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THE VITAL ROLE OF THE WHITE HOUSE OFFICE OF SCIENCE AND TECHNOLOGY POLICY IN THE NEW ADMINISTRATION

Recommendations from Rice University's Baker Institute for Public Policy
Science and Technology Policy Program

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Science and Technology Advice to the President

Innovation, a hallmark of 21st century private industry in the United States and around the world, relies on a skilled and diverse workforce as well as advances in science and technology (S&T) made possible by strong public and private investments in research and development (R&D) [1-3]. The influence and products of S&T are present in almost every aspect of daily life. Wise government policies, forward-looking S&T investments, and broadened participation of women and underrepresented minority men and women in science, technology, engineering, and mathematics (STEM) and related fields will provide jobs and economic opportunity and continue to improve the well-being of individuals at home and abroad.

Many existing challenges and unforeseen crises will require an increased understanding of the science behind their causes and rely on new technologies to provide innovative solutions. The next administration will need to address a number of public policy challenges necessitating immediate S&T expertise, including emerging infectious diseases (such as Zika); chronic diseases impacting the future health of our aging population (such as cancer, heart disease, stroke, diabetes, dementia, Alzheimer's, and Parkinson's disease); environmental concerns (such as clean water and air quality); food security; and security threats to Americans (including terrorism, cyber-attacks, identity theft, and natural disasters). S&T alone will not solve these problems, but without new scientific knowledge and technological innovation, and sensible government policies, progress will be slow.

Since the new administration will immediately be faced with a host of challenges requiring timely S&T advice, it is important that the President move quickly to appoint a Science Advisor and put together a team for OSTP, ensure that OSTP has the support and access to other White House offices and councils it requires, establish S&T policy priorities, and navigate the ongoing budget process for federal R&D investment.

To ensure the future prosperity of all Americans, particularly those who have been left behind in recent decades, the next administration will be challenged to create new S&T-related policies and initiatives to improve STEM education and training at all levels; support pathbreaking science and engineering research; and unleash the power of private sector innovation through partnerships with states, universities, national laboratories, and private industry [4-7].

The President's decisions that relate to S&T rely, in large part, on information—data and analysis—from the Office of Science and Technology Policy (OSTP) and, specifically, on advice from the President's Science Advisor. The presidential transition is a critical period for ensuring S&T is responsibly and effectively represented in policymaking in the White House.ⁱ

i In this report, we intend S&T to be interpreted broadly by including R&D, mission agency applications, and policies related to private sector innovation, such as taxes, regulation, and government-industry joint activities. Science, technology, and innovation could be used to capture this scope, but we will stay with the more traditional S&T, which is explicit in legislation.

A large number of federal agencies do the work of the government, and S&T underpins everything they do. But it is the responsibility of OSTP to ensure the federal S&T effort as a whole is greater than the individual contributions of any one agency. It is the one place in the federal government that focuses on the efficiency and impact of the collective federal S&T effort. OSTP coordinates interagency R&D—including such areas as nanotechnology, climate change, and genomics—while keeping the President and Congress informed on the health of America's S&T enterprise and how the United States compares in this regard with the rest of the world. Coordination of agencies' S&T efforts is especially important during times of crisis: disease outbreaks, nuclear accidents, natural disasters, terrorist attacks, and other emergencies when a quick federal response is essential to inform and protect the public.

The President receives plenty of advice: from Cabinet Secretaries, heads of other agencies, and many other quarters. But the Science Advisor is one person the President can rely on for the most unbiased advice on issues related to S&T. In most recent administrations, the Science Advisor (the historical, informal title) has held the official title of "Assistant to the President for Science and Technology," reporting directly to the President [8-10]. This title is analogous to other senior presidential advisors who serve in the White House. The Science Advisor also serves as head of a legislatively established office, holding the title of "Director of OSTP," a position requiring Senate confirmation.

While science advice to the President arguably dates back to Vannevar Bush and the administrations of Franklin D. Roosevelt and Harry Truman, OSTP was formally created by the National Science and Technology Policy, Organization, and Priorities Act of 1976 (P.L. 94-282) under President Gerald Ford in an effort to ensure that the President always has access to the

U.S. Presidents on the Importance of S&T [16-19]

"There are those who say we cannot afford to invest in science... I fundamentally disagree. Science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been before."

—*President Barack Obama, 2009*

"With more research in both the public and private sectors, we will improve our quality of life and ensure that America will lead the world in opportunity and innovation for decades to come."

—*President George W. Bush, 2006*

"We have to do a better job of explaining the contribution that science and technology can make to saving the planet and allowing us to still have prosperous lives."

—*President Bill Clinton, 2000*

"On issues ranging from climate change to AIDS research to genetic engineering to food additives, government relies on the impartial perspective of science for guidance."

—*President George H.W. Bush, 1990*

The National Science and Technology Policy, Organization, and Priorities Act of 1976 [9, 20]

P.L. 94-282 mandates OSTP to:

- Serve as a source of S&T analysis and judgment for the President with respect to major policies, plans, and programs of the federal government.
- Advise the President and others within the Executive Office of the President on the impacts of S&T on domestic and international affairs.
- Lead an interagency effort to develop and implement sound S&T policies and budgets.
- Work with the private sector to ensure federal investments in S&T contribute to economic prosperity, environmental quality, and national security.
- Build strong partnerships among federal, state, and local governments, other countries, and the scientific community.
- Evaluate the scale, quality, and effectiveness of the federal S&T effort.

best S&T advice [9, 11-15]. The statute provides the President with flexibility in organizing OSTP's structure and managing its operations. It authorizes the appointment of up to four Associate Directors, in addition to the aforementioned Director; all require Senate confirmation. OSTP also maintains support and professional staffs to carry out the work of the office. OSTP is additionally supported by detailees—professional and technical staff members on loan from other federal agencies and funded by those agencies—as well as scientists and engineers holding fellowships or supported by their home universities through the Intergovernmental Personnel Act (IPA). While legislation and executive orders have added tasks and responsibilities to OSTP, its mission has remained unaltered.

In addition to managing OSTP, the President's Science Advisor plays key roles in two other national bodies that inform and guide S&T policy: the President's Council of Advisors on Science and Technology (PCAST) and the National Science and Technology Council (NSTC). PCAST is an advisory body, established by Executive Order, composed of leaders in S&T appointed by the President and co-chaired by the Science Advisor.ⁱⁱ NSTC is a high-level council, established by Executive Order, chaired by the President and includes the Vice President, Cabinet Secretaries whose Executive Departments have significant S&T responsibilities, as well as the heads of several federal agencies that support significant R&D. The principal function of NSTC is coordination across the federal S&T enterprise.ⁱⁱⁱ

ii The first Executive Order for PCAST was issued by President George W. Bush (EO 13226) on September 30, 2001. President Barack Obama reestablished PCAST with EO 13539 on April 21, 2010, with the Science Advisor and one non-federal member as co-chairs, for a total of 21 members. EO 13596, issued December 19, 2011, switched funding of PCAST to the Department of Energy (DOE).

iii NSTC operates under EO 12881 from November 23, 1993, issued by President Bill Clinton.

Many U.S. Presidents have assigned a particularly high priority to S&T policy issues, appointing the Science Advisor early in the administration; consulting regularly with the Science Advisor on issues that relate to S&T policy; housing OSTP staff in the Dwight David Eisenhower Executive Office Building; and including the Science Advisor in Cabinet and other high-level meetings [15, 21-26].

In this report, we offer 10 recommendations in two categories: advice for the President in selecting a Science Advisor, establishing OSTP, and developing federal S&T policies; and advice for the President's Science Advisor in the dual roles as Assistant to the President for S&T and Director of OSTP.

Recommendations to the President of the United States

The following recommendations are offered for the President's consideration:

Recommendation 1: Select, early in the post-election transition period, a nationally respected scientist or engineer to serve as Science Advisor and Assistant to the President for S&T. Once in office, the President should nominate her or him for the position of Director of OSTP. This should take place in the same time frame as the appointment of Cabinet Secretaries, the Director of the Office of Management and Budget (OMB), and other high-level officials in the Executive Office of the President (EOP). As is the case with other senior aides, the Science Advisor must be an individual who has the trust and respect of the President [27-30].

Presidents have historically benefitted by receiving advice on appropriate candidates for Science Advisor from the nation's S&T leaders, through organizations such as the National Academies of Sciences, Engineering, and Medicine (NA-SEM) and other professional organizations and individuals.^{iv} In the past, most Science Advisors have held advanced degrees in their fields [10].

Recommendation 2: Direct the Office of Presidential Personnel to seek the advice of the Science Advisor in filling the many sub-Cabinet and other senior agency positions that relate to S&T, e.g., the directors of the National Science Foundation (NSF), National Institutes of

Qualifications for the Role of Science Advisor

- National recognition and respect as a leader in science and engineering
 - Extensive knowledge of the federal government and global S&T policy experience
 - Strong connections to the S&T community
 - Established leadership, communication, diplomatic, political, and management skills
-

iv Examples of such organizations include the American Association for the Advancement of Science (AAAS), the Association of American Universities (AAU), and the Association of Public and Land-Grant Universities (APLU).

Health (NIH), National Institute for Standards and Technology (NIST), administrators of the National Aeronautics and Space Administration (NASA) and National Ocean and Atmospheric Administration (NOAA), as well as many other presidential appointees with major S&T-related responsibilities in the federal government, including S&T-related senior positions in OMB.^v

Recommendation 3: Ensure that OSTP has the leadership, access, structure, and resources to enhance the integration of S&T advice in federal policymaking within the EOP and, as appropriate, across the federal agencies.

- a. Direct the appropriate White House officials to ensure that the OSTP Director and staff continue to be fully housed in the Dwight D. Eisenhower Executive Office Building. This proximity better enables OSTP staff to support the work of other White House offices and advise the President.
- b. Nominate four OSTP Associate Directors (ADs), with advice from the Science Advisor, as soon as possible and determine the focus and structure of OSTP.
 - The statutes do not prescribe the OSTP structure. However, an organization with four divisions has been the norm, with the Senate-confirmed ADs serving as division heads.^{vi}
 - The President may wish to also appoint OSTP ADs as Deputy or Special Assistants to the President so they can immediately begin to work full-time at OSTP as they await Senate confirmation.
 - In the appointment of OSTP senior leadership, consideration should be given to leaders within the S&T and innovation community with management experience and knowledge of the operations of the EOP [33, 34].
- c. Clarify the role and responsibilities of the Chief Technology Officer (CTO). One option is for the CTO to be jointly appointed as an OSTP AD, with Senate confirmation, and report to the OSTP Director.^{vii} This position should be coordinated with the Chief Information Officer (CIO) currently housed in OMB and the OSTP AD for Technology, if the CTO does not hold this title [35].
- d. Ensure the Science Advisor is included in all Cabinet meetings attended by other Assistants to the President, as well as meetings of the National Security Council (NSC) and other high-level meetings, particularly when issues related to S&T are likely to be discussed. In considering possible appointments to the Cabinet beyond the statutory members (Vice President, heads of the 15 Executive Departments, and the Attorney

v For a full list of positions, consult NA-SEM's 2008 report *Science and Technology for America's Progress: Ensuring the Best Presidential Appointments in the New Administration* [31].

vi In the Obama administration, the four OSTP divisions are: Science, Technology and Innovation, National Security and International Affairs, and Environment and Energy. The administrations of Presidents Bill Clinton and George H.W. Bush administrations used a similar structure although specific titles and responsibilities have varied, while the George W. Bush administration had only two divisions: Science and Technology [8, 9, 32].

vii The first CTO was appointed in 2009 and served as both an Assistant to the President and as the Senate-confirmed AD for Technology. The two subsequent CTOs have served only as Assistants to the President, maintaining executive privilege. During this time, the AD for Technology position has remained vacant, and its responsibilities have been partially transferred to the Deputy Director for Technology [35, 36].

General), the President may wish to appoint the Science Advisor, given the importance of S&T across the federal government.

- e. Direct all White House budget and policymaking entities—especially OMB, NSC, National Economic Council (NEC), Domestic Policy Council (DPC), and Council on Environmental Quality (CEQ)—to collaborate closely with OSTP on a broad range of policies that have an S&T component. Ideally, for White House councils, this would involve joint appointments at the level of the OSTP Director, ADs, and other senior staff reporting to the Director.^{viii}
- f. Include in the annual budget request to Congress adequate funding for OSTP to retain a sufficient number of knowledgeable and well-trained full-time staff members—professional and administrative—necessary to handle the increased workload as well as ensure continuity between administrations.^{ix} This will allow for a reduction in the number of short-term agency detailees within the office [28, 37, 38].^x

Recommendation 4: Consult with the Science Advisor to quickly appoint a diverse membership of PCAST, including accomplished individuals—women, men, under-represented minorities, and persons with disabilities—who are nationally respected leaders in S&T, including professionals with experience at research universities, national laboratories, institutes or centers, business and industry, not-for-profit foundations, federal government, military service, and other domestic and international sectors that have strong S&T components. Early in the administration, the President should establish a practice of regularly meeting with PCAST and charging PCAST to carry out studies and issue reports on topics that the President considers particularly important to the nation.

Recommendation 5: Renew the existing Executive Order for NSTC, or develop a presidential directive detailing its operations, and charge OSTP, in consultation with OMB, PCAST, and the NSTC Cabinet Secretaries and agency heads to:

- a. Draft a strategy paper outlining the administration's S&T and innovation goals—containing priorities and measurable objectives—to be released in the first 100 days.

viii President Obama organized joint appointments for ADs and the CTO through Executive Order and included language in an early Presidential Policy Directive to include the Science Advisor in all NSC meetings where issues related to S&T are on the agenda.

ix Major OSTP responsibilities include implementation of the President's policy objectives; budget planning for R&D funding agencies; advising the President on federal regulations that relate to S&T and innovation; required reports to Congress; management of the NSTC and staff support for PCAST.

x In 2016, OSTP has a staff of approximately 120 people. This includes approximately 30 political and career staff (full-time employees paid by OSTP), 60 detailees from other federal agencies, 10 IPA appointees, and 20 fellows funded by various non-government organizations [9]. While the number of full-time OSTP staff has remained relatively constant in recent years, the number of individuals on detail from other agencies has grown much larger than the historical average, reflecting an increase in workload. Detailees who understand the workings of the various federal agencies and who have necessary policy expertise are vital to the effectiveness of OSTP. But as the OSTP portfolio increases, the agency will require additional budgeted staff positions who can serve as stays between administrations, versus short-term appointments.

- b. Organize and oversee a multi-year planning process to monitor progress and ensure that the administration's S&T and innovation objectives are met [39].
- c. Prepare action agendas for semi-annual meetings of the NSTC principals, chaired by the President, to review progress in implementing the administration's S&T and innovation strategy [29, 30, 40-41].
- d. Develop policy options for the President's consideration, including interagency initiatives; convene meetings of S&T agencies and non-government experts; and draft relevant Executive Orders and presidential directives to move the President's S&T and innovation agenda forward [8].

Recommendations to the President's Science Advisor

In most recent administrations, the President's Science Advisor has held two titles and two appointments.

As Assistant to the President for S&T, the Science Advisor is one of the President's senior aides, a member of the White House staff, reports directly to the President, provides confidential advice, is protected by executive privilege, and serves as co-chair of PCAST. As a voice for science in the EOP, the Science Advisor is expected to make the arguments for research priorities and funding. But the Science Advisor cannot be seen as the science community's stand-in to boost research budgets [10, 21, 43].

As a voice for science in the EOP, the Science Advisor is expected to make the arguments for research priorities and funding. But the Science Advisor cannot be seen as the science community's stand-in to boost research budgets.

As Director of OSTP, the Science Advisor is the statutory head of a small federal agency, and thus requires Senate confirmation and testifies before Congress. Clearly there is overlap in the two functions and it benefits the S&T community as well as the administration to have the roles performed by one individual. But OSTP management, coordination, appropriate advocacy, and advisory roles can, in theory, conflict [44].

The following recommendations are offered for the President's Science Advisor:

As the Assistant to the President for Science and Technology

Recommendation 6: Provide confidential, unbiased advice to the President that is based on current scientific evidence and technological capability. In the role of Assistant to the President for S&T, she or he must garner the trust and respect not only of the President, Vice President, and Chief of Staff but also of the many other senior advisors and White House staff. This is best done by demonstrating loyalty to the President, protecting confidential information, sharing credit for accomplishments, ensuring that White House colleagues have access to unbiased current information on S&T knowledge as it applies to their areas of responsibility and, most importantly, avoiding the appearance of using a White House

position to advocate on behalf of special interests of the S&T community. In the White House, an effective Science Advisor balances expertise, self-confidence and assertiveness with relevance, collegiality and team spirit. It is desirable to quietly contribute to the achievement of the President's agenda with vision, expertise, and knowledgeable engagement of the relevant agencies [21-26, 45-47].

As Director of OSTP

Recommendation 7: Draft the administration's strategy paper for federal S&T and innovation policy—consulting with the NSTC Cabinet Secretaries and agency heads, OMB, other federal officials, and PCAST—for release in the first 100 days, and oversee an S&T planning effort to ensure that the President's priorities and objectives are met.^{xi}

- a. Organize and oversee a multi-year (2-5 years) planning process in consultation with OMB and the NSTC Cabinet Secretaries and agency heads to monitor progress in meeting the President's S&T priorities, consider course corrections, and draft Presidential Review Directives to develop potential presidential initiatives.
- b. Focus the S&T planning effort on federal funding of basic and applied research, non-defense development, and advanced technology defense development as well as regulatory and management issues that limit the effectiveness of that investment.^{xii}
- c. Develop a road map, as a part of the S&T planning process, for regulatory changes and a process to assess progress [48,49].
- d. Enlist the active involvement of the NSTC Cabinet Secretaries and agency heads in the S&T planning process. Develop action agendas for the President's semi-annual meetings of the NSTC principals to assess progress, revise the plan as needed and deal with any other S&T-related matters that require attention at the President's level. More frequent meetings, chaired by the President or Vice President, could be convened if S&T issues arise that require immediate attention. In the latter case, attendance could be limited to those NSTC principals whose Departments or agencies are directly involved in the issues at hand.

As Director of OSTP, the Science Advisor is the statutory head of a small federal agency, and thus requires Senate confirmation and testifies before Congress.

xi The President may wish to consider setting long-range goals for the nation's investments (public and private) in R&D, as well as the federal component. Several Presidents have stated a goal for the national effort of 3% GDP, but no President has set a federal goal. One report recommends a long-range goal of 0.3% of GDP (an increase from the present level of 0.2%) for federal basic research funding and annual funding increases of at least 4% growth (after inflation) to reach that goal [4]. This level of annual funding is in line with historical trends, from 1975 to 1992, where real growth exceeded 4% (after inflation) for basic research. Applied research is funded at a level similar to that of basic research.

xii The Department of Defense (DOD) R&D includes basic research (6.1), applied research (6.2), and advanced technology development (6.3), but the majority of DOD funding is traditionally allocated to downstream development activities that "focus on moving new technologies from prototypes through production and into operational status in the hands of the warfighter" [54].

- e. Emphasize flexibility in multi-year planning for R&D funding, given the vagaries of the appropriations process as well as unexpected events and opportunities. Detailed planning is likely to be most appropriate for interagency initiatives, and the construction and maintenance of large-scale facilities and instrumentation, especially those that involve several agencies. Consideration should be given to establishing a capital budget for certain R&D investments, particularly those that involve infrastructure.

Recommendation 8: Work with the OMB Director to ensure that in developing the President's annual budget, proper attention is given to the President's S&T strategy and priorities as well as those of the individual Executive Departments and agencies. Also ensure the President has a sense of the priority that the budget in any given year places on S&T, specifically R&D investments, perhaps by sending the President a memorandum that summarizes the collective R&D requests of all agencies [15, 21, 25, 50, 51].

- a. Continue to issue joint annual memorandums from the Directors of OSTP and OMB for the heads of Executive Departments and agencies describing the President's priorities at the start of the budgeting process.
- b. Participate in OMB budget/management reviews to help coordinate efforts and improve the transparency of the budget process.
- c. Coordinate the work of OSTP staff and their OMB counterparts, including the Program Associate Directors (PADs), to help analyze the agency requests and develop agency R&D recommendations for the President.

Recommendation 9: Serve as the President's public face for S&T, nationally and globally, to ensure that the public and Congress, as well as foreign leaders, understand the U.S. perspective on current challenges that relate to S&T policy and the reasons for the choices the President makes [45, 52, 53].

- a. Work closely with the President's media, communications, and legislative staff, and attend, when possible, S&T and innovation outreach events.
- b. Represent the President in the international scientific community on issues related to S&T, such as ministerial bilateral and multilateral meetings related to various international agreements, as well as less formal gatherings, and apprise the President of ways to further advance international cooperation.^{xiii}

Recommendation 10: Ensure that OSTP has the expertise and appropriate access to other federal agencies and officials in OMB and other White House offices to enable the most effective execution of the President's S&T priorities and other activities that are consistent with the agency's statutory responsibilities.

xiii In this role, the Science Advisor should also coordinate with the Science and Technology Advisor to the Secretary of State and the Department of State's Bureau of Oceans and International Environmental and Scientific Affairs (OES) in organizing such meetings and in fostering international S&T partnerships.

- a. In staffing OSTP, recruit experts who understand how the federal government works—including budget and regulatory policies and practices of OMB and the Executive Departments and agencies—have specific technical expertise in important areas of S&T, and are familiar with the major S&T policy issues facing the country.
- b. In recommending OSTP Associate Directors (and Special Assistants or Deputy Assistants to the President, or supervisors with other titles) for presidential appointments, place a high priority on appointing established experts in science, engineering, and technology who not only are well established in their fields and professions but also are experienced managers.
- c. Consider the creation of the position of chief economist within OSTP to engage with other White House policy councils as well as OMB, the Departments of Commerce and Treasury, and other parts of government that focus on S&T and the STEM workforce as they relate to innovation-based economic growth.
- d. Appoint a senior staff member in OSTP, reporting to the director, with the responsibility of ensuring the effectiveness of federal government-university-industry partnerships, giving particular attention to eliminating unnecessary regulations that limit researcher productivity, impose cost burdens on the universities, and impede meaningful university-industry cooperation [4, 48].
- e. In setting the agenda for OSTP, direct OSTP staff to:
 - Work closely with OMB, other White House offices, and agency heads to ensure that the President has timely information on key S&T-related developments, is kept informed of particularly important ongoing policy developments, and is alerted to special opportunities for presidential initiatives, particularly S&T issues that span many federal agencies.
 - Coordinate the development of projects and initiatives proposed by agencies to align them with the President's S&T strategy and PCAST and NSTC reports.
 - Seek the help of non-government bodies with scientific, technical, and policy expertise to conduct timely studies with and in support of OSTP staff and PCAST. OSTP should also review its relationship with the Science and Technology Policy Institute (STPI) and the National Science Board (NSB) to work with these organizations effectively in implementing S&T activities.

Conclusion

Science, technology, and innovation are vital to America's economy, workforce, and the competitiveness of U.S. industry. They assure our nation's security, the quality of our environment, and the safety, health, and overall well-being of the American people.

Considering the many policy challenges that relate to S&T and the accelerating pace of scientific discovery and technological innovation around the globe, it is critically important that the President move quickly to appoint the Science Advisor and organize a capable OSTP that can begin to engage the many Executive Departments and agencies that support R&D and rely on advances in S&T to carry out their missions. It is in this spirit that the above recommendations, based on the informed views of a large number of experts, are offered to underscore sound practices, help identify opportunities for the new administration, and ensure appropriate attention is given to fast-changing S&T and innovation knowledge to ensure its utilization in federal policy decision-making.

The following list is just a sampling of S&T-related policy areas where the Science Advisor and OSTP staff, working with counterparts in OMB and other White House offices, as well as heads of Executive Departments and agencies, might focus their attention. For more comprehensive coverage of key issues, analysis, and recommended policy options, we refer to a selection of authoritative reports in the attached bibliography. We wish to emphasize that this is not a comprehensive list of topics, OSTP responsibilities and activities, or relevant reports. Rather, it is intended as a reminder that S&T policy and the work of OSTP are integral to most of the federal government's responsibilities, and there is an abundance of good, expert advice on how to improve the complex process of federal policymaking.

Science, technology, and innovation are vital to America's economy, workforce, and the competitiveness of U.S. industry.

Research, Discovery, and Innovation

Discoveries and inventions resulting from sustainable federal investments in research and early-stage development carried out in universities and national laboratories and centers are vital elements of the innovation chain leading to economic growth, quality jobs, and other societal benefits. One factor that could hold back progress of U.S. S&T, especially science and engineering research, is the plight of early-career investigators unable to secure funds for their research. The primary role of OSTP is to ensure that the President has accurate information on the state of U.S. S&T and innovation, as well as advice on R&D spending priorities and agency budgets, including ideas for possible presidential S&T initiatives. In addition, OSTP has a role in coordinating interagency activities and supporting efforts by agencies to reform their policies and set funding priorities [2, 4, 5, 55, 56].

Scientific Integrity and Ethics

Confidence in the integrity of the scientific process, inside and outside the federal government, and the ethical behavior of researchers, including reproducibility of scientific data, is essential to the advancement of S&T and critically important to the credible use of scientific evidence in policymaking. A primary role of OSTP is to ensure that federal rules on scientific integrity and ethics are promulgated and enforced by all federal agencies involved in S&T, both at the federal level and at research institutions funded by federal monies [8, 57].

National and Domestic Security

Advanced scientific knowledge and technological capability are essential for protecting the American people at home and abroad. Given the complexity, scope, and level of federal spending devoted to security and public safety, having an advisor who will give confidential, objective advice on S&T-related issues is of vital importance to the President. The nation's ability to protect the American people requires a robust national S&T capability as growing threats are considered across the chemical, cyber, biological, and nuclear spectrum. The role of OSTP is to provide current S&T information and advice to the President on S&T aspects of security and public safety as well as work with the NSC and federal agencies on options for presidential initiatives [58-61].

Science, Technology, Engineering, and Mathematics (STEM) Education and Workforce

The performance of U.S. K-12 students on Program for International Student Assessment (PISA) examinations continues to be disappointing and does not bode well for a U.S. labor market that increasingly requires technical skills. The causes are many, including lack of resources in many communities, but improving the education and in-service training of STEM teachers is essential. In addition, educating and energizing students as they complete STEM degrees—community colleges, four-year colleges and universities—and broadening participation in STEM fields, especially of women and underrepresented minorities, are vital to maintaining the U.S. science and engineering workforce. An important role for OSTP is to promote quality STEM education programs in federal agencies and national labs and to coordinate some of those efforts, while recognizing the value of diverse approaches [6, 62-66].

It is critically important that the President move quickly to appoint the Science Advisor and organize a capable OSTP that can begin to engage the many Executive Departments and agencies that support R&D and rely on advances in S&T to carry out their missions.

Energy and Environment

Meeting the energy needs of the United States and other nations of the world while protecting human health and the world's ecosystem and mitigating climate change is, arguably, the number one challenge of the 21st century. OSTP plays an important role in reviewing pending regulation and coordinating interagency energy R&D efforts and partnerships with

Central Role of the White House OSTP in the U.S. Federal Government

The following figure is just a sampling of the many S&T-related policy areas that will require OSTP involvement.



industry—to develop clean, low-carbon energy technologies, improved climate monitoring and weather prediction systems—as well as promoting international cooperation [67-72].

Health and Medicine

The health and well-being of our nation will require sustained investment in biomedicine as it relates to health care and public health. An essential role of OSTP is to understand how S&T can address, with various stakeholders, health-related challenges to ensure the health of Americans at home and abroad. OSTP should also be involved in the prediction of, and response to, epidemics in coordination with international efforts [73-74].

Food Security and Water

As the Earth's population grows, so too will the need for clean water and high-quality, safe and nutritious food. Policy and technological options of the future will likely differ significantly from those of the present or past due to urbanization and changes in the environment. OSTP plays a central role in understanding the related S&T challenges and, in consultation with relevant agencies and other stakeholders, in developing policy options for the President that address growing domestic and global food and water security challenges [75-78].

Space Science and Exploration

Innovation and knowledge of the origin and workings of the universe have long been advanced by America's leadership in space science, exploration and discovery. OSTP has important roles in coordinating interagency activities and helping to facilitate partnerships between NASA, private industry, and international governments and institutions. Since NASA is an independent agency that is not represented on the President's Cabinet, OSTP provides an important White House contact for the agency in strategic planning (e.g., development of a road map for human exploration) and budget issues. The same is true for the NSF, which supports astronomy and most other fields of space science and earth science, including climate change [79-81].

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References

- [1] National Science Board (NSB). 2016. "Science and Engineering Indicators 2016." Arlington, VA: National Science Foundation (NSF).
- [2] President's Council of Advisors on Science and Technology (PCAST). 2012. "Transformation and Opportunity: The Future of the U.S. Research Enterprise." Washington, D.C.: EOP.
- [3] Council on Competitiveness. 2016. "Work: Thriving in a Turbulent, Technological and Transformed Global Economy." Washington, D.C.: Council on Competitiveness.
- [4] American Academy of Arts and Sciences. 2014. *Restoring the foundation: the vital role of research in preserving the American dream.* Cambridge, MA: American Academy of Arts and Sciences.
- [5] National Academy of Sciences, Engineering, and Medicine (NA-SEM). 2010. *Rising above the Gathering Storm, Revisited: Approaching Category 5.* Washington, D.C.: National Academies Press (NAP).
- [6] NA-SEM. 2007. *Rising above the gathering storm: Energizing and Employing America for a Brighter Economic Future.* Washington, D.C.: NAP.
- [7] Deloitte Touche Tohmatsu Limited. 2016. "2016 Global Manufacturing Competitiveness Index." Washington, D.C.: Deloitte.
- [8] Sargent Jr., John F., and Dana A. Shea. 2014. "The President's Office of Science and Technology Policy: Issues for Congress." Washington, D.C.: Congressional Research Service (CRS).

- [9] Shea, Dana A., and John F. Sargent Jr. 2016. "Office of Science and Technology Policy (OSTP): History and Overview." Washington, D.C.: CRS.
- [10] Lane, Neal F., and Kirstin R.W. Matthews. 2009. "The President's Scientist." *Cell* 139 (5): 847–50.
- [11] Stine, Jeffery K. 1986. "A History of Science Policy in the United States, 1940-1985." Report for the House Committee on Science and Technology, Task Force on Science Policy, 99th Cong., 2nd sess., Committee Print. Washington, D.C.: Government Publishing Office (GPO).
- [12] Blanpied, William A. 2010. *A History of Federal Science Policy from the New Deal to the Present.* Houston, TX: Rice University Press.
- [13] Stever, Guy. 2002. *In War and Peace: My Life in Science and Technology.* Washington, D.C.: Joseph Henry Press.
- [14] Ford, Gerald R. May 11, 1976. "Gerald R. Ford: Remarks Upon Signing the National Science and Technology Policy, Organization, and Priorities Act of 1976." Washington, D.C.: The American Presidency Project.
- [15] Golden, William T., ed. 1993. *Science Advice To The President.* 2nd ed. Washington, D.C.: AAAS Press.
- [16] Obama, Barack. April 27, 2009. "Remarks by the President at the National Academy of Sciences Annual Meeting." Washington, D.C.: Office of the Press Secretary.
- [17] Bush, George W. January 31, 2006. "Address Before a Joint Session of the Congress on the State of the Union." Washington, D.C.: The American Presidency Project.
- [18] Clinton, William J. January 21, 2000. "Remarks at the California Institute of Technology in Pasadena, California." Washington, D.C.: The American Presidency Project.
- [19] Bush, George H.W. April 23, 1990. "Remarks to the National Academy of Sciences." Washington, D.C.: The American Presidency Project.
- [20] U.S. Congress. May 11, 1976. National Science and Technology Policy, Organization, and Priorities Act of 1976.
- [21] Bromley, D. Allan. 1994. *The President's Scientists: Reminiscences of a White House Science Advisor.* New Haven, CT: Yale University Press.
- [22] Press, Frank. 1981. "Science and Technology in the White House, 1977 to 1980: Part 1." *Science* 211 (4478): 139–45.
- [23] Press, Frank. 1981. "Science and Technology in the White House, 1977 to 1980: Part 2." *Science* 211 (4479): 249–56.
- [24] Gibbons, John H. 1997. *This Gifted Age: Science and Technology at the Millennium.* New York, NY: Springer Science & Business Media.
- [25] 2001. "White House Office of Science and Technology Policy 25th Anniversary Symposium." In *Summary of Symposium Proceedings.* Cambridge, MA: MIT.
- [26] Golden, William T., ed. 1988. *Science and Technology Advice To President, Congress, and Judiciary.* 1st ed. New York, NY: Pergamon Press.
- [27] Carnegie Commission on Science, Technology, and Government. 1988. Science & Technology and the President: A Report of the Carnegie Commission on Science, Technology, and Government. New York, NY: Carnegie Corporation.
- [28] Miller Center Commission No. 5. 1989. "Report of the Commission on the Presidency and Science Advising 1989." Charlottesville, VA: White Burkett Miller Center of Public Affairs.

- [29] Center for the Study of the Presidency and Congress (CSPC). 2008. "Presidential Leadership to Ensure Science and Technology in the Service of National Needs: A Report to the 2008 Candidates." Washington, D.C.: CSPC.
- [30] Bond, Jennifer Sue, Mark Schaefer, David Rejeski, and Rodney W. Nichols. 2008. "OSTP 2.0 Critical Upgrade: Enhanced Capacity for White House Science and Technology Policymaking: Recommendations for the Next President." Washington, D.C.: Woodrow Wilson International Center for Scholars.
- [31] NA-SEM. 2008. *Science and Technology for America's Progress: Ensuring the Best Presidential Appointments in the New Administration*. Washington, D.C.: NAP.
- [32] Stine, Deborah D. 2009. "The President's Office of Science and Technology Policy (OSTP): Issues for Congress." Washington, D.C.: CRS.
- [33] NA-SEM. 1988. *Science and Technology Advice in the White House: Recommendations for President-Elect George Bush*. Washington, D.C.: NAP.
- [34] Perry, Sara Jansen, Emily M. Hunter, and Steven C. Currall. 2016. "Managing the innovators: Organizational and professional commitment among scientists and engineers." *Research Policy* 45 (6): 1247–62.
- [35] Sargent Jr., John F. 2010. "A Federal CTO in the Obama Administration: Options and Issues for Consideration." Washington, D.C.: CRS.
- [36] Scola, Nancy. August 25, 2014. "The Chief Technology Officer of the United States is leaving. What now?" *Washington Post*.
- [37] Kelly, Henry, Ivan Oelrich, Steven Aftergood, and Benn H. Tennenbaum. 2004. "Flying Blind: The Rise, Fall, and Possible Resurrection of Science Policy Advice in the United States." Washington, D.C.: Federation of American Scientists.
- [38] Wells Jr., William G., and Mary Ellen Mogee. 1990. *Strengthening the Policy Analysis and Research Role and Capability of the Office of Science and Technology Policy, Executive Office of the President: A Background Paper*. New York, NY: Carnegie Corporation.
- [39] NSB. 2001. "Federal Research Resources: A Process for Setting Priorities." Arlington, VA: NSF.
- [40] Carnegie Commission on Science, Technology, and Government. 1997. *Science and Technology and the President: A Report to the Next Administration*. New York, NY: Carnegie Corporation.
- [41] CSPC. 2000. "Advancing Innovation: Improving the S&T Advisory Structure and Policy Process." Washington, D.C.: CSPC.
- [42] Lane, Neal F. 2009. "Office of Science and Technology Policy," in *Change for America: A Progressive Blueprint for the 44th President*, edited by Mark Green and Michele Jolin, 50-58. New York, NY: Perseus Books Group.
- [43] Smith, Bruce L. R. 1992. *The Advisers: Scientists in the Policy Process*. Washington, D.C.: Brookings Institution Press.
- [44] Staats, Elmer B. 1980. "Reconciling the Science Advisory Role with Tensions Inherent in the Presidency." *Technology in Society* 2 (1–2): 79–96.
- [45] Pielke, Roger, and Roberta A. Klein, eds. 2010. *Presidential Science Advisors: Perspectives and Reflections on Science, Policy and Politics*. New York, NY: Springer Science & Business Media.
- [46] Lane, Neal F. 2006. "Politics and Science: A Series of Lessons." *Social Research* 73 (3): 861–74.

- [47] Lane, Neal F. 2008. “Essay: American Physics, Policy, and Politics: An Uneasy Relationship.” *Physical Review Letters* 101 (26).
- [48] NA-SEM. 2015. *Optimizing the Nation’s Investment in Academic Research: A New Regulatory Framework for the 21st Century: Part 1.* Washington, D.C.: NAP.
- [49] Bipartisan Policy Center. 2009. “Improving the Use of Science in Regulatory Policy.” Washington, D.C.: Bipartisan Policy Center.
- [50] U.S. Congress, Office of Technology Assessment. 1990. “Helping America Compete: The Role of Federal Scientific and Technical Information.” Washington, D.C.: GPO.
- [51] Marburger, John H., and Robert P. Crease. 2015. *Science Policy Up Close.* Cambridge, MA: Harvard University Press.
- [52] Press, Frank, John H. Gibbons, Neal F. Lane, and John P. Holdren. 2012. *Science and Politics: Forum of Presidential Science Advisors.* Washington, D.C.: The Sackler Colloquium The Science of Science Communication.
- [53] Colglazier, E. William. 2016. “The Art of Science Advice.” *Science & Diplomacy* 5 (2).
- [54] American Association for the Advancement of Science. 2016. “Guide to the President’s Budget: Research & Development FY2017.” Washington, D.C.: American Association for the Advancement of Science.
- [55] MIT Committee to Evaluate the Innovation Deficit. 2015. “The Future Postponed: Why Declining Investment in Basic Research Threatens a U.S. Innovation Deficit.” Cambridge, MA: MIT.
- [56] American Academy of Arts and Sciences. 2008. *ARISE: advancing research in science and engineering: investing in early-career scientists and high-risk, high-reward research.* Cambridge, MA: American Academy of Arts and Sciences.
- [57] Institute of Medicine and National Research Council (NRC). 2002. *Integrity in scientific research: creating an environment that promotes responsible conduct.* Washington, D.C.: NAP.
- [58] U.S. Department of Defense (DOD). 2014. “2014 Quadrennial Defense Review.” Washington, D.C.: DOD.
- [59] PCAST. 2013. “Immediate Opportunities for Strengthening the Nation’s Cybersecurity.” Washington, D.C.: EOP.
- [60] PCAST. 2003. “The Science and Technology of Combating Terrorism.” Washington, D.C.: EOP.
- [61] NRC. 2015. *A Survey of Attitudes and Actions on Dual Use Research in the Life Sciences: A Collaborative Effort of the National Research Council and the American Association for the Advancement of Science.* Washington, D.C.: NAP.
- [62] NA-SEM. 2016. *Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students’ Diverse Pathways.* Washington, D.C.: NAP.
- [63] American Academy of Arts and Sciences. 2016. *Public Research Universities Recommitting to Lincoln’s Vision: An Educational Compact for the 21st Century.* Cambridge, MA: American Academy of Arts and Sciences.
- [64] PCAST. 2012. “Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics. Report to the President.” Washington, D.C.: EOP.
- [65] PCAST. 2010. “Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America’s Future.” Washington, D.C.: EOP.

- [66] NSB. 2012. "Diminishing Funding and Rising Expectations: Trends and Challenges for Public Research Universities." Arlington, VA: NSF.
- [67] MIT. 2007. "The future of coal: options for a carbon-constrained world." Cambridge, MA: MIT.
- [68] U.S. Department of Energy (DOE). 2015. "Quadrennial Energy Review: Energy Transmission, Storage, and Distribution Infrastructure." Washington, D.C.: DOE.
- [69] Deutch, John, Ernest J. Moniz, S. Ansolabehere, M. Driscoll, P. Gray, J. Holdren, P. Joskow, R. Lester, and N. Todreas. 2009. "Update of the MIT 2003 The future of nuclear power." Cambridge, MA: MIT.
- [70] National Academy of Engineering and NRC. 2010. *The Power of Renewables: Opportunities and Challenges for China and the United States.* Washington, D.C.: NAP.
- [71] Intergovernmental Panel on Climate Change (IPCC). 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Geneva, Switzerland: IPCC.
- [72] NRC. 2012. *A National Strategy for Advancing Climate Modeling.* Washington, D.C.: NAP.
- [73] MIT. 2016. "Convergence: The Future of Health," Cambridge, MA: MIT.
- [74] Alberts, B., M.W. Kirschner, S. Tilghman, and H. Varmus. 2014. "Rescuing US biomedical research from its systemic flaws." *Proceedings of the National Academy of Sciences* 111 (16): 5773–77.
- [75] PCAST. 2012. "Report to the President on Agricultural Preparedness and the Agriculture Research Enterprise," Washington, D.C.: EOP.
- [76] NRC. 2012. "A Sustainability Challenge: Food Security for All: Report of Two Workshops." Washington, D.C.: NAP.
- [77] NRC. 2015. "Critical Role of Animal Science Research in Food Security and Sustainability." Washington, D.C.: NAP.
- [78] DOE. 2014. "The Water-Energy Nexus: Challenges and Opportunities." Washington, DC: DOE.
- [79] NRC. 2014. *Pathways to Exploration: Rationales and Approaches for a U.S. Program of Human Space Exploration.* Washington, D.C.: NAP.
- [80] National Aeronautics and Space Administration (NASA). 2009. "Seeking A Human Spaceflight Program Worthy of a Great Nation." Washington, D.C.: NASA.
- [81] NA-SEM. 2016. *New Worlds, New Horizons: A Midterm Assessment.* Washington, D.C.: NAP.