

Next Steps for Ensuring America's Advanced Technology Preeminence

APRIL 12, 2021

As technology and industry strategy experts, the undersigned authors commend Congress and the Biden administration for focusing on U.S. advanced technology competitiveness. Toward that end, they offer a number of recommendations for further action.

AMERICA, WE HAVE A PROBLEM

By a number of metrics—including its dropping position in international innovation ranking systems, its growing trade imbalance in high-tech industries, its decline in real manufacturing value-added output, and in the weaknesses of its defense industrial base—the United States has clearly seen its technological leadership in both innovation and production erode.

It is critical that the United States maintain its preeminence in technological innovation and production, particularly against a surging and adversarial China, because it enables national power (both soft and hard), as well as a thriving economy and good middle-class jobs.

In order to compete in a world in which Chinese economic and technology advancements threaten to displace U.S. leadership, the federal government must put in place and fully fund a national advanced technology strategy. Without such a strategy, the United States will in all likelihood continue to lose market share in a host of advanced industries—including aerospace, computing and communications, Internet services, life sciences, materials, semiconductors, and vehicles—with negative implications for innovation, national security, and living standards.

This requires updating antiquated economic thinking, especially thinking that holds that laissez-faire markets (which China does not embrace) are enough. This “black box” view of technology and its applications might have worked 50 years ago, when innovation industries represented a smaller part of the U.S. economy—and when the Chinese economy was backward. But today, holding on to the market-only view makes it more difficult to advance the kinds of policies needed to effectively help American innovators and producers outcompete economic systems in which “innovation mercantilism” on the one hand and strong and legitimate industrial strategies on the other make it harder for companies in America to compete.

As such, it is time for Congress and the Biden administration to embrace bold ideas and proposals focused on supporting advanced technology research, development, and production in America.

KEY NATIONAL OBJECTIVES

There are three major national objectives for an advanced industry and technology policy.

1. Support the Creation of Breakthrough Technologies and Encourage Their Commercialization and Production in the United States

There are a set of existing and emerging advanced technologies that are key to U.S. economic success and national security. There have been several lists of these technologies, such as the ten listed in the Endless Frontier Act. While experts may quibble about whether one or two might be added or subtracted from various lists, there is general agreement on the most important technologies for the nation's future.

When we say “support the creation of these technologies,” we mean not just their initial creation in the laboratory but also to extend their development along the technology readiness level (TRL) index from around TRL 3 (proof of concept) to at least TRL 7 (system prototype). Equally important is the development and commercialization of advanced process technologies that enable these technologies to be cost-effectively produced in the high labor-cost environment of the United States. These involve moving new technologies up the equally crucial manufacturing readiness level (MRL) index, from MRL 3 to at least MRL 7, if not to MRL 8. Improvements in measurement technology are also important.¹

Support for these technologies can and usually should entail both “supply-side” policies (for example, through programs such as DARPA, ARPA-E, Manufacturing USA Centers, NSF's industry-university centers, and NASA programs (such as its E3 program for cleaner jet engines), as well as “demand-side” policies (for example, through procurement, such as supporting the upgrading of the electrical grid and investing in smart city applications).² Special attention must be given to policies that link supply and demand together, to bring technologies through the “valley of death,” and to allow innovators to sustain development efforts by earning sufficient returns on early investments to advance up the learning curve and fund further improvements in product development and advanced production processes.

2. Support Companies in Key Advanced Technology Industries

U.S. competition with other nations, especially China, is won or lost based on what companies in America do. That includes companies headquartered in America and in allied nations (with a focus on the latter's production in America); existing companies and start-ups; and firms of all sizes. It also includes firms in key industries such as aerospace, biopharmaceuticals, computers and electronics (including semiconductors), electrical equipment, machinery, software, and transportation. Early adopters of key technologies—so-called “lead users”—are also crucial (and can include public sector organizations as well as firms). This should by no means entail targeting particular firms for assistance; the government generally cannot know enough to do this effectively. But it does mean targeting broad sectors, for assistance, such as advanced semiconductor manufacturing and packaging.

3. Support the Development of Additional Regions of Innovation

In order to expand overall U.S. economic opportunity and international technology competitiveness, it is important that the number of regions capable of successfully attracting and growing high-tech innovators (both entrepreneurs and branches of existing companies), such that high-tech wealth and jobs are not concentrated in just a few regions, also expands. Over the last

half century, advanced technology innovation has become concentrated in only a few places (mostly on the coasts), which has not only meant dramatically increased costs of doing business in these successful hubs but weaker innovation systems in the rest of the nation, as the successful hubs have drawn in talent. Policies directed at certain metropolitan areas that already have innovation strengths could help them increase their appeal to talent and tech activity, so they become self-sustaining technology hubs themselves—resulting in less innovation offshoring, a stronger overall U.S. advanced technology innovation ecosystem, and more economic opportunity for more people. The benefits of these designated hubs will extend not just to the states where they are located, but also to adjacent states, as the spillover effects strengthen regional economies. As such, both the Endless Frontier Act and the Innovation Centers Acceleration Act include support for the creation of new self-sustaining regional technology hubs, thereby not only growing the local technology-based economy but doing so over a broader geographical area.³

POLICIES TO ADVANCE THESE OBJECTIVES

Fortunately, Congress is more focused on these issues than any time since the late 1980s, and there is increasing bipartisan agreement that something needs to be done. We offer a number of proposals to achieve these three national objectives.

1. Improve and Pass the Endless Frontier Act

The Endless Frontier Act is a bold and needed initiative that could play a key role in ensuring U.S. advanced technology leadership. However, we suggest a number of improvements to the legislation, mostly around ensuring that the bill supports not just early-stage university research but also later-stage applied research, and that the legislation strengthens the program's connections with industry. The program will have enhanced economic impact if it supports research that industry actually uses here in America.

In particular, under the main program to provide grants to higher education, the program would be strengthened if nonprofit entities were made eligible to lead research consortia. There are a number of areas wherein the legislation could strengthen industry ties, such as by allowing matching grants to companies for their own doctoral fellowship programs and requiring a cash match of at least 10 percent from industry for any higher education institution or consortium to receive funding. A cash match is an insurance policy that the research will benefit companies in America, and not simply result in academic journal articles. In addition, the legislation should build in a reporting requirement, especially for successful commercialization and technology transfers to firms in the United States. And to better strengthen the legislation's innovation hubs component, at least 20 percent of the grant funding to university centers should go to those centers geographically located in designated regional technology hubs.

The legislation should include a provision to fund industry-supported and university partnership research and development (R&D) consortia in the 10 core technologies. To qualify for support, businesses must provide at least half the funding for such consortia, as well as take a leadership role in shaping the research activities. Moreover, these partnerships should take the lead in developing technology road maps for each of the 10 technology areas. These road maps should solicit input from key industry stakeholders, trade and professional associations, and other technology experts. The Defense Advanced Research Projects Agency's (DARPA's) process has done this in a more informal way for some particular technologies.

It is also critical that the final legislation retains and even strengthens the provisions to establish a competitive regional technology hub program. The reality is that it will be impossible to transform reasonably strong technology regions into world-class ones (such as Silicon Valley and Boston) without a focused and dedicated program such as this. The other provisions in the legislation do not meet this need.

The legislation also rightly requires a strategy and report on economic security, science, research, and innovation to support the national security strategy. Congress should make it explicit that any such strategy must be based on an in-depth analysis of U.S. industry (and other institutions') strengths, weaknesses, opportunities, and threats (including by benchmarking U.S. industry, institutions, and policies against those of major competitor nations) as well as an in-depth assessment of U.S. technological and industry strengths, weaknesses, opportunities, and threats in the core 10 technology areas, including how the United States matches up against key competitors. To the extent possible, this should assess where the United States stands in the development, commercialization, production, and use of each of the core 10 technologies, especially vis-à-vis key U.S. military adversaries.

2. Fully Fund the CHIPS Act to Support U.S. Semiconductor Reshoring and R&D

Key aspects of the Creating Helpful Incentives to Produce Semiconductors for America (CHIPS) Act include the following important measures:

- Provision of \$10 billion in matching grants for World Trade Organization (WTO)-consistent state/local incentives to attract semiconductor manufacturing facilities, which would help level the playing field with respect to other nations' incentives;
- Investment of \$7 billion over five years for semiconductor research at agencies such as the National Science Foundation (NSF), Department of Energy, and DARPA;
- Creation of a Manufacturing USA Institute for Semiconductor Manufacturing as well as a National Semiconductor Technology Center to research and prototype advanced semiconductors;
- Introduction of a 40 percent investment tax credit for semiconductor equipment and facilities expenditures; and
- Creation of a \$750 million multilateral security fund to support development and adoption of secure microelectronics and microelectronics supply chains.⁴

President Biden's infrastructure plan supports investing \$50 billion through the CHIPS Act.⁵ It is critical that Congress appropriate these direct and indirect funds for this critical industry.

3. Improve the R&D Tax Credit

Compared with America's competitors, the R&D credit is quite parsimonious.⁶ As such, Congress should double the rate of the credit, and improve the ability of newer, pre-revenue companies to take advantage of it. In addition, companies' expenditures on global standard-setting activities and on training for frontline workers should be eligible for the credit. The American Innovation and Jobs Act would do some of this, as would proposed legislation to double the credit.⁷

Congress also should provide tax credits for building and operating critical mineral and rare earth element processing facilities would begin to make the United States competitive against unfair

Chinese trade practices and make viable a key U.S. industrial sector. Cleanly processed minerals and rare-earth elements are vital to making the batteries for electric vehicles and avoiding expanded dependence on China, as the United States currently processes less than 4 percent of the minerals needed for batteries.

4. Reestablish the Commerce Department's Advanced Technology Program

To strengthen industry-government cooperation and provide more federal support for commercial R&D, Congress should reestablish the National Institute of Standards and Technology's (NIST's) Advanced Technology Program (ATP), which would share the cost of industry-defined and industry-led early-phase technology development projects selected through merit-based competitions.

ATP was for product innovations. But companies can be slow to adopt many innovative and new production technologies for several reasons—including both the high technical and market risk of going first and having critical learning invariably spill over, thereby making it easier for followers to learn from the inevitable initial mistakes of the leaders. As such, Congress should reestablish ATP and expand its scope to also include support for innovative production process pilot programs. Any company in the United States could apply for funding (to be matched by its own funding) to demonstrate an advanced technology production process in a U.S. facility. In exchange for the support, the company would have to agree to exchange best practices and lessons with other firms in the United States.

5. Expand and Put on a Sustainable Footing the Manufacturing USA Center Program

The Manufacturing USA manufacturing institutes represent an important new innovation organizational model. They are one of the only mechanisms that establish national consortia of the entire manufacturing and innovation ecosystem: large OEMs, small companies, new ventures, academic and training institutions of all types, MEPs, FFRDCs, federal agencies, state and local economic development and workforce development programs. While the centers themselves are located, by necessity, in particular geographic areas, the purpose of the institutes is not to support regional development but rather to support manufacturers with similar technology needs across the entire nation.

Sixteen institutes have been established over the past seven years, and now is the time to buttress that model. Congress should provide more funding to establish significantly more centers, with the establishment of centers decided by industry, on the basis of firms coming together to show leadership and commit funding. China has committed to the establishment of around 45 centers. Germany has over 60 centers. The United States should try to have at least 40 to 50 centers, including new manufacturing tech demonstration and training centers and regional satellite centers for existing institutes, provided adequate industry commitment.

At the same time, funding levels for each institute should be increased and not time-limited after five years. As long as industry is still adequately engaged with a center, including providing funding, government funding should continue. In addition, institutes will need additional funding to work more closely with regional manufacturing ecosystems and to establish more regional technology prototyping demo centers for companies to utilize to test new manufacturing technologies. Expanded funding should also be made available to help the institutes coordinate their work across technologies and platforms; to establish stronger links to federal R&D agencies

that traditionally do little in manufacturing R&D. Finally, increased funding is needed to expand education and workforce development efforts. Manufacturing technologies will not be implemented unless an advanced manufacturing skilled workforce is ready to implement them. This has become a key role for Institutes, but more should be done, particularly to promote cross-institute collaborations.

6. Ensure That any National Infrastructure Legislation Enables Technology Demand Initiatives

Demonstrations of new process technologies and their required infrastructure support are one of the largest gaps in today's federal funding portfolio. For large-scale, capital-intensive sectors, the contrast between the United States and its key competitors, especially China, is stark. U.S. facilities are increasingly forced to be followers because private investors are too risk-averse to fund early commercial-scale facilities. The Departments of Energy and Defense should support a robust portfolio of cost-shared projects to accelerate process innovation in key sectors and work with consortia of firms to develop road maps to guide demonstration planning.⁸ In addition, by supporting key technology-related infrastructure investments and ensuring that a significant share of procurement is from companies in America (or at least from close allies), innovation and production can be spurred. Areas of investment could include modernizing and making smart the electric grid; deploying broadband, including 5G wireless systems, in high-cost rural areas; and supporting the development of smart cities.

7. Establish a Tax Incentive for Companies Reshoring Production From China to U.S. Labor Surplus Areas

Congress should establish a reverse-auction tax credit based on the amount of value-added production allocated to a qualified labor market area.⁹ For example, if a company bids to move \$50 million of annual value-added production (the value of sales subtracted by input costs, such as electricity and supplier parts) back to the United States if it receives a tax credit of \$20 million (40 percent of value added), and another company says it will move back \$70 million for a \$25 million credit (35 percent of value), the latter company would receive priority for credit funds because it would be asking for less of a subsidy per dollar of value added than the first company. There would be a one-time auction and all the bids would be accepted in reverse order of the subsidy share being asked for until all the appropriated funds are expended. To qualify, companies would have to close a Chinese facility and open a different one in a U.S. labor surplus area to make the same product(s).

8. Create an “Innovation Voucher” Program

As in almost a dozen other countries, innovation vouchers can spur innovation and stimulate knowledge transfer by allowing small and mid-sized enterprises to “buy” expertise from universities, national labs, and research institutions to conduct studies, analyze the innovation potential of new technologies, etc. A promising example has been the Small Business Voucher Pilot program in the Energy Department's Office of Energy Efficiency and Renewable Energy (EERE), which has provided vouchers to 114 small businesses across 31 states, disbursing more than \$22 million since 2015. The administration should work with Congress to extend such vouchers across the entire federal lab system under the auspices of NIST by authorizing \$50 million that would be state-matched. The place to start would be with the Small Business Innovation Voucher Act, introduced by Sens. Cortez Masto (D-NV), Todd Young (R-IN), and Chris

Coons (D-DE) with companion House legislation by Reps. Jason Crow (D-CO) and Tim Burchett (R-TN), which would authorize a \$10 million program run out of the U.S. Small Business Administration that provides vouchers of between \$15,000 and \$75,000.¹⁰ Such a program should be larger and also work in partnership with NIST's Manufacturing Extension Partnership (MEP).

9. Establish an Advanced Technology and Industry-Sector Analysis Unit

No federal entity is responsible for competitiveness analysis, especially advanced industry competitiveness. Congress should beef up efforts at the Department of Commerce, perhaps as a combined effort of its International Trade Administration (ITA) Industry and Analysis unit and efforts at NIST. Their job would be to create a new traded-sector and emerging technology analysis unit that prioritizes interpretation and analysis. It should assess key indicators of overall U.S. competitiveness performance—such as foreign direct investment, jobs, output, and market share—and develop strategic policy road maps. It should also revive the annual report “The U.S. Industrial Outlook” as a mechanism for raising awareness about competitive position by sector. This unit could also take the lead in analysis of critical supply chains.¹¹ Congress should provide additional funding for improving federal data used to analyze industry competitiveness, including Improvements in input-output tables, so we can reliably see domestic supply chains, creation of trade in value-added statistics, which the Bureau of Economic Analysis (BEA) is developing now in conjunction with NSF, and creation of satellite accounts in key competitive industries.¹²

10) Establish an Advanced Manufacturing Scaled-Up Capital Program

Hardware invented in the United States frequently isn't scaled up here because the financial system does not support it. U.S. venture capitalists prefer “capital-lite” firms, particularly in software and media, that scale at almost zero marginal cost, rather than capital intensive businesses that need to build factories. As a result, many hardware technologies are “orphaned” in the United States and must therefore grow up abroad. To address this gap and compete more effectively with Chinese and other state-sponsored scale-up financial support programs, Congress should either create a modern-day Reconstruction Finance Corporation (RFC) or expand the mission of the Development Finance Corporation (DFC) to reduce scale-up risk in designated critical industries. Either way, the organization would provide project finance and associated assistance through grants, loans, loan guarantees, and other instruments. In addition, the Ex-Im Bank and Development Finance Corporation should be tasked to provide guarantees and other financial assistance to leverage hardware companies that receive support to scale up globally.

CONCLUSION

America is running out of time. Once lost, a firm's—or a nation's—technology advantage is almost impossible to regain unless it is willing to spend enormous sums of money, as China is doing. If the federal government does not act boldly within the next few years to significantly strengthen the U.S. advanced technology economy, it runs the risk of seeing an America that will have permanently lost much of the advantage it gained in the last half of the 20th century. We believe that it is not too late for action.

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