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

"*Reimagining Our Innovation Future*"

Thursday, April 15, 2021
10:00 a.m. – 12:00 p.m.
Zoom

Purpose

The purpose of this hearing is to examine the current outlook for U.S. leadership in science and technology and discuss how new investments and new, inclusive models of partnership in science and technology can be leveraged to ensure continued leadership and address economic, security, environmental, public health, and other societal challenges from the local to the global level.

Witnesses

- **Mr. Norm Augustine**
- **Dr. Frances H. Arnold**, Linus Pauling Professor of Chemical Engineering, Bioengineering and Biochemistry, California Institute of Technology
- **The Honorable Ernest J. Moniz**, President and Chief Executive Officer, Energy Futures Initiative, and Former Secretary, U.S. Department of Energy
- **Dr. Farnam Jahanian**, President, Carnegie Mellon University

Overarching Questions

- What is the state of U.S. leadership in science and technology, and the outlook for continued leadership, particularly in areas of science and technology that will help drive economic competitiveness and national security in the coming decade? Why is it important for the U.S. to maintain leading capabilities in both fundamental research and technology development?
- How can Federal science agencies more effectively partner with each other, universities, companies, foundations, local and state governments, and diverse local and national stakeholders, to advance scientific and technological solutions for local, national, and global challenges? How do we incorporate an inclusive approach to the partnerships to ensure that we are tapping all of the nation's brainpower?
- What investments in research, development, and the STEM workforce are required to ensure that competitiveness and solutions-driven research are mutually reinforcing and not competing goals?
- How do we balance research collaboration and the security of Federally funded research?

U.S. RESEARCH & INNOVATION LANDSCAPE

Overall Spending

According to the National Center for Science and Engineering Statistics at the National Science Foundation (NSF), the total U.S. investment in R&D by all sectors was $656 billion in 2019. The business sector has accounted for most of the growth in total U.S. R&D over the last decade. In 2009, businesses invested $247 billion in R&D, compared to $126 billion by the Federal government. In 2019, these numbers rose to $464 billion and $139 billion, respectively, which means the business sector now accounts for 70 percent of all U.S. R&D. The remaining $53 billion comes from states, foundations, non-profit organizations, and universities' institutional funds.

Federal R&D Investment

Federal support for R&D as a percentage of the nondefense discretionary budget has held mostly steady at 10 percent since 2000, but the total size of the nondefense discretionary budget decreased under the 2011 budget deal known as "sequestration." In the years 2012-2017, Federal investments in R&D decreased in absolute numbers, surpassing the 2009 level only in 2018. In constant dollars, the R&D buying power at several Federal agencies is still lower than it was prior to sequestration.

The Federal government invests broadly across the R&D spectrum. The majority of the non-defense R&D budget, which totaled approximately $91 billion in FY 2020 (not including emergency funding for COVID), is dedicated to basic and applied research. Approximately 29 percent of all Federal R&D is intramural, i.e. performed by the Federal agency itself, 16 percent is performed by Federally Funded Research and Development Centers (FFRDCs), 20 percent is performed by business, 28 percent is performed by universities, and 6 percent is performed by other non-profit research organizations.

Federally Funded Research and Development Centers

FFRDCs, which includes the Department of Energy National Laboratories, play an important role in our R&D enterprise. In particular, they play a unique role in supporting large-scale, long-term R&D, including through the construction of major user facilities in key technology areas, including computing and biotechnology. Because they are distributed across the country, including in states and regions that are generally not among the highest in research and innovation capacity, they also serve an important role in local economic development and in providing STEM education and research experiences to students who might otherwise not have such access.

University R&D Investment

The United States has long been home to many of the world's leading research institutions. In 2019, U.S. universities performed a total of $83.7 billion in R&D from all sources, including $39.5 billion in Federally funded R&D. The share of academic R&D funded by Federal agencies declined from 57 percent in 2009 to 50 percent in 2019. Other sources of funding include institutional funds, industry, and foundations. In 2019, institutional funds supported 27.7 percent of university research. University research advances foundational knowledge in science and technology. Universities are also the source of thousands of spin-off companies that contribute to regional economic development and job creation. Such spin-offs are primarily clustered in geographic proximity to the university.

Corporate R&D Investment

Since 2000, the rise in U.S. investments in R&D has largely been driven by increased investments in the private sector, which prioritizes short-term applied research and experimental development focused on improving specific products and processes. Decades ago, tech companies invested significantly more in higher-risk fundamental research. By 2017, businesses funded nearly 30 percent of all fundamental research. However, the U.S. pharmaceutical industry alone accounts for more than 50 percent of the increase in corporate sponsored fundamental research since the mid-2000's. Similarly, philanthropic support for research has been on the rise, but it has been overwhelmingly focused on biomedical research. While some fundamental research performed by companies is published in the open literature, much of it remains proprietary.

Public-Private Partnerships

There are many partnerships between the government (including national labs), universities, and the private sector, and the Committee on Science, Space, and Technology often explores the nature of those partnership models - what works, what can be expanded, and what new models may be viable. Such partnerships require a sustained commitment by all parties and new ways of partnering as new challenges and opportunities arise. They also require new thinking as to who the partners must include. There is increasing focus on bringing to the table non-traditional partners, including local governments and community organizations, civil society organizations, labor organizations, and others who might be users of, or might be affected by, the research being carried out.

CHALLENGES TO THE INNOVATION ENTERPRISE

Stagnant or Decreasing Funding for Fundamental Research

The U.S. R&D enterprise is under pressure, especially the fundamental research that creates the foundation for new innovations and trains the next generation of STEM talent. University researchers spend a significant portion of their time applying for grants from programs with proposal success rates as low as 10 percent. Because of the low success rates, agencies and peer review panels are taking fewer risks in the grants they do fund. Many of the most talented students who otherwise might have made significant contributions to U.S. leadership in S&T see little to no future in academic research and pursue careers in the private sector, or head abroad to countries in which research funding is more readily available.

International Competition

The U.S. innovation enterprise currently faces unprecedented global competition and action is needed to maintain our competitive edge. Innovation has been a key driver of economic growth in the United States and other nations have raced to replicate our successful models for innovation. China alone has accounted for almost one-third of total global growth between 2000 and 2017, compared to 20 percent for the U.S and 17 percent for the European Union. In that time frame, the U.S. has shifted from making up 37 percent of global R&D share to 25.5 percent. China's investments likely exceeded those of the United States in 2019. As a share of GDP, the U.S. is close to dropping out of the top 10 in R&D expenditures.

If the U.S. is to maintain its competitive edge in science and technology, the nation must reinvest in our innovation enterprise to expand capacity, participation, and collaboration and allow for greater risk-taking. This is a particularly urgent issue for the U.S. in areas such as artificial intelligence, quantum computing, biotech, and other fields that will serve as the major platform technologies for innovation and competitive advantage, and lead to unprecedented national security challenges in the 21st century.

Also relevant to international competition is our ability to attract top talent from around the world. Temporary visa holders accounted for one-third of all STEM doctoral degrees awarded by U.S. universities in 2017, and half or more of all doctoral degrees awarded in engineering, mathematics, and computer sciences. The United States has long benefited from attracting the best talent from around the world. Thirty-five percent of all U.S. Nobel laureates have been foreign-born scientists since the Nobel Prize was first established in the early 1900s and 44 percent of the companies in the Fortune 500 were founded by immigrant entrepreneurs or their children. However, increasingly, foreign students are either choosing to study outside of the U.S. (the EU and Australia are popular destinations) or returning to their home countries after receiving their degrees in the United States.

As the Committee has heard from many expert witnesses, it is not an either-or question for universities. They want to attract the best global talent and recruit more U.S. citizens graduating with bachelor's degrees in science and engineering to pursue masters and doctoral level studies. However, in many fields, especially in information technology fields, U.S. students can earn good salaries straight out of college and are forgoing advanced degrees. Other challenges to the domestic STEM pipeline are discussed below.

Lack of Diversity in the STEM Enterprise

In 2017, the majority of scientists and engineers – all individuals trained or employed in STEM – employed in STEM occupations were employed in the business sector (64 percent), followed by education (13 percent) and government (11.6 percent). The skilled technical workforce – those who use S&E expertise in their jobs but do not have bachelor's degrees – account for a substantial component of the U.S. STEM workforce. The STEM workforce is aging. The median age of scientists and engineers in the labor force was 43 years in 2015, compared to 41 years in 1995.

In 2017, women with STEM degrees constituted 47.7 percent of employed individuals across all occupations, but only 29 percent of those in STEM occupations. There is significant variation across fields. Women are represented in relatively high proportions in social sciences (59 percent) and life sciences (48 percent) and relatively low proportions in engineering (15.5 percent), physical sciences (29 percent), and computer and information sciences (25.5 percent), the single largest and fastest growing STEM occupation. In 2017, underrepresented minorities accounted for 13.7 percent of all STEM degree holders working in STEM occupations and 13.6 percent of STEM degree holders employed in computing jobs. There is also a lack of regional diversity in our STEM workforce and research capacity. The 60,000,000 individuals living in rural areas in the United States are significantly underrepresented in STEM.

Institutional participation in the Federal research enterprise is also a factor in diversity. While there are 645 accredited U.S. institutions that award graduate degrees in science and engineering, the top 100 institutions perform 80 percent of all Federally funded research. None of the top 100 institutions is a Historically Black College and University (HBCU). Only seven are high Hispanic enrollment institutions. While some are in rural areas, they are heavily concentrated in urban and coastal regions. The top 30 institutions in terms of R&D expenditures accounted for 42 percent of the total spent on R&D (all funding sources) within the higher education sector in FY 2019. Those 30 institutions, while an essential part of our innovation enterprise, accounted for only 13 percent of the science and engineering bachelor's degrees awarded in 2018.

Studies on innovation have clearly demonstrated the benefits of diverse perspectives to innovation capacity and competitiveness.[1] Diverse perspectives and experiences are also required to maximize the benefits of technology and innovation for all Americans and minimize the risks. The ethical and societal risks of artificial intelligence systems, discussed at length in a 2019 Committee hearing, is just one example.[2]

If the United States does not increase and diversify participation in STEM, and particularly in fields such as computer and information science, we will continue to lose our competitive advantage. Our national security enterprise, which is competing with companies for the same talent, only hires U.S. citizens. The shortfall in domestic STEM talent is not just a competitive disadvantage, it is a significant national security risk.

COVID's Impact on Innovation

As discussed in a February 2021 hearing before the Committee, in 2020 and 2021, many of the existing demographic disparities highlighted above have been further deepened and exacerbated by the ongoing COVID-19 pandemic. In addition, across many fields, months of research time was lost. Even now, due to ongoing social distancing requirements, laboratories and facilities are not back up to full capacity. While some funding was provided to research agencies in the *CARES Act*[3] and the *American Rescue Plan Act of 2021*[4], it falls far short of the need. Last month, the Committee favorably reported H.R. 144, the *Supporting Early-Career Researcher Act*[5] and continues to push for passage of H.R. 869, the *RISE Act of 2021*[6] to get the U.S. research enterprise up and running and prevent a catastrophic loss of U.S. STEM talent.

Research Security

Concerns about threats to research security have increased in recent years. Such threats primarily arise from the failure of researchers applying for federal funding to disclose foreign affiliations, commitments, and sources of funding that may present a conflict of interest. Foreign talent recruitment programs, in particular, have been found to incentivize or coerce participants to acquire "through illicit as well as licit means, proprietary technology or software, unpublished data and methods, and intellectual property to further the military modernization goals and/or economic goals of a foreign government."[7] While data regarding the full scale and scope of the risks that threaten research security and integrity have not been made public, individual instances of undisclosed conflicts of interest and attempts to exfiltrate certain technologies have been widely reported in the press. The academic research community has called for a coordinated and harmonized approach that balances the need to address security risks with the importance of scientific openness, international collaboration, and competing for global STEM talent.

To that end, the Committee on Science, Space, and Technology developed the *Securing American Science and Technology Act* (SASTA) which was enacted through the *National Defense Authorization Act for Fiscal Year 2020*. This legislation directed the establishment of an interagency working group to

[1] https://www.forbes.com/sites/forbesinsights/2020/01/15/diversity-confirmed-to-boost-innovation-and-financial-results/?sh=45c6ec0c4a6a
[2] https://science.house.gov/hearings/artificial-intelligence-societal-and-ethical-implications
[3] https://www.congress.gov/bill/116th-congress/house-bill/748/text
[4] https://www.congress.gov/bill/117th-congress/house-bill/1319/text
[5] https://www.congress.gov/bill/117th-congress/house-bill/144
[6] https://www.congress.gov/bill/117th-congress/house-bill/869
[7] https://trumpwhitehouse.archives.gov/wp-content/uploads/2021/01/NSTC-Research-Security-Best-Practices-Jan2021.pdf

coordinate agency action on research security and a National Academies of Science Roundtable to bring together stakeholders and experts in the law enforcement, intelligence, and national security communities with the research and academic community to facilitate discussions regarding threat mitigation.[8] The Committee also developed legislation, enacted in the *National Defense Authorization Act for Fiscal Year 2021*, to harmonize disclosure requirements and enforcement across Federal research agencies.[9]

In the final days of the Trump Administration, the Joint Committee on Research Environments (JCORE) Subcommittee on Research Security released congressionally mandated guidance to research institutions on best practices for mitigating threats to research security.[10] President Trump also issued National Security Presidential Memorandum 33 (NSPM-33) directing agencies to take steps to protect federally funded research.[11] While some stakeholders have expressed concerns about the policies put forth in NSPM-33[12], at a March 11 meeting of the National Science, Technology, and Security Roundtable, a Biden Administration official confirmed that OSTP will move forward with implementation.[13] The Committee continues to conduct oversight and advance policies to address research security.

Data Sources

NSF National Center for Science and Engineering Statistics: https://www.nsf.gov/statistics/

AAAS R&D Budget Analysis: https://www.aaas.org/news/primer-federal-rd-budget-trends

Quantifying the Immediate Effects of the COVID-19 Pandemic on Scientists

[8] https://www.congress.gov/bill/116th-congress/senate-bill/1790/text (See Sec 1746)
[9] https://www.congress.gov/bill/116th-congress/house-bill/6395/text (See Sec 223)
[1010] https://trumpwhitehouse.archives.gov/wp-content/uploads/2021/01/NSTC-Research-Security-Best-Practices-Jan2021.pdf
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