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The Very Healthy US Defense Innovation System

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The US defense innovation system enjoys tremendous advantages that other countries cannot readily replicate. It has accumulated capabilities over decades of funding and experimentation that dwarf other countries' efforts, and the incentives to innovate in the United States are not easily replicable elsewhere. The unique US political system favors substitution of technology for labor, openness to new ideas, and competition among decentralized organizations to solve national security challenges. The constant worrying that the United States is losing its defense innovation advantages is simply part of the politics that keep the United States far, far ahead of its potential rivals.

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Many Americans believe that US power and security are slipping away, lost by a dysfunctional Congress and a bloated, slow-moving, gold-plating acquisition bureaucracy that cannot keep up with agile rival nations as they tap fast-moving commercial technology to build modern weapons. Critics cry that the Defense Department lags behind America's leading high-tech firms in developing advanced technologies.[1] Indecision and gridlock have seemingly become the American Way.

We are much more sanguine about the capabilities of the US defense research and development system. The system is pushed toward innovation by specific contextual factors that are unique—that is, the sources of US military-technological advantage are enduring and are unlikely to be replicated by others.

A LAYERED DEFENSE

It is not that the United States cannot lag behind in some fields of militarily relevant technology or be surprised on the battlefield. Surprise is a constant problem in warfare, and technology is pioneered in many places. Adversaries' technological investment surely can raise the costs to the United States of blithely sticking to operational concepts that previously promised great effectiveness at low cost.[2]

However, the United States has been mobilized on such scale, for so long, with a special emphasis on applying its vast science and engineering resources to its defense that it will not easily fall behind in weapons technology or quality. Currently the United States invests about $70 billion a year in defense R&D, as much as at the height of the Cold War and about two-thirds of what all countries, American friend or foe, currently spend on defense R&D.[3] China is the only great power that spends more on defense than the United States spends on just defense R&D. The United States has been spending comparable amounts for decades, emphasizing defense R&D for some 70 years. That spending has a cumulative effect, because it builds a foundation of tacit knowledge, experience in integrating complex systems, and human capital that understands the specialized parameters of military systems, the performance requirements of which often differ from those of even high-end civilian systems.

The history of the US defense R&D effort reveals the key contextual characteristics that make it unique. The intensity of the interest in defense research began at the start of World War II, with scientists rather than the military. Led by Vannevar Bush of the Massachusetts Institute of Technology, they gained their own organization to manage wartime research, what was eventually called the Office of Scientific Research and Development (OSRD).[4] Although the OSRD itself was disbanded in the postwar years, parts of its work continued in various university- and contractor-managed organizations and laboratories, labeled Federally Funded Research and Development Centers (FFRDCs) or University Affiliated Research Centers (UARCs). Those institutions play a vital role in creating "soft" innovation capabilities in the United States—preserving the institutional memory of past R&D efforts, cultivating multiple design-team philosophies that enable diverse approaches to technological challenges, and using their independence to prevent the capture of the US R&D effort by the pecuniary biases of government customers and private-sector suppliers. The peak technologies in the arms race changed over time, but the US institutions and level of investment maintained the US lead: space and ballistic missiles, then sensors and precision weapons, followed by the prospect (partly imagined) of strategic defenses.

INCENTIVES FOR INNOVATION

R&D investment isn't the only thing that did not go away with the end of the Cold War. The incentives that drive American military innovation survived, too. There are at least three.

First, the concern for avoiding casualties runs deep in American military operations, stemming from both a persistent national labor shortage and the democratic nature of American government.[5] The United States resisted the maintenance of a large, professional military. Even when the United States succumbed because of the Cold War, it sought to limit the military's growth and the political impact of casualties through the intense application of technology. Thus, the great and successful effort to improve the accuracy of conventional weapons and the speed and stealth of the platforms: if a target can be identified and located, it can be de-

1 See, for example, Aaron Mehta, "Pentagon Tech Advisers Want Special Career Track, 'Innovation Elevator' for Big Thinkers," *Defense News*, October 26, 2017; Jill Aitoro, "The Next Sputnik: Here's Why US Stands to Lose Technological Edge to China," *Defense News*, December 2, 2017.

2 Eugene Gholz, "Why US Strategy Must Adapt to Technological Change," *World Politics Review*, April 18, 2017.

3 Keith Hartley, "Defense R&D Spending: A Critical Review of the Economic Data," *World Economics* 12, no. 1 (January-March 2011): 103–14.

4 Harvey M. Sapolsky, *Science and the Navy: The History of the Office of Naval Researc*h (Princeton NJ: Princeton University Press, 1990).

5 Harvey M. Sapolsky and Jeremy Shapiro, "Casualties, Technology, and America's Future Wars," *Parameters* (July 1999).

stroyed with little risk to US personnel.

Second, the race to develop new weapons and doctrine is spurred on in the US system by inter-service competition.[6] Each of the armed services seeks special prominence among the others as being the answer to emerging dangers or the foreign policy desires of the president. This competition creates the incentive to innovate. For example, it gave the United States the lead in the race to develop ballistic missiles and satellites of all types.

Resistance to centralization is protected first and foremost by the military services' strong cultures, with their proud traditions and their situations as "total organizations" that control their members' entire lives. Even the civilians who work for the services tend to have a relatively strong sense of their organizations' mission, compared to other government workers, because of the services' relatively clear definitions of their critical tasks. In addition to the organizations' natural drive to protect their professional jurisdiction, Congress, which has often pushed for centralization and planning, also protects competition by separating out favored causes. At the same time that it sought to reduce inter-service rivalry by passing the Goldwater-Nichols Act in 1986, Congress created the Special Operations Command, essentially a new service with its own global jurisdiction and budgetary independence. More recently, Congress has elevated cyberwarfare to a separate warfare command and laid the groundwork for the creation of a separate Marine Corps-like Space Corps from within the Air Force. One hand praises centralization and planning while the other advocates decentralization and competition, the stimulants of innovation.

Third, US military power benefits from immigration, a continuing source of new ideas and great energy. Many great American military innovations were the ideas of immigrants. For example, Abraham Karem, the designer of the Predator drone, immigrated to the United States from Israel. Immigrants contribute to every field of defense-related technology, including computer science, aeronautical engineering, nanotechnology, and robotics. Immigration may be under scrutiny in the United States these days, but it is mainly the problem of illegal immigration that is contentious, not immigration itself.

THE IRRELEVANCE OF REFORM

Relative labor scarcity and inter-service competition can help the military come up with ideas for technology, but if the military intends to tap the technologies of the future, someone will have to design and build the systems. Can the existing prime contractors effectively use advances in technology to build the best weapon systems? Former Defense Secretary Ashton Carter set up initiatives like the DIUx (Defense Innovation Unit—eXperimental) during the Obama administration, fueled by a concern that the military's style is a poor fit for the modern American culture of innovation.

The prime contractors usually are the integrators of technologies produced by others.[7] Their job is to bring together and manage to an exacting schedule and within certain budget limits a network of subcontractors with the appropriate technology and skills to build systems that can survive and dominate a battlefield, usually after traversing another difficult environment like space or the ocean. The technologies are important, but it is weaponizing them that counts the most. That is what Lockheed, Northrop, and the other primes do for the American military.

Secretary Carter's DIUx may help a little. So, too, may the Defense Department's new Strategic Capabilities Office, the Defense Innovation Board, and the CIA's experimental venture capital unit, In-Q-Tel. These initiatives reinforce and complement what defense agencies in the United States have been doing for decades. More important, creating these agencies is also politically smart, as it shows defense agencies dealing directly with what the American public perceives to be the very cutting edge of technology and innovation.

No harm done unless the Department of Defense gets so caught up in pursuing the new organizations that it somehow forgets that what it really buys is the expertise in designing and building complex systems specifically for military roles. Systems integration works in any field because the integrators understand their customers' particularities and peculiarities. In defense, that means that the systems integrators that make complex weapons systems need to know a little bit about warfighting, the jargon that the military uses to talk about its missions, and the political dealmaking (organizational and electoral) that chooses which projects get funded and survive to eventual deployment with the operational military. The commercial technology companies are already in the mix of weapon systems' supply chains, along with defense-unique suppliers; there is no real lack of technology access. And the commercial technology companies will never specialize in the defense-unique aspects of the weapons or be responsive enough to the military

6 Harvey M. Sapolsky, Eugene Gholz, and Caitlin Talmadge, *US Defense Politics: The Origins of Security Policy*, 3rd ed. (New York: Routledge, 2017).

7 Eugene Gholz, Andrew D. James, and Thomas H. Speller, "The Second Face of Systems Integration: An Empirical Analysis of Supply Networks to Complex Product Systems," *Research Policy* (forthcoming, 2018).

customers' quirks to produce cutting-edge military systems, to keep the demanding military customers happy, and to work gracefully with them in the complex political ballet of defense acquisition. DIUx and the rest are just a veneer, a new part of that politics.

THE SOURCE OF DISCONTENT

If the US defense innovation system is robust and unique, then why do so many feel insecure about it? Because in addition to the defense innovation system, during the Cold War the United States created a system to find dangers and worry about them. Nearly all of America's think tanks, academic research institutes, and contract study groups stayed in place at the Cold War's end, searching the globe for security problems: counterterrorism operations and cyber defense joined the top tier, along with nuclear proliferation. The threat/policy opportunity radars have kept turning.[8] Terrorism, cyber, and climate change threats have an endless quality to them, ideal to justify continuing planning and budget requests.[9] There is a constant fear that everything used to be better, that Congress or the administration is being complacent.

The United States pays a lot to avoid being surprised. Part of that price is paid to maintain a vast network of laboratories, institutes, test ranges, and development centers, public and private, secret and open, working on every frontier trying to build better weapons. The network is bigger and better than everyone else's, and it is better funded.

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8 David M. Edelstein and Ronald R. Krebs, "Delusions of Grand Strategy: The Problem with Washington's Planning Obsession," *Foreign Affairs* 94, no. 6 (November/December 2015): 109–16.

9 Alexander Osipovich, "Pentagon Pits Traders Versus Hackers," *Wall Street Journal*, October 16, 2017, B1.