerney. Thanks for the thanks as well, and it's a pleasure to be here. At 70 FTE, we're estimating approximately $15 million for that, so a doubling of that would be the approximate number in terms of FTE count. That's for the Federal staff that would be on to be able to provide that nonpartisan independence and in keeping with our agency. But we also could have resources to tap into external expertise, so there's expenses at times to reach out and pay for convening of experts and so on through National Academies or others. And we're also updating the flexibility of our hiring process and so on in terms of getting—bringing—we bring folks under, for example, the *Intergovernmental Personnel Mobility Act*, or the IPAs, which other agencies also use to bring in scientific but term-limited staff for a time to augment the permanent staff.

Mr. MCNERNEY. So the $30 million that you aimed at, that's just personnel? That doesn't include outside activities?

Dr. PERSONS. Any hypothesized outside—that's correct, so——

Mr. MCNERNEY. Thank you. Dr. Blair, what was the OTA's budget at the time it was defunded.

Dr. BLAIR. Twenty-five million dollars.

Mr. MCNERNEY. OK. And that's about $37 million in today's budget, today's dollars?

Dr. BLAIR. That sounds about right.

Mr. MCNERNEY. Thank you. Mr. McCord, how did the NAPA study team incorporate the operating costs of an enhanced GAO versus a renewed OTA in its analysis?

Mr. MCCORD. Congressman, we were not asked to do a cost-benefit analysis of whether, you know, a marginal dollar would be better here or there. We were looking really more at the capability. We did not advocate a specific number of people that GAO should add, so therefore, there was not a price tag on 10 more people or 100 more people at GAO versus the office that we recommend—we recommended a fairly small amount for the advisory office, only in the $5–$10 million range.

I think our main point with respect to GAO was that, again, the TA effort is 17 years old, 18 years old. But the new office is relatively new, I think only within the last year so that we believe it should be given a chance to do more, but we didn't price out how much, you know, you might be willing to spend to let them do a little more, add more capability. That would be one of the many decisions that you face in terms of how much you as a body and the other body as well are willing to pay for more capability, which everybody seems to agree that we need.

Mr. MCNERNEY. Thank you. Again, Dr. Blair, the consensus studies produced by the Academies are the gold standard for evidence-based advice and have directly informed the work of this Committee. Thank you.

The NAPA study team determined that the Academies' consensus model is not well-suited for assessing policy options. Do you agree with that?

Dr. BLAIR. To a degree. By far, the bulk of what we are asked to do at the Academies are more narrowly prescribed studies, that is, you come to us for an authoritative view on what to do. When there are deep ideological differences or policy differences, then the

model such as the old OTA model of articulating completely the consequences of alternative pathways without recommending a particular course of action is something we don't do very often. We could do it more, particularly if we're asked in those terms. But historically, by far the bulk of our work is to have an authoritative committee come in and produce a report that provides an authoritative view on where we should go usually in a somewhat more narrowly defined topic than a broad topic like the future of biotechnology or quantum computing or something like that.

Mr. MCNERNEY. Artificial intelligence.

Dr. BLAIR. Or artificial intelligence.

Mr. MCNERNEY. Ms. Manley, I was intrigued by your study of former Members. What led you to take that approach? And do you think that that was as informative as other approaches might be?

Ms. MANLEY. Our approach was driven by our interest to understand the lived experience of Members and their staff specifically. We didn't set out to determine whether or not reinstating the OTA or reinvesting in support agencies was one way or the other. We actually didn't go in with any kind of hypothesis on what our findings were. We just wanted to understand what the experience was, and these are our findings.

Mr. MCNERNEY. So that was basically the focus. What is the experience of these former Members give you?

Ms. MANLEY. What's driving the gap, yes.

Mr. MCNERNEY. Sure, thanks. All right. I yield back, Ms. Chairman.

Chairwoman JOHNSON. Thank you very much. Mr. Cloud.

Mr. CLOUD. Thank you, Chairwoman. Good morning. Thanks for being here. And I look forward to the conversation. I appreciate the input that you're giving.

Of course, we do have many challenges facing our Nation, and you mentioned a few of them. One that was not mentioned that is of primary concern and one of the biggest challenges to our Nation of course is our national debt and the fiscal issues. You know, this program was cut for budget reasons back in 1995 when our national debt was a resounding $5 trillion, and we would love to be there today now of course. On the other hand, we do have very real scientific challenges, especially as we consider the global threats that we face and need to ensure that we're able to meet those challenges for our Nation.

I was wondering, Mr. McCord, could you kind of recap some of the resources that are available to us as Congressmen and women?

Mr. MCCORD. Thank you. Yes. The primary resources that we look at and study are support agencies, Congressional Research Service not represented here today, which tends to do the shorter turnaround tasks from Congress, and then the Government Accountability Office, which is really the main heavy hitter in the field today that is something that is under the control of the legislative branch.

We're well aware that there's many resources out there, the National Academy. I worked on the Hill for 24 years before my time at——

Mr. CLOUD. Right.

Mr. MCCORD. My boss was deluged with books that people would come by to give him on topics of every imaginable subject.

Mr. CLOUD. I have a stack on my desk as well.

Mr. MCCORD. So Dr. Manley referred to this, I think the most advised body. So we recognize that there's the outside resources that you have to assess whether someone has an ax to grind that makes you question their input, in addition to the——

Mr. CLOUD. Right.

Mr. MCCORD [continuing]. Scientific community. What I think was driving our recommendation for an advisor and perhaps also the interesting re-creating OTA is that there should be somebody that is responsible only to you that is a voice, that is a coordinator that—you know, that you can trust. So right now you have——

Mr. CLOUD. It seems to me, and this has been touched on, but that the greatest challenge isn't the amount of information; it's the ability to triage——

Mr. MCCORD. Yes.

Mr. CLOUD [continuing]. And get helpful and effective information for decisionmaking. And so I appreciate the fact that the conversation has kind of been geared that way little bit. I mean, we have the leading scientists—access to them across the whole country. I mean, we had Bruce Bimber in here the other day, you know, so we have access to people.

But the question for me is how do we get effective information to people, we've been talking about the fact of a bipartisan effort here. I think the better term is nonpartisan of course when we're talking about science because really the data should lead it and not one party or both parties. But I don't have a whole lot of comments that necessarily putting that within the legislative branch produces that. Indeed, in the past, reports were often taking too long and some were withheld by the chair of the committee and not given access to the rest of Congress.

And so I'm wondering if in your proposal, do you have any recommendations that address those issues?

Mr. MCCORD. We certainly agree that you need unbiased, you know, nonpartisan advice that you can trust. When we talk about putting—for example, adding an advisor to key committees—not to this Committee of course. This Committee is a little bit of an exception in terms of already having the—you know, expertise on this issue, but on other committees. We certainly do not advocate having Democratic advisors and Republican advisors. I think it would be very much regret if that's the road that, you know, someone ended up going down.

But we do think that the committees that produce the legislation don't have enough capability. Mr. Beyer referred of course to an even greater challenge in a personal office, and it is my experience that I think it's probably unavoidable that organizations like GAO or an advisor if you follow our recommendation or OTA if you create OTA, they're going to have to prioritize. They'll probably put committee requests first unless there's a really large investment and capability. I think that's going to be a fact of life. But on the team that you do have, does have to be nonpartisan.

And I started my career——

Mr. CLOUD. I wanted to get one more question in for——

Mr. MCCORD. Sorry.

Mr. CLOUD [continuing]. Dr. Persons. You've been producing reports in the GAO, and my understanding is you've been able to get them to us a lot quicker. Previously, you know, when they would take a year or two sometimes would get a request for a report and it wouldn't be until the next Congress, completely different people making the decisions, to get that information. And so you've been able to do that much quicker. Is that true? Could you speak to that?

Dr. PERSONS. Yes, thank you for the question, and thanks for the compliment, Mr. Cloud. We are working on cycle times to get down to several weeks for the single-pagers that you have in your packet, the S&T spotlights, which are just brief 101s on the technology, up to an intermediate scale, which is about a 6-month—6- to 9-month turnaround descriptive only, and then up to 12 to 18 months in doing that.

We do have that advantage of our congressional protocols and our extensive review process. We think we could have the quality and still meet the operational tempo. And that is part of—for the new science, tech assessment, and analytics team, our strategy is to be content-focused not just deliver a report per se even though, as the studies rightly point out independently with Belfer and NAPA, that there's still the need for the larger studies but there's also the need for this agility to reach out and also to be proactive to essentially say, Congress, you haven't asked for this yet but we're seeing something that's coming and we just want you to know about it.

Mr. CLOUD. Thank you very much. Thank you, Chairwoman.

Chairwoman JOHNSON. Thank you very much. Mr. Casten.

Mr. CASTEN. Thank you, Madam Chair. And for totally selfish reasons I want to thank you all for coming today. I think I can say this with confidence but one needs to be careful about superlatives in this line of work. I think I am the only Member of Congress as a freshman who made a campaign promise before getting elected to restore the OTA. I'm sure that's why I won. It really resonates in the district.

The reason for that is somewhat personal. When I got out of graduate school with a master's in biochemical engineering in 1997 I went to work for Arthur D. Little. And this was in the day the internet was coming around but we still had a corporate library that we had to use to do all of our research. And the—whether we were looking at hydrogen storage technology or advances in battery technology or biomass gasification technology, we had this whole volume of OTA reports that we would go to look at not to tell us about will the technology work but what are the theoretical limits that you can get to in this technology if it did work, you know, with 100-percent efficiency, what would it get to so you can kind of backdoor what makes sense.

Dr. BLAIR. I have a CD for you.

Mr. CASTEN. Thank you. Microfiche, please.

But as I'm sitting there—this is 1998, 1999—I'm noticing that they all sort of stop around I think 1994, 1995-ish. And I said to my boss, you know, where's the section of the library where I find the rest of these reports? And my boss sort of chuckled and he said,

well, good news bad news. Bad news is Gingrich killed the OTA. Good news is we get to sell a lot more consulting services now because what used to be free to the public you now got to pay for. What the government used to get from OTA they now had to hire us, so we had a lot of work for DOE (Department of Energy) and EPA and USDA (U.S. Department of Agriculture) doing all of this analysis.

And so I have the very lived experience that dropping the OTA didn't save the government a dime, probably cost more because my billing hour rates were a lot higher than what the OTA charged. But it probably made us dumber because now you could only get that information if you could afford to pay for it. And it made us ever-more dependent on lobbyists for the information.

Now, since getting elected, I love what GAO does. I love what CRS does. It is fundamentally not synthetic. It is a report of what's out there in the existing literature, and when I want to go and find out what are the thermodynamic limits, the way I answer that question now is I hire a good staff. So I have staff that I've hired onto my team who have degrees in engineering and biostatistics and math. That is not the typical congressional staff.

And the fact that we now have to go and do that with staff from what used to be provided elsewhere is a glaring hole. And I would reiterate we didn't save any money. We just got dumber.

And, you know, back in Illinois we had that FutureGen project, huge carbon capture sequestration. With a master's degree and the back of a napkin, you could prove that that was inanely stupid and would never work. We spent 4 billion Federal dollars to prove what you could prove on the back of a napkin.

So, as you might imagine, I am a bit concerned, Mr. McCord, about the NAPA conclusions. And when Mr. Lucas I believe asked you, your answer was mostly about the political reasons why you thought this was best in GAO. Leave us to sort out the politics. Are there nonpolitical reasons why the NAPA report concluded that the OTA from a scientific perspective—given my experience—why there shouldn't be a re-creation of the OTA?

Mr. MCCORD. Thank you for that question. I would say that our panel consensus was that a more modest approach was more likely to succeed, so——

Mr. CASTEN. But that's a political conclusion. I'm asking leave all the politics aside. I want to know—let's focus on what's necessary, and then we can deal with what's politically possible. What I want is for us not to be dumber. Is there a reason why not re-creating the OTA would be scientifically useful?

Mr. MCCORD. Again, I don't think we would agree with the characterization that it's a political judgment, but again, looking at something that has failed to happen for 25 years, you can have something that's incredibly desirable that people aren't willing to pay for, and you have nothing at the end of that. And that's kind of where we sit today with respect to an OTA. So, again, we do not oppose the creation or re-creation or refunding of OTA, but we think that a better way to get there would be to follow this approach of creating an advisory office that is somewhat smaller that coordinates what's already being done in Dr. Persons' office and

being done at CRS and see then if you need more. You can always move in that direction to see if you need more.

Mr. CASTEN. Well, I'm basing basically out of time. Ms. Manley, do you have any reasons why from a nonpolitical basis—just a yes or no because I know I'm out of time—non-politically that are reasons not to create the OTA?

Ms. MANLEY. No.

Mr. CASTEN. Dr. Blair? OK. Dr. Persons, I'm going to leave you off on that.

I just want to close with this. I just got back from the Madrid conference. If the justification for not creating the OTA is that in 25 years we haven't found the political will, in 25 years we haven't found the political will to get serious about climate change. That is no reason for inaction. This is a much smaller problem. Let's do it.

Thank you. I yield back.

Chairwoman JOHNSON. Thank you very much. Mr. Waltz.

Mr. WALTZ. Thank you, Madam Chair. Panel, thank you so much for coming today.

I'm interested and just want to talk to you for a moment about the networking gap that you identified in the report. And I just want to echo my colleague Mr. Cloud. I don't think there's a dearth of information out there. It's really a debate of how to access it, how to triage it and make it useful for decisionmakers and policymakers.

I represent Florida's 6th congressional District in central and northeast Florida, and the district that I'm in is home to several universities, including Embry-Riddle Aeronautical University, Stetson University, Bethune-Cookman, and others. And they really are doing phenomenal work, much of it federally supported, in paving the way for research and development in science and technology.

And the NAPA report identified a gap in the networking support category, which basically the report defined as assisting Congress and gaining access to outside S&T experts. So, Mr. McCord, what do you see as preventing Congress from fully accessing and utilizing these important critical academic experts as a resource for us?

Mr. MCCORD. Well, as has been noted, your institution gets a lot of input, and you have to then filter whether or not you think that it's got, you know, too much of a personal interest or ax to grind on when it comes in. On the networking side, I think we felt that if you had this advisory office that we talked about, someone that would be the face of science and technology for the Hill, that they would be able to do a coordinating function to be a face that people could reach out to and an ombudsman for an office like yours to go to say I'm having trouble getting the information I need; can you help me get in touch with the right people?

Rather than have—it's not to say that you wouldn't have a workaround. You probably do since the thing we're talking about doesn't exist. Perhaps you go to GAO and CRS separately and say can you help me or perhaps you reach out to someone you know and trust, you know, someone like Dr. Blair who's outside the legislative branch entirely. What we think this coordinating office could

do, though, is, again, to be more of the face of science and technology and an ombudsman to help you with these problems.

Mr. WALTZ. Thank you. Ms. Manley, would you add anything to that?

Ms. MANLEY. It's related, but I'd actually like to just get this on the record. Speaking only for myself personally, a lot of this conversation has been about how we would bolster GAO and some of the other support agencies. But from my experience working with large bureaucracies and inside of them it is very difficult to change an institution from within, especially culturally. And from my work with tech startups, some of the most successful ones are the ones that deeply understand users from the start and can design from the ground up exactly what's needed.

So a lot of this conversation has been focused on what's happened in the past and whether or not it was political or whether or not it was extremely useful and saved lots of dollars. But I think we've all acknowledged here that if we were to reinstate an OTA, it would be vastly different, completely different from the past. So I just want to get that on the record to say that it isn't a completely absurd idea to do that, but I do think it needs to be done in commendation with GAO.

Mr. WALTZ. Thank you. And just in the interest of time, looking over the horizon, I mean, looking at long-term trends rather than the immediate requests, how would that office or how would the advisor do that versus what GAO and what CRS is currently able to do? Would that be a specific mandate? And I'm really interested in looking at, you know, decades-out trends that we can start absorbing and hopefully begin legislating toward.

Mr. MCCORD. Thank you. Well, in the panel's view, this office especially at the beginning would not have the capacity to do all of that itself. It probably would need to go out and contract with other people and work with other people, including GAO and probably including the National Academies of Sciences also. And from my background in the defense world, it was routine to have witnesses come in at the start of—the Director of National Intelligence comes in and does—here's what I see. Combat commanders from around the different geographic parts of the world do the same.

So it's kind of that model of people that have that broad view come in and tell you what they see. And the horizon can be, you know, whatever you the Members—do you want 5 years, do you want 10 years, do you want 20. That would be something for this Committee and others to kind of give direction to.

Similarly, I think you would want to decide do you want them to look at here are the big developments in science and technology that we see, or here are the big developments that we see where public policy is farthest behind? So you could have—again, that would be something that we would kind of leave to you to decide what do you want that horizon-scanning function to be.

Mr. WALTZ. Thank you. And thank you all for coming today. Madam Chair, I yield.

Chairwoman JOHNSON. Thank you. Mr. Lamb.

Mr. LAMB. Thank you all for being here. I think this is a really important topic. I'm kind of struggling with it a little bit because the conversation is at a pretty abstract level. You know, generally

what types of advice Congress should get and from whom. Is there a way—maybe we could go down the line—and I don't know who wants to start. Ms. Manley was kind of where I got this thought. But, you know, Members of Congress are not just here kind of thinking up ideas and what to work on every day like philosopher kings or something. We're very responsive to our constituents and the problems that they have and the things that they bring to our attention.

So is there a way that maybe you could each specify a problem that we are trying to solve here in the lives of our everyday constituents? And I think, Ms. Manley, you mentioned a little bit about data privacy and elections and that kind of thing. But is there a way for you to put it in those terms that better scientific and technology advice here in the institution of Congress, what's an example of a specific problem we might be able to solve that an average constituent of mine is going through?

Ms. MANLEY. Sure. I think a perfect example where there's sort of a war of experts is on what to do about the big tech companies. A lot of experts even within Harvard will say we should break up the tech companies. Other folks would say that would be disastrous. So I think having an independent expert body that could really weigh in with all of the different options would be incredibly valuable. It's not something that individual offices could really take a look at comprehensively, so that's a prime example of where this expertise is really, really needed in a time-sensitive way.

Mr. LAMB. Yes. I think that's a good example. And even within your example, there are those who say some companies should be broken up and not others, like they wouldn't even treat that as one category.

I guess my observation is that I don't even think we're anywhere close to a consensus existing in the American public that that's one of the highest-priority problems that an average middle-class, working-class person faces. You may be able to draw those connections in the classroom, but in the real world I don't think that consensus exists yet.

So does anyone have anything to say about the way that better or more contemporaneous scientific advice could address something, you know, say, related to the workforce or working conditions or salaries or consumer buying power, things that really people are going through on a day-to-day? Go ahead, Dr. Persons.

Dr. PERSONS. Yes, thanks, Mr. Lamb, appreciate it. And I think I'll just mention two, but they are related. I mentioned earlier in my remarks about just the burgeoning or the unfolding of 5G wireless and the impacts there, lots of opportunities for that technology, you know, exponentiating our bandwidth and things. But it's at risk for creating a have and have-nots narrative in terms of your middle-class working. Is that something that's going to be for urban dense core areas only, or will it be available to the middle class or even especially in the rural areas, some of which don't even have 3G yet. So that's that.

The second thing is with respect to machine learning and artificial intelligence, again, a key thing under the leadership of this Committee, there's been some great work on and apparently some draft legislation, but that has a lot of impacts on what's the impact

on the workforce. I think the key thing is that it's not clear, as we reported in our 2018 report that it's the jobpocalypse as I'll say. It's not going to eliminate all jobs, but there's going to be a disruption in terms of certain types of jobs.

And it's still somewhat of a predictive thing. We'll be wrong in one sense but less wrong if we're not doing this foresight, tech assessment-type work that's necessary in the scientific-advisory-body way.

But we're sort of the frog being boiled slowly in the water on machine-learning systems, and that's why GAO's doing this foresight work, as well as tactically, we're working on and synthetically working on machine-learning algorithms and looking at accountability for that because you're going to see it in things where let's suppose a Federal agency may have a hiring system, and they implement a machine-learning algorithm to filter and sort on job applicants. How do we know, for example, that that algorithm, even if it's purchased off-the-shelf from a software company, is compliant with the *Civil Rights Act of 1964*? So it's that kind of thing where we're moving in a statistical computing world that's necessary for things like what we're talking about here. Thank you.

Mr. LAMB. Thank you very much. Yes, it's almost like having interpreters. I mean, it's almost like this technology presents an entirely different language in which we have to think in order to make rules.

And with that, Madam Chairwoman, I yield back.

Chairwoman JOHNSON. Thank you very much.

Mr. FOSTER. Madam Chair?

Chairwoman JOHNSON. Mr. Foster is recognized for a second round.

Mr. FOSTER. Thank you very much. I really appreciate this opportunity to finish up on some of the things.

I guess the thing I feel most strongly about is, Dr. Persons, I didn't have a chance to compliment you enough on the work that you're doing inside GAO. It is important to reconfigure yourself to meet this.

You know, I've been working very hard with a number of my colleagues to try to get the OTA resurrected. Our odds of success are not 100 percent. And, as I said before, I think we need, you know, an all-of-the-above approach here because of the importance of this.

And, you know, I think the other thing that I muse about frequently is the fact that we simply don't have on staff. You know, what you really want to do as a Member if you see something, a story in the press, is say, hey, is that garbage or not? Is that a real issue, you know, an issue for my constituents or for my district or for our country, or is that just sort of hype?

And so if there is someone that you have right at hand that you trust, you know, if OTA was sort of enmeshed in Congress so there are several people that you would know on a first-name basis, call them up and say, hey, is this garbage or not, that's sort of the dream. Ultimately, that's the sort of help that you get from your staff.

And another one of the sources of frustration I think was discussed in the Belfer report is that Congress doesn't have the ability to absorb the information at the rate—even though there are a lot

of reports that could be read, we simply don't have the ability to absorb.

And so one of my questions, what are the ideas that are out there to provide high-quality sort of long-term—you know, and not rotators or temporary fellowships and stuff, but people who make their career as science advisors close at hand to Congress? Any ideas on what's been tried there? Yes, Dr. Blair?

Dr. BLAIR. Resurrecting ancient history I think, in the OTA experience, one of the sort of quiet resources that the agency provided that I think is aspirational for all the groups that we're talking about here was what George Brown and Ted Stevens, former chairs of that board, referred to as the shared staff. And that is in the OTA experience when a major assessment was done in a particular area, that expertise was then available for all the committees and often individual Members' offices to become really an authoritative resource in that area.

And so I think, as the body of expertise develops in whatever mechanism is developed, making as a high priority the availability of those staff to serve both as shared staff of the committees and Members' offices but also as the Rolodex for identifying resources outside the Congress that can be a benefit across the board. So I think that's a mechanism that's important to keep in mind.

Dr. PERSONS. Yes, sir, I just point to just from a capacity thing at GAO, as you know, again, 70 FTEs. We've hit that mark we had targeted for FY 2019 in terms of permanent hires. They are available to Congress now. Again, our design of this is to be proactive so the only burden Congress has to have is just ask the question. And then at times there will be questions that we might not be able to answer immediately or in a fulsome way, but then it becomes a risk-management discussion about what work might need to be done.

But when you look at the Belfer Center report, page 62, 63 about the ideal system with this, existing with the Congress, convening groups of stakeholders, serving congressional needs, options-oriented, that implies a permanent staff, which is what we have, as well as this scale and reach-out to not only National Academies but other external experts.

A final thing that we're doing is in addition to the AAAS (American Association for the Advancement of Science) Fellows program and the TechCongress Fellows, all of which I think adds to or supports the absorptive narrative that you're hearing from Belfer and NAPA, we also send staff on details from GAO, and we want to be able to be embedded where that's possible. In fact, this Committee now has one of the STAA staff with it at the moment. We've had previous staffers on the Hill. It's something that we do because we're passionate about pushing out and serving you in a nonpartisan, fact-based, agile manner.

Mr. FOSTER. Yes, Ms. Manley.

Ms. MANLEY. I think another way to think about addressing this S&T gap is the role of universities. Our follow-up report from this recent one is to understand current pathways for STEM talent to serve on Capitol Hill, which universities have created effective pathways in how can we scale those. So I think it's up to universities to make sure that understanding policy is not just something

that the policy schools do, and it's something that's integrated into other types of curriculum like law and engineering and mathematics.

Mr. FOSTER. Thank you. And I guess I also can't close this discussion without just saying we have to do something somehow to figure out how to raise the level of staff salaries so that we can have, you know, this be a viable career. And we're about to lose in my office Susannah Howieson there who handles our Science Committee work here. We'd have to like double the salary that we could offer her to be able to keep her compared to the offers here. And, you know, someone with a young family in the D.C. area, you're constrained.

And this is a problem. I don't know how to fix it. And I think if any of us ran for reelection with a platform of doubling staff salaries, I don't think we would last very long, but I think we should at least scale our salaries with, say, the median income in the United States.

Well, I thank all of you for your attention to this idea and yield back.

Chairwoman JOHNSON. Thank you very much.

Before we bring the hearing to a close, I want to thank our witnesses for testifying before the Committee today and to say that the record will remain open for 2 weeks for additional statements from the Members and for any additional questions the Committee might ask of the witnesses.

The witnesses are now excused, and the hearing is now adjourned.

[Whereupon, at 11:59 a.m., the Committee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by the Hon. Michael McCord
January 9, 2019

Mr. Michael McCord's responses to House Science, Space and Technology Committee to two written follow up questions.

1. **One of the features of OTA that has been cited as a contributing factor to its political vulnerability is the fact that it primarily served the needs of committee leadership which limited buy-in from rank-and-file Members. However, the NAPA study team recommended that GAO apply the same protocols it uses for its auditing work for its S&T work and GAO declared its intention to do so in its S&T plan. These protocols, last updated in 2017, prioritize requests from committee leadership. Are these protocols well suited to technology assessment requests? How can GAO strike a balance between aligning its work with congressional committee priorities and being responsive to individual Members?**

The Academy Panel's report acknowledges that the current GAO protocols for receiving science and technology (S&T) resource support requests should be a starting point for taking this work forward. There are four principal points to make in responding to this question about GAO.

First, GAO has resource constraintsin its newly established STAA group that limit its avility to appropriately accommodate all individual member requests. With approximately 50 staff members at the present time (with plans to grow its staffing to 100-140 FTEs in future years), the STAA could be quickly overwhelmed with work if all 535 members had an equal authority for calling on GAO's S&T resource support. With the current STAA size, and the enormity of the potential congressional demand for S&T resource support, the Panel deems it appropriate to start with a tried and tested protocol that has generally served congressional needs well. Realistically, if GAO were expected to respond to every individual member, we presume that the STAA staffing size would likely need to be, at least, several hundred.

Second, GAO provides some quick turnaround and consultative support to all Members and staff on topics related to its prior work, and the Panel recommends that GAO continue to do so. Additionally, GAO's work is available to all congressional clients via its website (e.g., the "find an expert" link). In a significant number of cases, a report that GAO prepares in response to one specific request may be useful to a wide number of members once published. The Congressional Research Service has used this approach successfully for many years.

Third, the former Office of Technical Assessment (OTA), dismantled in 1995, operated in a similar fashion as is the current GAO protocol. OTA's governance group gave priority to committee chairs when requesting technology assessments, and not to individual members. The Congressional Budget Office, where I began my career in the legislative branch, also uses this method of prioritizing its work.

Fourth, the report calls for Congress to provide additional resources to GAO to build the STAA staff numbers in order to both enhance quality and quantity of S&T resource support, and the timeliness of it. With additional resources, based on our research, we understand that GAO is prepared to consider how it might adjust its protocol to receive a broader range of congressional requests.

Finally, in considering how to best meet the broad array of congressional S&T resource support needs, the report also highlights the pivoltal role of both the Congressional Research Service (CRS) and the Office of the Congressional Science and Technology Advisor (OCSTA). CRS serves the needs of all staff and Members already, and should continue to do so. Furthermore, the report recommends creation of the OCSTA to serve, in part, as an ombudsman for congressional offices. As such, individual members who might not be chairs of committees could ask the OCSTA for support, and the OCSTA, in its role as the chair of the Coordinating Council, could identify areas where there was significant congressional interest for consideration and evaluation by CRS and/or GAO, or could refer individual members to other resources in OCSTA's S&T network for assistance.

In summary, the Panel's view reflects the need to impose limitations due to resource constraints. These are in keeping with how the OTA operated in the past. As GAO's STAA team dedicated to S&T resource support grows, there should be opportunity to add greater access beyond the current GAO protocol. This should be an aim of both GAO and Congress. In the meantime, CRS and the OCSTA can also play roles in expanding S&T resource support to both staff and Members

2. **The NAPA study team recommended that GAO make some changes in its organization and operating policies to accommodate unique features of technology assessment. Among in the changes recommended by the team is that GAO establish a core Science, Technology Assessment, and Analytics (STAA) team to focus solely on technology assessment. GAO does not currently have staff dedicated to technology assessment, but rather utilizes staff from other offices. Why is it important for there to be separation between the GAO staff working on audit and performance evaluation work and the staff working on technology assessment?**

At the outset of our response, it is important to point out a concern with a comment embedded in the question: *"Among in the changes recommended by the team is that GAO establish a core Science, Technology Assessment, and Analytics (STAA) team to focus solely on technology assessment. GAO does not currently have staff dedicated to technology assessment, but rather utilizes staff from other offices."* We do not believe that this statement is correct. The establishment of STAA was not a Panel recommendation. It was established due, in part, to a request in appropriations report language, and not a Panel-instigated action. That said, it is correct that the STAA currently does not have a staff team solely dedicated to doing TA work. Instead, the STAA has its own staff members who work on both TA and traditional auditing work.

The report recognizes that the S&T resource support products have characteristics that are significantly different than the majority of work performed by GAO. There are demonstrable differences between the characteristics of traditional GAO work – performance evaluation and audit work which is generally backward-focused – and S&T resource support to fill the gaps identified in the report. In short, S&T resource support is more future-focused than audits and performance evaluations. In light of these fundamental differences, the Panel has concerns with deploying the same people in STAA to work on both kinds of GAO products.

As such, the Panel urges GAO to make a concerted effort to identify and carve out a specialized team whose leaders take deliberate steps to focus solely on S&T support work as requested by Congress. The leaders of this group should work to instill a tailored approach to preparing S&T support products, one that reflects inherent differences from other GAO work.
There are features of how the OTA operated during its lifetime that might be adapted by the STAA team with respect to its organizational culture. The report calls for GAO to take several actions to enhance the operating environment in the S&T support sphere, to include greater use of peer review, networking, and more flexible hiring practices, among other things.

As a best practice, the Panel sees value if GAO would establish an exclusive core team of staff members within STAA that would only focus on S&T products. By doing so, the STAA might be more likely to establish the requisite distinctively creative culture to augment the value and quality of its S&T products, separate from its traditional set of products. During the course of the Academy's discussions with GAO senior leaders, GAO posited that there may be value to allowing some STAA staff members to perform both traditional and S&T work in order to be more efficient and cost-effective given current resource constraints. There are certain synergies to tap into when GAO subject matter experts working outside of the STAA can also contribute to the S&T work needed by Congress. Thus, the Panel recognizes that there are financial challenges to establishing a large and exclusive team of GAO staff members who only can work on S&T resource support to Congress. The report thus concludes that GAO should use its discretion when building an STAA team dedicated to providing S&T resource support.

For both of these issues: how to prioritize Congressional requests if there are not enough staff resources to expeditiously answer every request in a first-come, first-served fashion; and the extent to which GAO can create a separate STAA staff largely firewalled off from the rest of the organization, Congress must balance what level of responsiveness and what structure and culture it deems desirable with the level of personnel and financial resources it is willing to devote to S&T support. The Panel's assessment was that funding constraints would play a role on both fronts.

Responses by Dr. Tim Persons

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

"Experts Needed: Options for Improved Science and Technology Advice for Congress"

Questions for the Record to:

Dr. Timothy Persons

Chief Scientist and Managing Director, Science, Technology Assessment, and Analytics

U.S. Government Accountability Office

Submitted by Chairwoman Eddie Bernice Johnson

Question 1: One of the features of OTA that has been cited as a contributing factor to its political vulnerability is the fact that it primarily served the needs of committee leadership which limited buy-in from rank-and-file Members. However, the NAPA study team recommended that GAO apply the same protocols it uses for its auditing work for its S&T work and GAO declared its intention to do so in its S&T plan. These protocols, last updated in 2017, prioritize requests from committee leadership. Are these protocols well suited to technology assessment requests? How can GAO strike a balance between aligning its work with congressional committee priorities and being responsive to individual Members?

Yes, our congressional protocols are well suited for technology assessment requests. These protocols, which we developed in consultation with Congress, are intended to provide clearly defined and transparent policies and practices relating to GAO's work for Congress. They hold GAO accountable for commitments made to Congress and ensure that GAO is consistent in dealing with all committees and Members. The protocols clarify GAO's authority to conduct work, delineate priorities for initiating work, and identify factors that are considered prior to accepting congressional requests for work. They help us prioritize and respond to congressional requests, including technology assessments, in a balanced manner. Demand for GAO's work currently exceeds existing resources. Therefore, while we accept individual member requests, our protocols call for us to prioritize mandates and requests from Chairs and Ranking Members of congressional committees and subcommittees.

To strike a balance between congressional committees and individual Member needs, GAO's wide variety of technical products and services are available to both committees and individual Members. While we prioritize requests for technology assessments from Chairs and Ranking

Members of congressional committees and subcommittees because these assessments are often resource intensive, we provide technical assistance equally to all Members regardless of position. Members can request technical assistance through informal channels such as a phone call or email; such work can range from answering questions about prior work to conducting smaller-scale analyses. Members can also request briefings on our work. For example, in April 2019 we briefed congressional staff on the National Institute of Standards and Technology's (NIST) measurement services and standards development activities, and in July 2019 we briefed staff on sustainable chemistry technologies. We also participate in events, such as an October 2019 Data Roundtable for the House Veterans' Affairs Committee where our Chief Scientist participated as a subject matter expert to discuss data portability, use of electronic health records, and privacy and security concerns.

In addition, we may undertake work that is not directly tied to requests, which is available to individual Members. This approach can be useful for topics that are of broad interest to Congress, generally longer-range, crosscutting, and transformational issues. This allows us to bring to Congress's attention important emerging science and technology issues that may affect the nation's future. For example, we developed our Science & Tech Spotlights under this authority to quickly inform Congress of S&T topics of broad interest. The Science & Tech Spotlights are quick turnaround public products; examples include blockchain, opioid vaccines, and hypersonic weapons.

Question 2: The NAPA study team recommended that GAO make some changes in its organization and operating policies to accommodate unique features of technology assessment. Among in the changes recommended by the team is that GAO establish a core Science, Technology Assessment, and Analytics (STAA) team to focus solely on technology assessment. GAO does not currently have staff dedicated to technology assessment, but rather utilizes staff from other offices. The GAO plan for enhancing its S&T analysis function includes a plan to designate staff "whose primary focus will be technology assessments." Will these analysts also be responsible for performing audit and performance evaluation work? Does GAO plan to create a core STAA team that is separated from the rest of GAO? If not, why not?

In January 2019, the Comptroller General directed the creation of the Science, Technology Assessment, and Analytics (STAA) team. STAA currently has over 70 full time staff. Depending

on the authorization and appropriations process, we aspirationally plan to grow STAA to 140 full-time staff as we adapt to meet future congressional demand.

One of the key activities within STAA is developing technology assessments (TA), such as those we conducted on irrigated agriculture and protecting the U.S. electric grid. Over the past calendar year, about one-half of the staff members within STAA were primarily focused on TAs. While working on TAs, some staff may be available to other GAO teams as consultants in their areas of technical expertise, but they generally do not have primary responsibility for audit and performance evaluations.

STAA's technology assessment team currently includes engineers (e.g., biomedical, electrical and electronics, systems, petroleum, aerospace), chemists (e.g., analytical, environmental, inorganic, organic, theoretical), biologists, and physical scientists (e.g., nuclear physics, environmental science, geology), and others. We also plan to continue hiring technical staff. We recently hired an additional biologist and are still recruiting other scientific/technical specialist staff. These staff are intended to increase the emphasis on our technology assessment, technical assistance, and/or any other science and technology work requested by the Congress.

STAA's staffing model allows us the flexibility to meet congressional science and technology needs, whether it is through a technology assessment, such as our work on artificial intelligence; an evaluation of federal science and technology programs, such as our work on public access to federal research; or a technical evaluation, such as our ongoing work on infectious disease modeling.

Responses by Dr. Peter Blair
1/10/2020

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

"Experts Needed: Options for Improved Science and Technology Advice for Congress"

Questions for the Record to:

Dr. Peter D. Blair
Executive Director, Division on Engineering and Physical Sciences
The National Academies of Sciences, Engineering, and Medicine

Submitted by Chairwoman Eddie Bernice Johnson

One of the features of OTA that has been cited as a contributing factor to its political vulnerability is the fact that it primarily served the needs of committee leadership which limited buy-in from rank-and-file Members. However, the NAPA study team recommended that GAO apply the same protocols it uses for its auditing work for its S&T work and GAO declared its intention to do so in its S&T plan. These protocols, last updated in 2017, prioritize requests from committee leadership. Are these protocols well suited to technology assessment requests? How can GAO strike a balance between aligning its work with congressional committee priorities and being responsive to individual Members?

Regarding the first question, in my view, the GAO "congressional protocols" are problematic in many respects as applied to generating science and technology advice generally, and especially as applied to technology assessments. First the words, "science," "technology," or "technology assessment" do not appear anywhere in the protocols at all. Specific functions were established in GAO for technology assessment because, in order to be effective, the needs are different from other kinds of analysis as I outlined in my testimony. The GAO protocols were designed to structure government agency performance audits for Congress and don't distinguish between audits and technology assessments in defining a suitable task statement for a technology assessment. They also could be strengthened considerably in assessing priorities for committee requests matched to the jurisdiction of committees and in determining if a prospective assessment is duplicative of work being done elsewhere. This is in contrast to the OTA model, for example, where the Technology Assessment Board of House and Senate members with advice from an outside panel of experts is charged by statute to make such determinations. The GAO results over the last 17 years using the existing protocols illustrate the shortcomings. For example, attached is a table showing the 15 products GAO lists as technology assessments to date. Not one assessment to date resulted from a bicameral, bipartisan request from committees of jurisdiction over the subject under study and only four involved a bipartisan request from any committee of jurisdiction at all.

Regarding the second question, it is hard to see how the current GAO protocols can be used effectively to deal with the shortcoming I just illustrated, let alone sorting out how to prioritize individual member requests alongside committee requests. A much more effective mechanism for being responsive to individual member requests would be to establish a collaborative partnership with CRS, which was designed from the outset for such service and already has well-established mechanisms for this purpose. The partnership could draw broadly on whatever relevant work has already been produced by GAO on the topic (in the STAA or elsewhere) as well as the relevant work at CRS (and in some cases CBO). Even if a dedicated OTA-like agency were reinstituted, building on the design strengths of the congressional support agencies and establishing collaborative approaches to such needs would be far more effective than trying to reinvent the wheel in any one of the agencies.

		Technology Assessment	Committees/Subcommittees of Jurisdiction				Other Committees or Subcommittees				Other Individual Members	
			Senate		House		Senate		House		House	Senate
			Chair	Ranking	Chair	Ranking	Chair	Ranking	Chair	Ranking		
1	2019	**Technologies, Practices, and Implications for Water Scarcity**			Natural Resources, Grijalva Energy Subcomm, Lowenthal						DeFazio	Markey
2	2019	**Protecting the Electric Grid from Geomagnetic Disturbances**	Homeland Security, Johnson	Homeland Security, McCaskill								
3	2018	**Artificial Intelligence: Emerging Opportunities, Challenges, and Implications (Forum Highlights)**								Science, I&O Subc., Edwards Science, Energy Subc. Miller		
4	2018	**Chemical Innovation: Technologies to Make Processes and Products More Sustainable.**						Approps., Fin. Srvs. Subc. Coons				Collins Markey
5	2017	**Medical Devices: Capabilities and challenges of technologies to enable rapid diagnoses of infectious diseases**	Homeland Security, Johnson	Homeland Security, McCaskill	Energy & Commerce, Waldon							Upton
6	2017	**Internet of Things: Status and implications of an increasingly connected world**		Comm. Sci,& Transp., Subc. Commun., Brian Shatz					Over. & Govt Reform, Chaffetz	Over. & Govt Reform, Cummings		Booker Fischer Gardner
7	2016	**Municipal freshwater scarcity: Using technology to improve distribution system efficiency and tap nontraditional water sources**				Natural Resources, Grijalva Subc. On Energy, Lowenthal					DeFazio	Markey
8	2016	**Water in the energy sector: Reducing freshwater use in hydraulic fracturing and thermoelectric power plant cooling**				Natural Resources, Grijalva Subc. On Energy, Lowenthal					DeFazio	Markey
9	2015	**Nuclear Reactors: Status and Challenges in Development and Deployment of New Commercial Concepts**						Approps., Energy & Water Subc Feinstein				
10	2015	**Neutron Detectors: Alternatives to Using Helium-3**				Science, I&O Subc., Edwards Science, Energy Subc. Miller						
11	2011	**Climate Engineering: Technical Status, Future Directions, and Potential Responses**				Science, Johnson						
12	2010	**Explosives Detection Technologies to Protect Passenger Rail**					Approps, Leg Branch Subc., Nelson	Approps, Leg Branch Subc., Murkowski	Approps, Leg Branch Subc., Wasserman-Schultz	Approps, Leg Branch Subc., Aderholt		
13	2005	**Protecting Structures and Improving Communications during Wildland Fires**	Energy & Nat. Res. Domenici	Energy & Nat. Res. Bingaman	Armed Services, Hunter				Science, Environ. Subc., Ehlers	Science, Environ. Subc., Wu	Udall	
14	2004	**Cybersecurity for Critical Infrastructure Protection**	Gov. Affairs, Collins	Gov. Affairs, Lieberman Commerce, Hollings			Gov. Reform, Tech. Info. Pol. Subc. Putnam					
15	2002	**Using Biometrics for Border Security**					Approps, Leg Branch Subc., Nelson	Approps, Leg Branch Subc., Bennett				

1/10/2020

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

"Experts Needed: Options for Improved Science and Technology Advice for Congress"

Questions for the Record to:

Dr. Peter D. Blair
Executive Director, Division on Engineering and Physical Sciences
The National Academies of Sciences, Engineering, and Medicine

Submitted by Congressman Jim Baird

The National Academies of Science was created in 1863 by a congressional charter approved by President Lincoln, tasked with serving as an advisor to the federal government on science and technology. Do you have any recommendations for how Congress can better utilize the National Academies? And do you have any recommendations for how the National Academies can better serve Congress?

Regarding the first question on better utilization of the Academies, Congress has traditionally come to the Academies seeking authoritative analysis and advice from widely recognized experts serving as pro bono volunteers on a formally appointed National Research Council (NRC) study committee organized to provide detailed evidence-based recommendations on prospective courses of action. Thousands of our reports examining a wide range of policy-relevant topics are available for free download at www.nap.edu. Such studies have proved historically to be an important resource for Congress. However, traditional process for commissioning new studies, as I outlined in my testimony, could be streamlined in a variety of ways.

For example, congressionally mandated studies commissioned to the NRC typically require passage of legislation, which takes time and may preclude many worthy efforts. This legislative process, along with the follow-on discussions that are often needed to reconcile congressional intent with the terms of reference defined by the contracting federal agency, can further add significantly to the time it takes to initiate a new study. A standing "task order" contracting mechanism like the arrangement GAO currently has with the Academies for commissioning expert meetings could provide a way to speed up the process of commissioning NRC studies.

Tailoring Academies activities to congressional needs would benefit from collaborative discussions to clearly articulate Congress's needs and to fashion Academies' products and processes to meet those needs. When reports originate from congressional mandates, the legislative language often is used by the Academies staff and the sponsoring agency as a basis for creating the statement of task in the contract with the agency. When Congress desires policy, budgetary, or organizational recommendations, it helps considerably to have such expectations made explicit in the legislative language. Staff at the National Academies can provide technical assistance on draft legislation to ensure that any studies originating from legislation are feasible in terms of cost, scope and timeline. We also welcome input from Congress throughout the study process by providing information and/or presentations to the study committee that help them better understand how Congress intends to use their report.

In addition to commissioning new studies, Congress could call for Academies assistance in numerous ways. As Congress has experienced a growing need for more timely information in recent years, the Academies have developed a variety of mechanisms for addressing topics across the agenda of Congress. Some inquiries can be addressed in discussions or larger informational briefings with Academies staff, drawing upon our published work, or by simply connecting Congressional staff with any of the thousands of Academies members and volunteers that comprise our considerable reservoir of authoritative expertise. More formally, on narrowly focused topics, the Academies can convene "fast track" studies that considerably reduce the typical amount of time to complete a study. Other mechanisms include workshops, expert meetings, roundtables, standing committees, and other convening activities.

Regarding the second question on how the Academies can better serve the Congress, the Academies study process has adapted steadily over the years to respond to changing circumstances. Examples include adoption of special procedures for reviewing potential sources of bias and conflicts of interest of prospective committee members for studies that inform regulatory decisions, special procedures for protecting proprietary information from public disclosure in studies addressing industrial technology innovation, or report review procedures tailored to specific needs, such as to accommodate use of national security classified information or information otherwise restricted from public disclosure.

These various adaptations have been successful at tuning the Academies study process to specialized needs and broadening the usefulness of Academies studies to areas where commissioning work has been challenging. For example, working in many national security areas requires an overlay of complex policies, processes, and procedures associated with handling information that is national security classified or otherwise protected from public disclosure, which have to be reconciled with the otherwise generally very open policies, procedures, and traditions used in developing Academies reports.

There is now a track record for adapting to changing needs but, as noted earlier, a more pressing challenge in recent years has been a growing need for more timely information, which along with the prospects just outlined have been a focus of the ongoing internal NRC organizational transformation. The goal of this transformation is to provide a new focus on "enhancing the efficiency and responsiveness of the consensus study process while also continuing to develop alternative ways of meeting our sponsors' needs for analysis and advice." The Academies will, of course, adapt to these changing needs without compromising the access to extensive expertise and adherence to rigorous quality standards that you, Congress, have relied on for credible and lasting policy-relevant advice.

Appendix II

Additional Material for the Record

LETTER SUBMITTED BY REPRESENTATIVE EDDIE BERNICE JOHNSON

December 5, 2019

Hon. Eddie Bernice Johnson, Chairwoman
Hon. Frank Lucas, Ranking Member
House Committee on Science, Space, & Technology
2321 Rayburn House Office Building
Washington, DC 20515

Re: Options for Improved Science and Technology Advice for Congress

Dear Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee:

There is a welcome enthusiasm among policymakers on Capitol Hill to revitalize and strengthen Congress's internal science and technology expertise. This includes, in particular, an interest in restoring its technology assessment function—whether by reviving and modernizing the Office of Technology Assessment, or bolstering other congressional support agencies such as the Government Accountability Office's new Science, Technology Assessment, and Analytics team. We applaud these efforts, and commend your work on elevating these issues through activities such as the hearing on December 5, "Experts Needed: Options for Improved Science and Technology Advice for Congress."

While reviving OTA has become more salient in the last year—including, for instance, getting a mention in the Democratic presidential debates—we believe that making Congress smarter and more capable shouldn't be a partisan issue. Even in its day, OTA had strong Republican defenders like Sen. Chuck Grassley, who remarked in 1995: "In a very real sense, OTA is our source of objective counsel when it comes to science and technology and its interaction with public policy decision making." Former Sen. Orrin Hatch also proved prescient in arguing against OTA's defunding, remarking that, "As our economy becomes increasingly complex and technologically oriented, Congress will require, more than ever, an ability to effectively analyze technology in making policy decisions." We believe this perspective has been vindicated over the penny wise but pound foolish cuts to Congress since the 1990s. These were not just bad for OTA, but also undermined S&T expertise in committees, in GAO, and CRS.[1]

Likewise, the behind the scenes work on rebuilding congressional S&T expertise over the past few years has enjoyed strong bipartisan leadership—including through your work, the Select Committee on the Modernization of Congress's recommendations, and former Rep. Kevin Yoder's initiation of the NAPA report in the last Congress. Nonetheless, from our perspective in right-leaning civil society groups, we believe this debate would benefit from a broader inclusion and elevation of conservative and libertarian perspectives. There are legitimate anxieties to overcome about the creation of new expert bureaucracies.[2] Yet, there is also a strong conservative case for equipping today's Congress with more and better scientific and technical expertise, pointing the way to a bipartisan consensus.

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[1] To understand this capacity loss, see: Zach Graves and Daniel Schuman, "The Decline Of Congressional Expertise Explained In 10 Charts," *Techdirt*, October 18, 2018. https://www.techdirt.com/articles/20181018/10204640869/decline-congressional-expertise-explained-10-charts.shtml.

[2] Zach Graves and M. Anthony Mills, "Reviving Expertise in a Populist Age," *The New Atlantis*, Fall 2019. https://www.thenewatlantis.com/publications/reviving-expertise-in-a-populist-age.

December 5, 2019

Conservatives and libertarians are, by disposition, skeptical of attempts to strengthen the federal government to advance social ends. And they worry, in particular, that efforts to shore up "neutral expertise" can be cover for outfitting government with more technocratic tools with which to regulate social and economic life. But these arguments, however meritorious in and of themselves, miss the mark—at least when it comes to better equipping Congress.

First, both conservatives and progressives worry about the social and ethical implications of emerging science and technology, although they tend to emphasize different aspects. For instance, where progressives have tended to emphasize the environmental impacts of new technologies or their effects on democracy, social conservatives, increasingly, have tended to worry about the ethics of emerging technologies (the GOP is no longer the uncritical "party of Uber"). Moreover, there are a range of science and technology-related issues that preoccupy those on the right just as much as those on the left, from algorithmic bias and content moderation to genetic engineering. As originally conceived, technology assessment was not simply a matter of providing Congress with more expertise but equipping members with the tools they need to weigh the positives and negatives of emerging technologies and to deliberate about what actions to take, if any, to address harms. Such tools are needed now more than ever.

This leads to a second reason why conservatives and libertarians can and should support strengthening Congress's S&T capacity: Unlike executive agencies staffed by experts, legislative agencies (aside from the Copyright Office) are not regulatory bodies with rulemaking power. As such, a new technology assessment office (or broader S&T capacity enhancement) need not stifle technological innovation, or feed into an unaccountable technocracy. On the contrary, by creating a forum in which a diverse set of stakeholders can grapple with challenges and opportunities posed by science and technology, legislative branch experts might even prevent government from implementing misguided policies or overly burdensome regulations.

Finally—and relatedly—increased S&T capacity in Congress would be (as OTA itself was) directly responsive to Members' and committee's needs. This would help Congress, not just executive agencies, grapple with technical matters and to conduct meaningful oversight of the so-called administrative state.[3] In so doing, not only would this shift deliberation over science and technology-related issues back into the legislature, where it can be more democratically accountable, it would also help restore Congress's rightful role as a coequal branch of government.

Sincerely,

M. Anthony Mills
Director of Science Policy, R Street Institute

Zach Graves
Head of Policy, Lincoln Network

[3] Conservatives have long sought to limit what can be delegated to agencies, which would require a significant new investment in Congress. See, e.g. Berin Szoka, "Technical Expertise Is Just the Tip of the Iceberg," *Cato Unbound*, June 21, 2019. https://www.cato-unbound.org/2019/06/21/berin-szoka/technical-expertise-just-tip-iceberg.

REPORT SUBMITTED BY REPRESENTATIVE BILL FOSTER

Evaluating the 2019 NAPA Report on S&T Policy Assessment and Resources for Congress

Zach Graves & Daniel Schuman | December 3, 2019

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The authors would like to thank Adam Keiper for editing this paper, as well as Peter Blair, Robert Cook-Deegan, Kevin Kosar, and others who gave feedback as it was being drafted.

NAPA Report Summary

Congress directed that the Congressional Research Service engage an external entity to create a report on science and technology (S&T) expertise and capacity in Congress. This requirement, embedded in the FY 2019 Legislative Branch Appropriations bill,[1] arose from a bipartisan effort by Rep. Tim Ryan (D-Ohio) and then-Legislative Branch Appropriations Subcommittee chairman Kevin Yoder (R-Kans.), and was subsequently supported in the Senate. In early 2018, we both advocated for a study to be undertaken, and one of us testified[2] in favor of the study. As a result, CRS awarded a contract to the National Academy of Public Administration (NAPA),[3] which produced a report in October 2019.[4]

NAPA was instructed to meet three goals:[5]

1. Produce a report detailing the current resources available to Members of Congress within the Legislative Branch regarding science and technology policy, including GAO.

2. 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).

3. Address whether the creation of a separate entity would duplicate services already available to Members of Congress.

With respect to Congress's S&T support capacity, the NAPA report identified a gap in "horizon scanning"—that is, identifying emerging trends and opportunities. The report also identified modest gaps (which are partially served by current entities) in the areas of short-to-medium-term studies and analysis, external expert networking, and consultative services. After documenting these gaps, the report set forth three primary options for addressing them:

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

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[1] Joint Explanatory Statement for H.R. 5895, 115th Congress. https://www.appropriations.senate.gov/imo/media/doc/Joint%20Explanatory%20Statement%20H.R.%205895.pdf.

[2] Zach Graves, "Testimony before the U.S. House of Representatives, Committee on Appropriations, Legislative Branch Subcommittee," R Street Institute, April 17, 2018. https://www.rstreet.org/2018/04/17/zach-graves-testimony-before-the-u-s-house-of-representatives-committee-on-appropriations-legislative-branch-subcommittee/.

[3] NAPA has a history of working on this issue, having authored one of the early reports to Congress on technology assessment in 1970.

[4] "Science and Technology Policy Assessment: A Congressionally Directed Review," National Academy of Public Administration, October 31, 2019. https://www.napawash.org/uploads/Academy_Studies/NAPA_FinalReport_forCRS_110119.pdf.

[5] Note that this list and the three subsequent numbered lists below quote directly from the NAPA report's executive summary, pp. viii-xi.

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

Importantly, NAPA did *not* evaluate whether to restart OTA as currently authorized. Instead, the authors of the NAPA report assumed the technology assessment function would be covered by GAO's STAA program. The new agency proposed in NAPA's option #2 would be oriented to addressing identified gaps for short- and medium-term analysis (1-12 months) and horizon scanning, and would "serve all Members and staffs of Congress" rather than just committees.[6]

These options were evaluated based on three criteria, identified by NAPA:

1. ***Desirability:*** How well does it meet customer needs?

2. ***Feasibility:*** How difficult it is to implement? [Includes startup costs and time to full implementation.]

3. ***Viability:*** How likely is it to succeed in the long term? [Includes political durability and potential to duplicate work done by other entities.]

Based on those criteria, the three options were scored by NAPA as follows:[7]

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

Given this analysis, NAPA recommended the third option, enhancing existing entities and creating a new advisory office. In pursuit of this recommendation, NAPA called for the following specific actions:

[6] NAPA, p. 46.
[7] NAPA, p. 43.

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 [the NAPA] 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 [National Academies of Science, Engineering, and Medicine] ex officio member with the objective to limit duplication and coordinate available resources to most benefit the Congress.

Takeaway Points From the NAPA Report

Congress's S&T capacity gap is broader than TA

The NAPA report does a good job of addressing the first goal of the study—detailing the current resources available to Congress—particularly with respect to framing the context of Congress's historic decline of staff capacity and expertise.[8] Additionally, the report correctly frames the challenge as not just building expertise in support agencies like OTA, CRS, or GAO but also developing absorptive capacity in committees and personal offices, and changing political structures and incentives to promote more thoughtful deliberation. (The concept of "absorptive capacity" is discussed in the recent Belfer Center report.[9]) Thus, creating capacity for technology assessment is a necessary but not sufficient condition to address Congress's broader S&T expertise gap. More S&T experts, and staff to support and make use of them, are needed across the institution in various roles.

Congress needs a funding increase to boost S&T capacity

While the politics of the 302(b) allocation for the legislative branch are challenging, particularly for conservatives, it is increasingly clear that Congress needs a substantial boost to augment the

[8] To understand Congress's drastic expertise and capacity decline since the 1990s, see: Zach Graves and Daniel Schuman, "The Decline Of Congressional Expertise Explained In 10 Charts," *Techdirt*, October 18, 2018. https://www.techdirt.com/articles/20181018/10204640869/decline-congressional-expertise-explained-10-charts.shtml.

[9] Laura Manley, Ash Carter, et al., "Building a 21st Century Congress: Improving Congress's Science and Technology Expertise," Harvard Kennedy School, September, 2019. https://www.belfercenter.org/publication/building-21st-century-congress-improving-congresss-science-and-technology-expertise.

number and quality of full-time equivalent (FTE) staff across its support agencies, committees, and personal offices.

New authorizing legislation and hearings are needed

The NAPA report acknowledges that much can be done with existing authorities and through the appropriations process, but also recommends comprehensive new authorizing legislation and related hearings to educate Members and communicate the importance of S&T issues to the public. We agree.

GAO will play a prominent role

GAO has recently scaled up its capacity for technology assessment and other S&T functions to advise Congress. Future discussions of augmenting congressional S&T capacity, including reviving OTA, must include a prominent role for GAO to help fill this gap. This is also appropriate for GAO, as oversight of federal programs and expenditures increasingly requires scientific and technical insights. And STAA is already doing important work beyond the scope of OTA's mission.[10]

We also agree with NAPA that some STAA products could benefit from a more intensive expert-review process, and broader stakeholder engagement in the S&T community. That said, we think they deserve high marks so far for outreach and transparency.

While there is some uncertainty whether GAO's culture will be able to adapt to effectively cover the full range of OTA's work (particularly that part concerning non-technical values and horizon scanning), GAO should be given the opportunity to succeed—including additional resources and potentially new authorizing legislation (which NAPA suggests). Along these lines, we think there are valuable lessons from the "Center for Scientific and Technical Assessment" proposal from former Reps. Rush Holt and Amo Houghton, which sought to adapt OTA structural features onto a GAO-based technology assessment unit.[11]

What Needs Additional Evaluation

Insufficient analysis on reviving and modernizing OTA

As mentioned above, none of the options presented by NAPA explicitly includes the possibility of reviving OTA, and the report assumes that STAA will be the primary entity serving this function. NAPA may have considered revising OTA as part of its deliberations, but those deliberations do not appear in the report. This is unfortunate, as the desirability of reviving OTA is clearly a live issue in Congress. In particular, there has been recent congressional interest in pursuing a hybrid approach

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[10] See, e.g., Dan Lips, "Modernizing oversight to improve government efficiency and accountability," Legbranch.org, November 26, 2019. https://www.legbranch.org/modernizing-oversight-to-improve-government-efficiency-and-accountability/.

[11] See: H.R.4670, 108th Congress. https://www.congress.gov/bill/108th-congress/house-bill/4670; Also see the subsequent 2005 draft, which incorporated feedback from then-Comptroller General David M. Walker: https://github.com/zachgraves/futurecongress/blob/master/CSTA%20draft%202005.pdf.

that includes both OTA and STAA.[12] Additionally, while there is still some anxiety among Republicans about OTA, the political factors that led to its defunding are largely no longer relevant.

Underdeveloped political landscape analysis

A fundamental weakness of the NAPA report is how it assesses the political landscape. While NAPA was not explicitly directed by Congress to evaluate political considerations for building S&T capacity, political considerations are built into the report's analysis anyway, in the form of the "viability" and "feasibility" factors used to evaluate the different options. It is worth looking closely at each of these factors, to see what the report's analysis missed. Notably, there is a lack of detail regarding resource requirements and no analysis of broader legislative branch appropriations questions. Also,

On feasibility

Per NAPA, "feasibility" is determined by startup and implementation costs, as well as time to implementation.[13] Here is how the report estimates those costs for each of the three options under consideration:

> **Option #1: Enhance Existing Entities:** High feasibility. $1-2 million cost.
>
> **Option #2: Create a New Agency:** Medium feasibility. $8-10 million cost.
>
> **Option #3: Enhance Existing Entities and Create an Advisory Office:** Medium feasibility. $8-10 million cost.

These funding thresholds seem arbitrary and lack explanation in the report. Looking closely, these numbers also don't seem to match up to real-world details. The resources needed to expand capacity at GAO and CRS (options #1 and #3) will significantly exceed $1-2 million. The strategic plan for GAO's STAA program alone describes a planned increase from 70 FTE staffers to 140 FTE staffers in the coming years, increasing the program's salary and benefits cost from $15 million to $30 million annually.[14]

To suggest, as the NAPA report seems to do, that the STAA program as it currently exists can fill the gap for technology assessment left by OTA's defunding is a mistake. Given that about a third of STAA's FTE staffers are dedicated to technology assessment, doubling the program's staff would still leave it short of OTA's capacity: OTA had a permanent staff of 143, with another 60 or so contractors and a budget of $37 million in today's dollars. To approach OTA's capacity for

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[12] See: "Technology assessment: Legislative activity," FutureCongress Wiki. https://github.com/zachgraves/futurecongress/wiki/Technology-assessment:-Legislative-activity.
[13] NAPA, p. 42.
[14] "GAO Science, Technology Assessment, and Analytics Team: Initial Plan and Considerations Moving Forward," Government Accountability Office, April 10, 2019. https://www.gao.gov/pdfs/about/GAOScienceTechPlan-2019-04-10.pdf.

technology assessment—not to mention to fill the other gaps the NAPA report identifies—STAA would need a more significant expansion of resources than the NAPA report calls for. (We do not opine on whether the staff size is appropriate to meet today's needs.)

If you add the proposed Office of the Congressional S&T Advisor on top of the STAA (per option #3), that is another $5 million in initial costs.[15] Even without a similar capacity increase at CRS, NAPA appears to have significantly underestimated the costs of enhancing existing entities and thus the political feasibility of doing so. This is to say nothing of the suggested improvements in absorptive capacity among committees and personal offices, which would likely be quite costly. Kicking the can down the road to another study to determine right staffing levels—as the NAPA report does—further undermines the report's feasibility analysis.

Also insufficiently considered in the NAPA report: The type of legislative action that would be required to implement each of the options. *Appropriations* bills are enacted annually to fund the legislative branch; they also provide a regular vehicle for small changes. By comparison, *authorizing* language is enacted infrequently and involves a different set of committees (and is thus more politically challenging). Pursuing new authorizing legislation (as would likely be required by options #2 and #3) could entail a long and onerous process. (By way of comparison, the passage of OTA's authorizing bill took nearly a decade from its initial conception.) Appropriators have shown some interest in expanding STAA and in reimagining OTA. But it is unclear how they would view OCSTA (or any other new entity) that would be created by a different set of committees with different priorities from the Members who requested the NAPA report.

On viability

Per NAPA, "viability" entails political resilience as well as potential for duplication of work done by other entities. On political resilience, one of the perceived weaknesses of OTA was its lack of support among rank-and-file Members of Congress, since it primarily served committees. Yet the NAPA report recommends that GAO continue to use its existing congressional protocols for requesting technology assessments—meaning that STAA will continue to primarily work for committees, rather than meet broader congressional demand for S&T analysis. This risks creating the same vulnerability for STAA as beset OTA. It would have been beneficial for NAPA to give greater consideration to ensuring that all Members of Congress are able to benefit from STAA's expertise, including mechanisms by which Members can have their requests addressed (even if focused on quick turnaround and short- and medium-term products).

With respect to duplication, while the NAPA report looks at the work of the National Academies of Science, Engineering, and Medicine, it does not sufficiently consider other external sources of S&T expertise. As discussed below, we are also concerned that the report treats different kinds of expertise functions interchangeably.

[15] NAPA, p. 55.

In addition, the NAPA report does not consider how a legislative agency's governance can be structured to shield S&T analysts from political criticism. OTA was governed by a bipartisan, bicameral board that signed off on all technology assessments and acted as a barrier against attacks on the agency. While this structure ultimately failed to prevent the defunding of OTA, it did create a base of bipartisan support that nearly saved it. On the other hand, a small office like OCSTA is unlikely to build a broader support base than OTA, and may be even more politically vulnerable without such a bipartisan governing structure. STAA may also benefit from a bipartisan governing board, even if it were more advisory than OTA's (see footnote 11).

Missing critical analysis of CRS

The NAPA report recommends beefing up CRS in several areas. However, the report does not assess CRS's current capacity for S&T work versus the volume and type of congressional demands. Additionally, while the report does a good job reviewing literature and documenting stakeholder perspectives about GAO's institutional and cultural challenges, there is no similar analysis of challenges at CRS—despite growing concerns about CRS's management and the changing nature of its analytic culture.

On the management challenges, the R Street Institute's Kevin Kosar, who served at the agency for a decade, has described CRS's culture as "remarkably risk-averse," and increasingly politicized, which has led to a loss of talent.[16] With respect to its analytic culture, CRS's Susan Thaul testified earlier this year about a watering-down of CRS reports and a downgrading of expertise for those who work at the service.[17]

> Management fear of Member objections overrode the nonpartisan, expert analysis and judgment of their analysts.... In some cases, analysts are prevented ... from synthesizing new perspectives on issues, and are told to instead focus only on what others have said.

This trend runs counter to the idea that CRS can take a stronger leading role in science and technology analysis. In addition, Dr. Thaul raised the alarm on hiring at CRS. "[T]here has been an increasing trend away from more experienced and mid-career hires who may have substantial experience in the industries, organizations, and agencies that are the focus of congressional actions." Other experts on CRS, such as Louis Fisher, submitted testimony on how CRS has transmuted its policy of nonpartisan advice to neutrality, which, in his view, has undermined its analytical capabilities.[18]

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[16] Kevin Kosar, "Why I Quit the Congressional Research Service," *Washington Monthly*, January/February 2015. https://washingtonmonthly.com/magazine/janfeb-2015/why-i-quit-the-congressional-research-service/.
[17] Susan Thaul, "Written Statement to the Committee on House Administration at its hearing on 'Oversight of the Congressional Research Service,'" June 20, 2019. https://docs.house.gov/meetings/HA/HA00/20190620/109663/HHRG-116-HA00-Wstate-ThaulPhDS-20190620.pdf.
[18] Louis Fisher, " Statement to the Committee on House Administration at its hearing on 'Oversight of the Congressional Research Service,'" July 20, 2019. https://www.legbranch.org/app/uploads/2019/06/Fisher-testimony-Oversight-of-CRS-06-20-2019.pdf.

Clearly, not all reports—or analysts—are created equal. A short briefing paper from a senior specialist with decades of experience is far different from an early-career analyst performing an uncritical literature review and summary. At OTA, the process of long-form technology assessments created a deep level of in-house staff expertise that made possible a much higher quality of consultative expertise, as well as the ability to produce high-quality briefing papers with a quick turnaround. Unfortunately, the NAPA report seems to treat analytic products of similar length interchangeably, and overlooks the cultural and management problems at CRS. This also calls into question whether NAPA's taxonomy of S&T advice is overly focused on factors such as the number of pages and time frame for delivery. There are additional factors that are important to Congress, such as authoritativeness, relevance, and focus.

It would be prudent to have a more detailed understanding of CRS's institutional challenges prior to making a significant new investment in CRS. For instance, should resources be focused on increasing the number of FTE staffers? Or improving the seniority and tenure of analysts? Are there cultural and management issues that should be addressed first?

Coordination among advisory agencies

The NAPA report raised questions about how CRS, GAO, and the National Academies could coordinate approaches to issues of congressional interest. This subject could have used additional exploration. We note, for example, that NAPA appears to have had difficulty getting the full picture of CRS's work: "Because the CRS's work in response to congressional requests is largely confidential, our analysis of the CRS's consultative and quick turnaround products and services was constrained."[19] A more thorough understanding of the confidential requests made to CRS could have helped inform the kinds of outputs NAPA would like to see from a new S&T-focused entity. We cannot help but wonder whether the OCSTA, the coordinating office proposed by the NAPA report, would encounter difficulty in collaborating with CRS management.

Making expertise customer-oriented

Unaddressed by the report is the congressional user's perspective when requesting science and technology assessments and attempting to find information about final reports. If various analyses are conducted by CRS, GAO, and OCSTA, where do you look to find that information? Do they reference each other? Is there a unified web page that pulls together all the reports? Should STAA or CRS have a "Wikipedian in Residence"?[20] Should it make use of blogs, social media, and podcasts? In addition, how are these products requested? Does the staffer have to know which agency to contact or is there a one-stop shop that sorts it out? More thought must be placed into generating a seamless user experience for staff to ask questions and find resources.

Learning from international models

NAPA briefly and superficially mentioned some of the OTA-like entities that exist internationally and support their local parliaments. It would be worth addressing U.S. participation with

[19] NAPA, p. 31.
[20] "Wikipedian in Residence," Wikimedia Outreach Wiki. https://outreach.wikimedia.org/wiki/Wikipedian_in_Residence.

international bodies (such as through the EPTA Network) that also engage in this work, including learning from their experiences and collaborating on joint projects.[21]

Insufficient detail about institutional design for OCSTA

With respect to the NAPA report's proposed recommendation to create a new coordinating and horizon scanning entity, the report's authors leave out many critical features of how it would work. A number of questions need to be resolved before the viability and usefulness to Congress of the OCSTA proposal can be established:

- ***How will OCSTA pick topics?*** While OTA had a bipartisan, bicameral Technology Assessment Board, CRS responds to individual Member requests, and GAO has its congressional protocols, it is unclear how OCSTA would determine the topics for its horizon scanning work. Lack of congressional buy-in for such a new agency may prove to be a political liability that pushes it either into political peril or to extreme risk aversion.

- ***How will OCSTA integrate new resources into committees?*** NAPA proposed that its newly created OCSTA would play a role in placing staff inside congressional committees and would apparently serve as a funding mechanism. In theory, this could be a welcome way to get around limited committee allotments, but in practice it raises additional questions. The current technology fellows on Capitol Hill are used unevenly, with some committees making use of the fellows' expertise and others marginalizing them. How would OCSTA hire for fit with a committee and make sure a given fellow would be able to become a trusted member of the team and stay in place long enough to do productive work? How many committees would be served? Could these fellows be placed elsewhere? What would it cost? Who pays?

- ***How will OCSTA engage in horizon scanning?*** OCSTA's use of contractors to conduct horizon scanning—as proposed by the NAPA report—is concerning. This suggestion could lead to inconsistent analysis over time, the possibility of insufficient expertise in meeting the needs of Congress, a disconnect between analysts and the offices they serve, and potential funding limitations undermining the scope and rigor of the work product. The report does not sufficiently explore these tradeoffs.

- ***What would new authorizing legislation look like?*** While the NAPA report outlines a pilot for OCSTA starting with 10 FTE staffers and $5 million, it gives few details as to the office's oversight, statutory powers, or mechanism to coordinate with other support agencies or fellowship programs.

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[21] European Parliamentary Technology Assessment (EPTA) Network. https://eptanetwork.org/about/about-epta/members-and-projects; Notably, STAA is an associate member.

- ***Is OCSTA the right place for horizon scanning?*** If OCSTA's primary role is a coordinating entity, it's not clear that it—in the form imagined in the NAPA report—should take on the horizon scanning function (and its political liability).

Additional Resources

- Zach Graves and Daniel Schuman, "Fact Sheet: The Office of Technology Assessment," Lincoln Network and Demand Progress. https://lincolnpolicy.org/wp-content/uploads/2019/12/TA.pdf.
- Adam Keiper, "Science and Congress," *The New Atlantis*, Fall 2004-Winter 2005. https://www.thenewatlantis.com/publications/science-and-congress.
- Zach Graves and Daniel Schuman, "Science, Technology, and Democracy: Building a Modern Congressional Technology Assessment Office," Harvard Ash Center, Winter 2019-2020 (forthcoming).
- Zach Graves and Tony Mills, "Reviving Expertise in a Populist Age," *The New Atlantis*, Fall 2019. https://www.thenewatlantis.com/publications/reviving-expertise-in-a-populist-age.
- Peter Blair, *Congress's Own Think Tank.*
- M. Granger Morgan and Jon Peha, *Science and Technology Advice for Congress.*
- "Science & Technology Assessment Forum," Google Groups. https://groups.google.com/forum/#!forum/revive-ta.

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EXECUTIVE SUMMARY OF A REPORT SUBMITTED BY THE HON. MICHAEL MCCORD

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.

[For full report, see https://www.napawash.org/uploads/Academy-Studies/NAPA-FinalReport-forCRS-110119.pdf]

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