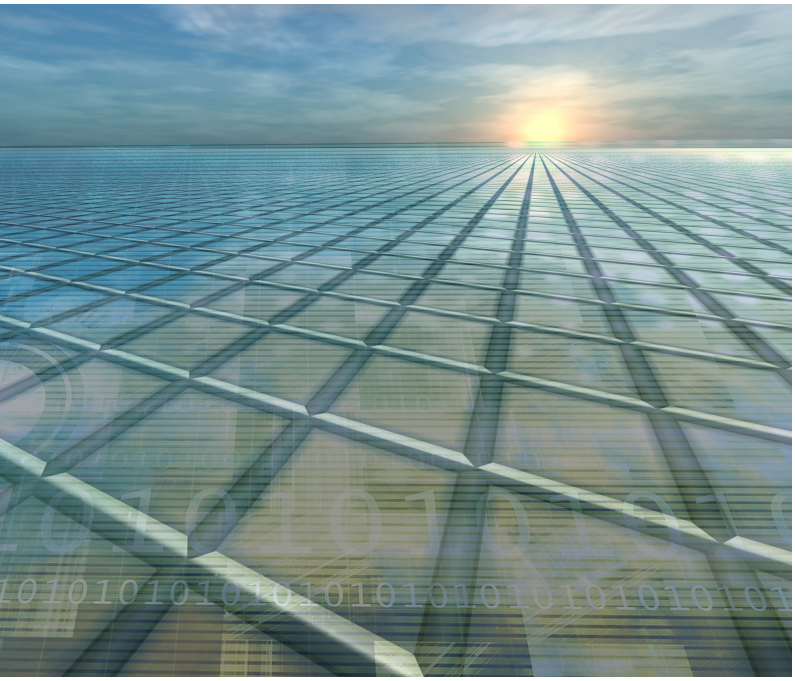
CHARTING NEW HORIZONS: TECHNOLOGY AND U.S. COMPETITIVE SUCCESS

By Christopher Ford



The United States is at an inflection point in how we tackle our most critical science and technology (S&T) issues. Implementing a 21st-Century American S&T strategy will require not merely developing fancy widgets, but also ensuring that the legal-regulatory environment; institutional and organizational practices; workforce factors related to education, training, and connectivity; and a range of technology policy and governance decisions are conducive to innovation and progress.

The United States is in a global technology competition with China, whose authoritarian rulers see the acquisition of cutting-edge technology as critical to their revisionist global agenda and Beijing's future military power.[1] In service of its geopolitical ambitions, China has been working steadily to catch up to and surpass the United States in the science and technology (S&T) arena, pursuant to calls from President Xi Jinping to make it "a world leader in science and technology."[2]

In response, U.S. leaders across the political spectrum have focused increasingly upon meeting this challenge. Most dramatically, the Biden Administration has promised to "make smart investments in manufacturing and technology … [to] spark American innovation, [and] stand up to the Chinese government's abuses."[3]

Indeed, President Biden has made reform and rejuvenation of the U.S. innovation economy a signature issue, directing a bottom-up review of federal S&T policy in ways not seen since the beginning of the Cold War. Among other things, he has specifically asked his Presidential Science Advisor for "recommendations … on the general strategies, specific actions, and new structures that the federal government should adopt" so the United States can "ensure that it is the world leader in the technologies and industries of the future that will be critical to our economic prosperity and national security, especially in competition with China."[4]

This call for new approaches and a clear S&T strategy to support U.S. competitiveness has been picked up by Congress. In June 2021, for instance, legislation was introduced in the U.S. House of Representatives to require that the Office of Science and Technology Policy produce a "national science and technology strategy"[5] analogous to—and coordinated with—the national security strategy reports already required by federal statute.[6] The legislation would also require the preparation of a Quadrennial Science and Technology Review[7] loosely analogous to the U.S. National Security Strategy.[8]

With the stage now being set for a national-level response—that is, a collaborative effort involving government, industry, and academia—to the technology challenges presented to us by Chinese revisionist ambition, it is critical to think carefully about how 21st-Century American S&T policy can rise to the task. And this, in turn, requires clear thought about technology and its benefits.

"Technology," after all, is not just a synonym for fancy hardware: it refers to knowledge *practically employed*. Possessing "technology," therefore, is not just having a fancy "widget," but also knowing what to *do* with it, in putting technical knowledge to use to produce new capabilities that meet users' needs. As an example, the greatest benefits of ongoing improvements in telecommunications technology as the world moves to fifth-generation (5G) networks will likely come not just from the mere existence of high-data-throughput networks but rather from what such connectivity does in improving existing wireless applications and developing new use cases.[9] Just as the development of 4G led to a new array of markets, products, services, and growth opportunities, so will 5G surely empower new things no one can predict today, but that will probably be responsible for most of 5G's aggregate societal impact and value. Advanced networks are nice, in other words, but the real value to society comes from the applications they catalyze.

S&T innovation, therefore, is in large part about how such tools fit together—not merely with each other, but also how they fit into, engage with, and catalyze changes in our society and our economy. Without a good fit there as well, even the cleverest tool is unlikely to be used well, technology "uptake" will be stunted, and the development of innovative new use cases will be held back. Technology policy must therefore not only strengthen our ability to develop new widgets but also ensure they can be rapidly and economically produced, are useable by their intended users, and function in a manner aligned with our nation's ideals (such as privacy and equity).

The best technologists understand this and know that one of the secrets to success lies in the broader "technosystem" into which such new tools fit, and in acquiring and understanding empirical data with which to understand these dynamics.[11] Such a mindset is essential to U.S. success in today's competitive environment. We need, therefore, not merely to develop fancy widgets, but also to ensure that the legal-regulatory environment; institutional and organizational practices; workforce factors related to education, training, and connectivity; and a range of technology policy and governance decisions are conducive to innovation and progress.

MITRE has drawn attention to these issues in a recent study we hope will help inform the Biden Administration's review of U.S. technology policy.[12] To boil things down to their essence, however, I would offer three recommendations:

1. **Don't overreach.** Rather than presuming that anyone can identify and manage the many factors that go into catalyzing technology innovation and adoption across the entire U.S. economy, a wise federal S&T policy should focus upon what is most needed in order to ensure national competitive success in the high-technology arena—including remedying actual, identifiable market failures.

   For example, there is a pressing need to fill gaps left by the decline of research and development (R&D) by large corporate laboratories on interdisciplinary questions that "integrat[e] multiple knowledge streams and capabilities" in order to accomplish the higher-risk, higher-capital cost tasks of trying to "'translat[e]'

research findings into executable solutions." As American corporations have chosen to focus upon short-term profits and the exigencies of producing and delivering goods and services to the marketplace, they have tended to eschew the costs and uncertainties of longer-term, in-house research. As a result, the market and private value of in-house research investments has declined, the absolute amount of research spending in private industry has stagnated, and the American corporate sector has been going through a "long process of withdrawal from research."[14] A national S&T strategy should address how to make up for this shortfall in R&D projects that cut across multiple technological and institutional "stovepipes."

We also need to address under-funding in the middle-ground "valley of death" in the technology life cycle between basic research and late-stage commercialization: that is, the phases in which new technological insights are validated and demonstrated in a relevant environment. This zone loosely corresponds to the area in between the traditional academic "sweet spot" of basic research and private industry's comfort zone in prototyping and deploying new applications. (As one study put it, for instance, "the great majority of university inventions fail to be commercialized, ending up in the Valley of Death prior to reaching industry." As a result, "the apparent consensus of thought among politicians, academics, and policy-makers is that an applied research–funding shortfall constrains basic university research from translating into further commercial development.") Recognizing this challenge, there has been increasing emphasis–both in the United States and elsewhere, including the United Kingdom—upon finding better ways to help promising ideas transit that gap, and not simply "die there" before their actual scalability and commercial attractiveness has been demonstrated.[13]

Improving the funding, development, and deployment of advanced "deep tech" applications and speeding innovations to market may require fundamental changes to update U.S. technology enablement programs. To be as effective and as sustainable as we need it to be, however, a national S&T strategy should tailor itself narrowly to bona fide S&T needs in redressing specific deficiencies and market failures in the American innovation economy that presently keep it from reaching its full potential, and federal S&T policy should focus U.S. Government efforts upon supporting that strategy. Looking across technology arenas to ascertain where innovation-catalytic needs are not yet being met through existing market mechanisms—in areas such as Advanced Manufacturing, Artificial Intelligence, biotechnology, climate and energy, cyberspace technology, health informatics, microelectronics, Quantum Information Science, and telecommunications—will help target unaddressed deficiencies.

2. **Ensure a "technosystem" focus**. Effective technology strategy needs not just to cover the development of new widgets in themselves, but also to address broad legal-regulatory, institutional, policy, and even sociological factors related to effective technology uptake and the development of new use cases. This requires "system of systems of systems" thinking that also embraces more practical questions of how the technology economy works in the broadest sense. Through this prism, technology governance—e.g., technical standards, tax incentives, supply chain security, technology controls, oversight and auditing of R&D funding,

and workforce quality issues—can be as important to success as the cleverest technical insights. Within the framework of a national S&T strategy, there is a special role for the government here, for such "technosystem" questions often involve issues and factors—or purely national-level or systemic concerns, such as national security or climate change—to which private sector actors may have little incentive (or ability) to direct attention and resources.

Technology development within the innovation economy, after all, is not simply about the movement of ideas from one entity to another. More fundamentally, "technology transfer is about relationships and collaboration among individuals and groups (industry, government, and academia) with varied interests."[21] The uptake of technology is not a linear and mechanistic process but a mediated one, depending in part upon variables—including legal and regulatory frameworks, standards-setting, liability regimes, and policy frameworks—that are affected by governmental choices and by the aggregated actions of stakeholders interacting through various forms of bargaining, collaborative partnership, and competitive dynamics.

A U.S. national S&T strategy must recognize this and acknowledge the federal government's role (for better or worse) in helping establish the "terrain" of incentive structures and the "guiderails" of public policy constraint that face all other actors in the innovation economy. It is a challenge for government to set such constraints wisely, disincentivizing choices that contravene the public interest (e.g., in leaving security-critical aspects of the innovation economy in non-trusted hands, or otherwise failing to account for major policy externalities) while leaving market actors as free as possible to innovate and compete, and facilitating collaborative partnerships that can make such actors ever more effective against state-sponsored foreign competitors.

3. **Keep it consistent with our values.** We clearly face formidable economic and technological challenges from China. But an analogue to Beijing's infamous "military-civil fusion" strategy,[22] for instance, is unavailable to us because American leaders must not use government coercion to compel such cross-sectoral collaboration and hijack market mechanisms for state purposes. In finding answers that play to the strengths of our own political culture, the U.S. economy, and the free-market dynamism of our people, we must ensure that whatever forms we adopt to coordinate national efforts to catalyze innovation revolve around genuinely voluntary collaborations between governmental, private sector, and academic stakeholders—as well as federally funded research and development corporations (FFRDCs),[23] which have a crucial role here as non-profit "honest brokers" who add value by reaching across organizations to share findings, promote cooperation, and resolve differences among competing interests.[24] Because the challenges of geopolitical and technological competitiveness that we face from the People's Republic of China are not solely American problems, our national S&T policy should focus explicitly upon building collaborative partnerships through technology diplomacy with like-minded friends, and particularly with high-end technology possessors in East Asia and in Europe, so we can meet these challenges together and move our collective innovation economy to the next level.

A key element for success will be the new U.S. Administration offering a vision for public-private collaboration that compellingly ties these strands together in a national "horizon strategy," an approach that involves stakeholders across a wide spectrum of issue areas and that focuses on charting the long-term, holistic future of technology development, uptake, and adoption.

About the Author

Christopher Ford is Senior Advisor for Geopolitical Policy and Strategy at MITRE Laboratories. Dr. Ford served until January 2021 as U.S. Assistant Secretary of State for International Security and Nonproliferation, and also fulfilled the duties of the Under Secretary for Arms Control and International Security. He is the author of *China Looks at the West: Identity, Global Ambitions, and the Future of Sino-American Relations* (Lexington: University Press of Kentucky, 2015) and *The Mind of Empire: China's History and Modern Foreign Relations* (Lexington: University Press of Kentucky, 2010).

For more information about this paper or the Center for Data-Driven Policy, contact policy@mitre.org

References

[1] See, e.g., Assistant Secretary of State Christopher Ford, "Why China Technology-Transfer Threats Matter," remarks at the U.S. Naval Academy (October 24, 2018), available at https://2017-2021.state.gov/remarks-and-releases-bureau-of-international-security-and-nonproliferation/why-china-technology-transfer-threats-matter/index.html.

[2] See, e.g., "China Focus: Xi calls for developing China into world science and technology leader," Xinhua (May 29, 2018), available at http://www.xinhuanet.com/english/2018-05/29/c_137213175.htm.

[3] Joe Biden for President Campaign, "The Biden Plan to Ensure the Future Is 'Made in All of America' by all of America's Workers" (undated), available at https://joebiden.com/made-in-america/.

[4] President-elect Joseph R. Biden, "A Letter to Dr. Eric Lander, the President's Science Advisor and Director of the Office of Science and Technology Policy" (January 15, 2021), available at https://www.whitehouse.gov/ostp/news-updates/2021/01/15/a-letter-to-dr-eric-s-lander-the-presidents-science-advisor-and-director-of-the-office-of-science-and-technology-policy/.

[5] H.R. 3858, draft legislation of "The National Science and Technology Strategy Act of 2021" (introduced June 11, 2021), available at https://republicans-science.house.gov/sites/republicans.science.house.gov/files/National%20S%26T%20Act%20Text.pdf. This new report would spell out "strategic objectives and priorities necessary to maintain the leadership of the United States in science and technology and to advance science and technology to address societal and national challenges, including near-term, medium-term, and long-term research priorities."

[6] 50 U.S.C. § 3043.

[7] H.R. 3858, supra.

[8] See, e.g., National Security Strategy of the United States of America (December 2017), available at https://trumpwhitehouse.archives.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf.

[9] See generally, e.g., Enrique Duarte Melo et al., Building the US 5G Economy, Boston Consulting Group (September 2020), at 10, available at https://api.ctia.org/wp-content/uploads/2020/09/Building-the-5G-US-Economy-1.pdf.; Doug Brake, "A U.S. National Strategy for 5G and Future Wireless Innovation," Information Technology & Innovation Foundation (April 27, 2020), available at https://itif.org/publications/2020/04/27/us-national-strategy-5g-and-future-wireless-innovation.

[10] See generally, e.g., U.S. National Telecommunications and Information Administration, National Strategy to Secure 5G Implementation Plan (January 6, 2021), at 6, available at https://www.ntia.gov/files/ntia/publications/2021-1-12_115445_national_strategy_to_secure_5g_implementation_plan_and_annexes_a_f_final.pdf; Melo, supra, at 8.

[11] Such is, for instance, the aspiration of MITRE's new Center for Data-Driven Policy. See https://www.mitre.org/research/policy-center.

[12] Christopher Ford, Charles Clancy, & Duane Blackburn, "A 'Horizon Strategy' Framework for Science and Technology Policy for the U.S. Innovation Economy and America's Competitive Success," MITRE Corporation (May 12, 2021), available at https://www.mitre.org/sites/default/files/publications/pr-21-1440-horizon-strategy-framework-science-technology-policy.pdf.

[13] Ashish Arora, Sharon Belenzon, Andrea Patacconi, & Jungkyu Suh, "The changing structure of American innovation: Some cautionary remarks for economic growth" (June 20, 2019), at 19–20 & 36, available at https://marker.medium.com/why-corporate-america-gave-up-on-r-d-43238193c29b.

[14] Kaushik Viswanath, "Why Corporate America Gave Up on R&D," Marker (July 7, 2020), available at https://marker.medium.com/why-corporate-america-gave-up-on-r-d-43238193c29b.

[15] See, e.g., Christopher Ford, Charles Clancy, & Duane Blackburn, "A 'Horizon Strategy' Framework for Science and Technology Policy for the U.S. Innovation Economy and America's Competitive Success," MITRE Corporation (May 12, 2021), available at https://www.mitre.org/sites/default/files/publications/pr-21-1440-horizon-strategy-framework-science-technology-policy.pdf.

[16] See, e.g., William Ker Ferguson, "A Policy Framed Analysis of the Valley of Death in University Technology Transfer," dissertation at the University of Southern Mississippi (2014), at 10, available at https://aquila.usm.edu/dissertations/261/.

[17] See, e.g., House of Commons Science and Technology Committee, "Bridging the valley of death: improving the commercialisation of research" (March 4, 2013), available at House of Commons - Bridging the valley of death: improving the commercialisation of research - Science and Technology Committee (parliament.uk).

[18] See, e.g., Alessandro Rossini, "Bridging the technological 'valley of death,'" PWC Blogg (November 6, 2018), available at https://blogg.pwc.no/digital-transformasjon/bridging-the-technological-valley-of-death.

[19] Id. at 19–23.

[20] Ferguson, supra, at 8.

[21] See, e.g., Emily Weinstein, "Don't Underestimate China's Military-Civil Fusion Efforts," Foreign Policy (February 5, 2021), available at https://foreignpolicy.com/2021/02/05/dont-underestimate-chinas-military-civil-fusion-efforts/; Assistant Secretary of State Christopher Ford, "China's 'Military-Civil Fusion' Strategy is a Global Security Threat," DipNote Blog (March 16, 2020), available at https://2017-2021.state.gov/the-prcs-military-civil-fusion-strategy-is-a-global-security-threat/index.html.

[22] Ford et al., supra, at 10–19.

[23] Id. at 24 & 27.

[24] See, e.g., FFRDCs – A Primer: Federally Funded Research and Development Centers in the 21st Century (MITRE Corporation: 2015), at 9, 19, & 21, available at https://www.mitre.org/sites/default/files/publications/ffrdc-primer-april-2015.pdf.

MITRE's mission-driven teams are dedicated to solving problems for a safer world. Through our public-private partnerships and federally funded R&D centers, we work across government and in partnership with industry to tackle challenges to the safety, stability, and well-being of our nation.

MITRE | SOLVING PROBLEMS FOR A SAFER WORLD®