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

HEARING CHARTER

Losing Ground: U.S. Competitiveness in Critical Technologies

Wednesday, January 29, 2020
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Purpose

On Wednesday, January 29, 2020, the Committee on Science, Space, and Technology will hold a hearing to review U.S. competitiveness in critical technologies and Federal investments in the research, development and STEM workforce that will be essential to maintaining U.S. leadership. The Committee will also examine opportunities for increased public-private partnership and the economic and national security implications of leadership – or loss of leadership – in these critical technology areas.

Witnesses

- **Dr. Diane Souvaine**, Chair, National Science Board
- **Dr. Eric Schmidt**, Founder, Schmidt Futures; Chairman, Defense Innovation Board; Chairman, National Security Commission on Artificial Intelligence
- **Dr. Chaouki Abdallah**, Executive Vice President for Research, Georgia Institute of Technology

Overarching Questions

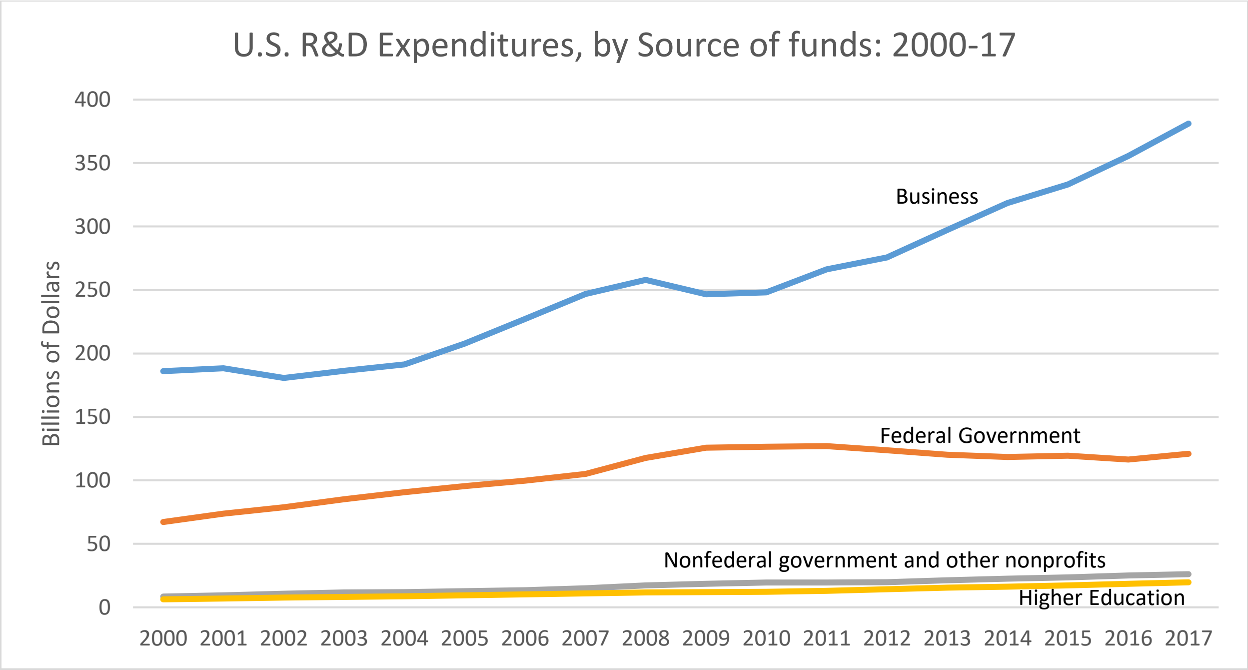
- What is the state of U.S. leadership in critical technologies such as artificial intelligence, quantum technology, synthetic biology, supercomputing, advanced materials, data storage, microelectronics, etc…? (this is not meant to be an exhaustive list)
- Why is it important for the U.S. to maintain leading capabilities in both fundamental research and technology development across these critical technology areas? What are the consequences of loss of leadership?
- What is the role of the Federal government in supporting research and development in these areas? Is the current scale and nature of investment sufficient? How can Federal agencies rethink their traditional funding models and partnership models to ensure continued leadership?

- How are universities or how can they rethink their organizational models and partnerships to situate themselves for continued leadership in research in critical technology areas? What steps are they taking to address the challenges in the U.S. STEM talent pipeline?
- How are companies or how can they rethink their approach to partnership with the Federal government and with universities in critical technology areas?

U.S. R&D Landscape

On January 15, 2020, the National Science Board (NSB) of the National Science Foundation (NSF) released its 2020 Science and Engineering Indicators report. The NSB reported that while the United States continues to lead in many key indicators, other countries are rapidly developing their science and technology capacity.

The total U.S. investment in R&D by all sectors was $548 billion in 2017. The business sector has accounted for most of the growth in total U.S. R&D over the last decade. In 2008, businesses invested $258 billion in R&D, compared to $117.6 billion by the Federal government. Today those numbers are $381 billion and $121 billion, respectively, which means the business sector now accounts for 70 percent of all U.S. R&D[1]. The remaining $46 billion comes from states, foundations, non-profit organizations, and universities' institutional funds.



[1] The most current data available from the business sector is from 2017, which is why the public vs private comparisons are from that year whereas more current data is available for the Federal government.

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" and is still below the level immediately preceding that deal. 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. However, the majority of the non-defense R&D budget, which totaled $77 billion in FY 2018, is dedicated to basic and applied research, or what the NSB is now defining collectively as "fundamental research" – original investigation that is undertaken to acquire new knowledge whether or not there is some practical objective in mind.

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. The examples most commonly cited are Bell Labs and Xerox PARC. Nine Nobel awards were given for work completed at Bell Labs, but Bell Labs began its final decline in the 2000s and was shuttered by 2008. Similarly, Xerox PARC no longer exists as it once did. Company investment in internal basic research has increased somewhat in the last few years. In 2017, businesses funded nearly 30 percent of all basic research. However, the U.S. pharmaceutical industry alone accounts for more than 50 percent of the increase in corporate sponsored basic research since the mid-2000's. Similarly, philanthropic support for research has been on the rise, but it is overwhelmingly focused on biomedical research. While some fundamental research performed by companies is published in the open literature, much of it remains proprietary.

The United States has long been home to many of the world's leading research institutions. U.S. universities perform about half of all basic research in our country and in 2018 performed a total of $79.4 billion in R&D. The share of academic R&D funded by Federal agencies declined from 57 percent in 2000 to 51 percent in 2017. Other sources of funding include institutional funds, industry, and foundations. In 2018, institutional funds constituted more than one-quarter of university research.

Federally funded research and development centers (FFRDCs), which includes the Department of Energy National Laboratories, also play an important role in our R&D enterprise, although they do not account for a large portion of the nation's total R&D performance. In 2017, FFRDCs performed less than 4 percent of all R&D. However, FFRDCs 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, biotechnology, and nanotechnology.

There are many partnerships between the government (including national labs), universities, and the private sector, and the Science Committee 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, for example in data sharing to advance AI research for public health and other areas in the public good.

International Competition

Around the world, global R&D funding has been increasing rapidly. 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. While the data are not yet available to confirm, the NSB estimates that 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.

With respect to STEM education and the workforce pipeline, U.S. students at the K-12 level continue to rank in the middle of advanced economies on international math and science tests, and their scores have barely budged in decades. At the higher education levels, the U.S. has seen small but sustained growth in the production of STEM bachelor and doctoral degrees. China has produced more bachelor level degrees in STEM since the early 2000s and surpassed the United States in 2007 as the world's largest producer of doctoral degrees in natural sciences and engineering. While quantity does not necessarily equal quality, anecdotally at least China has been making a concerted effort to improve upon the quality of their higher education to produce graduates with the skills most valued in U.S. graduates and essential to an innovation economy – not just subject matter expertise but critical thinking, problem solving, and team work skills.

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 for universities. They want to 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, those students can earn good salaries straight out of college and are forgoing more advanced degrees. Furthermore, our nation continues to see significant gaps in STEM achievement across racial and ethnic groups from the earliest education levels even as the nation's population becomes more diverse, and women continue to be significantly underrepresented in key fields. Universities have a role to play in the STEM pipeline challenge and a few have shown remarkable success with targeted efforts. However, as the Committee discussed at a hearing in 2019, our nation cannot solve its STEM pipeline challenge and meet our future workforce needs without addressing the achievement and access gaps that begin at the earliest ages.

Consequences of Decreasing Federal R&D Investments

Our entire 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 pay lines as low as 10 percent. As a consequence of the low pay lines, 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. In the field of artificial intelligence (AI), university faculty are leaving academia for large companies awash in data and computing resources. U.S. research infrastructure is crumbling. Many of our National Lab facilities are 50-60 years old. The same is true on many university campuses.

In areas of emerging technology that will have significant economic and security consequences, the U.S. risks falling behind. Other countries have clear national strategies and large coordinated investments in AI, biotechnology, and quantum science and engineering. The UK government has made synthetic biology a national priority since at least 2012. China has also developed an aggressive strategic roadmap in biotechnology and in 2017, China's government announced a goal of becoming a global leader in AI by 2030. The EU and China have both made significant commitments in quantum science and engineering. The U.S. only recently began to implement a national strategy for quantum science and engineering, and is still in the early stages of developing strategies for engineering biology and AI. Even with strategies in place, funding has to follow to realize the benefits and guard against the economic and security risks.

Many recent reports and expert groups lay out these risks in detail and make recommendations about what is required to maintain U.S. leadership:

Council on Foreign Relations, "Innovation and National Security: Keeping our Edge"

National Academies of Science, Engineering and Medicine, "Safeguarding the Bioeconomy"

National Security Commission on Artificial Intelligence, Interim Report to Congress

Defense Innovation Board Recommendations

National Academies of Science, Engineering, and Medicine, "Science and Innovation Leadership for the 21st Century: Challenges and Strategic Implications for the United States" (ongoing)