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# The Nature of the Defense Innovation Problem

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# Executive Summary

The Department of Defense (DoD) asked that we assess its innovation problem. This effort was spurred by the Department's continued struggle to engage the innovation ecosystem effectively to support improved acquisition, capabilities, and military outcomes. We considered the existing approaches that are heavily focused on process solutions and the standing up of new offices. It was clear that the challenge remains. As a result, we took a step back to clearly define the problem, its causes and challenges, and potential remedies rather than risk blindly identifying and chasing rapid or simple solutions that may not resolve the fundamental issues with obtaining and fielding the right innovative defense capabilities. As such, this report is an effort to look at the challenge from first principles and truly understand the nature of the defense innovation problem.

The innovation needed today takes place amid a dramatically changed technology landscape. When our technology organizations and acquisition structures were created decades ago, the U.S. DoD exerted an outsized impact both domestically and globally on the development of technology and, as such, were a major determinant of the pace of technological change. Today, the technological landscape is largely commercial, dispersed, proliferated, and beyond any government's control. The annual research and development (R&D) investment globally in 2019 was an estimated $2.4 trillion, with over 70% of that coming from outside the United States and almost half from outside of both the United States and China (Sargent, 2021). Moreover, the pace of change is being driven globally by a dispersed network of public and private actors.

The primary takeaway is the need to intentionally create an improved innovation ecosystem internal to the DoD, not simply continue to reform the existing acquisition framework or focus solely on the external community. This means the Department's organizations, experimentation, and people must be cultivated and protected. This concept cuts across major lines of authority and responsibility and requires that the DoD craft the skills and critical thinking necessary for leadership and workforce in a new reality of rapidly emerging, widely proliferated technology.

We identified the following recommendations and next steps that could begin moving the DoD more towards empowering, creating, identifying, assessing, and adopting operationally significant innovation (rather than attractive innovation that cannot be justified and pursued given limited resources). Achieving this reality will require long-term, fundamental attention to basic enablers, including experimentation and learning not only for defense innovation but also for the broader system that will acquire and field innovative capabilities.

## Recommendations Toward Operationally Significant Innovation

1. Create organizations that teach and sustain red teaming and experimentation activities and that report directly to leaders with the authority to move money and influence and support functions to field innovations critical to operational needs.
2. Craft experimentation and iteration opportunities within those organizations that directly engage warfighters to expand concepts for use of both novel and existing technologies as well as complementary changes in doctrine, organization, training, materiel, leadership, personnel, facilities, and policy (DOTMLPF-P).

3. Develop repositories of learning that create long-term corporate memory from innovative efforts for both the innovating office and the DoD, making the institution smarter while decreasing negative impacts of high personnel rotation tempos.
4. Attract and retain people and leaders with the skills, incentives, and empowerment to navigate this dynamic new world.
    a. Develop and apply education and training plans and programs to staff and leaders
    b. Apply outcome-aligned incentives and promotion criteria to leaders and staff to motivate and enable innovation.
    c. Empower organizational environments structured to enable innovation, testing, learning, selection, and fielding of operationally critical ideas.

## Next Steps: Pilot Options

Practical next steps to begin pursuing the recommendations above include the following pilot and study efforts.

i. Create and empower Experimentation Organizations (potentially at the Army Futures Command or an existing Rapid Capability Office).
ii. Pilot repositories of learning from experimentation organizations (again, potentially at the Army Futures Command or an existing Rapid Capability Office).
iii. Train a cadre of future leaders and workforce (e.g., at the Defense Acquisition University or a war college, building on the School of Advanced Military Studies (SAMS) and Seminar XXI curricula).
iv. Pilot incentives and promotion criteria with a cadre of military officers or civil servants.
v. Identify additional lessons on empowerment factors (learning successes and failures from past experiences). Build simulators to test innovation incentives policies (i.e., test before broadly implementing new policies) and develop policy readiness levels to inform policy decision making.

# Acronyms and Abbreviations

| | |
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| A&S | Acquisition and Sustainment |
| AIRC | Acquisition Innovation Research Center |
| ALLP | Acquisition Lessons Learned Portal |
| ASI | additional skill identifier |
| ASLSP | Advanced Strategic Leadership Studies Program |
| CGSC | Command and General Staff College |
| DAU | Defense Acquisition University |
| DE M-SHORAD | Directed Energy Maneuver-Short Range Air Defense [system] |
| DoD | Department of Defense |
| DOTMLPF-P | doctrine, organization, training, materiel, leadership, personnel, facilities, and policy |
| DTIC | Defense Technical Information Center |
| FY | fiscal year |
| GAO | [U.S.] Government Accountability Office |
| GSA | General Services Administration |
| NDAA | National Defense Authorization Act |
| O- | officer [rank] |
| OUSD | Office of the Under Secretary of Defense |
| Ph.D. | Doctor of Philosophy |
| PPBE | Planning, Programming, Budgeting, and Execution |
| R&D | research and development |
| R&E | Research and Engineering |
| RCCTO | [Army] Rapid Capabilities and Critical Technologies Office |
| SAMS | School of Advanced Military Studies |
| SERC | Systems Engineering Research Center |
| TTPs | tactics, techniques, and procedures |
| UARC | University-Affiliated Research Center |
| UAS | unmanned aerial system |

## Acknowledgements

This research is largely based on anonymous, in-depth discussions with over 25 stakeholders and subject-matter experts who had leadership positions or are currently closely involved with or participating in innovation, R&D, and acquisition practices. These individuals come predominantly from the U.S. DoD, though discussions were also held with Federal officials outside the DoD and experts in the U.S. commercial and academic sectors. Any errors belong to the authors.

# Background

Acquisition reform has been debated since at least the 1960s and shows no signs of slowing. The reason is that the DoD has consistently struggled to acquire weapon systems on budget, on schedule, and with expected performance (Government Accountability Office [GAO], 2019). The defense acquisition system has always been extremely difficult to navigate and has erected barriers to the expeditious and efficient adoption of new technology to support our national defense strategies. As the pace of technological development increases, the acquisition process has become an even larger impediment in the race against our adversaries. As mentioned in the 2018 National Defense Strategy, the timespan from the 1960s to the present has proved that "[t]he current bureaucratic approach, centered on exacting thoroughness and minimizing risk above all else, is proving to be increasingly unresponsive" (DoD, 2018).

Decades worth of acquisition reform attempts have ranged from funding, streamlining process, changing policy, creating new authorities, and even attempts at eliminating all three. These reforms have been subject to many studies that decompose these actions in detail. The history of acquisition reform reflects that much has been done to study the problem, identify candidate solutions, and execute reforms, only to return to the conclusion that more reform is needed (Eide and Allen, 2012).

For the purpose of this study, we note that each action toward acquisition reform has been an attempt to implement policy change that seemed beneficial at that time and in contrast to how the acquisition process worked in its former state. Also, many reforms sought quick solutions, but time often has shown that there are no "silver bullets" for system-wide improvements, and enduring challenges tend to require enduring efforts to make major changes. Current acquisition reforms have shifted to a focus that targets increasing acquisition speed and strengthening the DoD's technological edge.

## Innovation Problem: Still Unsolved, Still Evolving

In recent years, along with the focus on speed, we see a shift in the language around acquisition reform and a focus on innovation. Underlying this is a desire to innovate creative uses of rather mature commercial technology in response to rapidly changing threats that leverage globally available technology. It is also clear that innovation can involve not only technology-centric approaches but also the development of improvements in doctrine, organization, training, leadership and education, personnel, facilities, and policy. It is unclear that renaming or conflating these challenges is helpful, but it does indicate aspects of the problem that are now being emphasized and perhaps creates new opportunities, and new problems.

## Changed U.S. Role and Influence in a Changed Technology Landscape

It is also essential to understand how much the technology landscape has changed to appreciate the complexity of this environment, and especially the role and influence of the U.S. DoD on global research and development (R&D). In 1960, the United States contributed roughly 69% of global R&D investments and the U.S. DoD alone made up over one-third of total global R&D investment. The U.S. federal government was the

heavy hitter at home as well, investing double the amount seen from industry at the time. This was a period after World War II when the global R&D leaders had been devastated. Germany, France, and the UK– former powerhouses in R&D– were all rebuilding. In this moment, the U.S. had the foresight to invest and to rise in this vacuum of competition. Simultaneously, the Soviet Union provided a technological threat that solidified our national will and gave urgency to the endeavor.

Since that time, the investment in R&D around the world has grown to an estimated $2.4 trillion in 2019 and the role of industry in R&D investment has grown as companies increasingly see R&D as a path to economic growth. Since its global dominance in the 1960s, the United States has fallen to approximately 27% (or $656 billion) of the global share of R&D investment while China has risen to 22% (or $526 billion)– with the rest of the world making up the remaining investments (over $1.2 trillion annually) (Flagg and Harris, 2020). Domestically, the story isn't much different: The U.S. federal government slipped from approximately 65% of total U.S. R&D investment in 1960 to 21% in 2019, while investments by industry more than doubled, growing from 33% to over 70%. These trends leave the U.S. DoD in a dramatically different position than we enjoyed historically, with the DoD share of total global R&D falling from 36% in 1960 to roughly 3% in 2019 (Sargent and Gallow, 2021).

## Adapting to the New World is Critical to Innovation and Success

Why does this matter? During the Cold War, when many of our acquisition structures and systems were being created, the U.S. government and the DoD had a powerful position of control over the pace of technological development. That is simply not true today. If we believe that we can avoid changes to our underlying culture and systems and work around those hard truths by focusing on funding and process change, our success in this new world is unlikely.

Let's be clear: We cannot easily spend our way back to the global and domestic technological dominance we possessed in the 1960s. If the U.S. government as a whole wanted to reestablish the position of being double the U.S. industrial investment in R&D, it would require a massive increase in the federal R&D investment. Using 2019 estimates, the federal government invests $139 billion annually while U.S. industry invests roughly $464 billion; we would need an increase of roughly $789 billion annually over and above what the federal government already spends to return to the situation of having a federal investment double that of industry. This is infeasible, at least in the near term. Even if we increased the entire U.S. R&D investment by $789 billion to a total of $1.4 trillion, this would still leave the United States at 58% of global R&D investment and still lagging the historic position.

We must adapt to this new world or find ways to fight and win wars that do not require universal technological superiority. Within this incredibly challenging research and technology landscape, there is a strong concern across the DoD and the broader defense ecosystem that defense innovation is broken. Millions of taxpayer dollars have been spent "seeking innovation." Silicon Valley has become a focus for the DoD as a key site of a new emerging defense industrial base, promising to solve the Department's innovation problem (Flagg and Corrigan, 2021). However, innovation outreach and identification do not appear to be the fundamental problem. Over the last decade, outreach efforts and organizations have proliferated that focus on this early

stage in the process, with an apparent assumption that if the DoD could just find great technology, then it would somehow (almost automatically or simply) make its way through the remaining (rather complicated) processes of requirements, budgeting, and procurement to produce valuable warfighting capabilities.

Most efforts to adopt new technology are routing around the traditional pipelines to adoption, using alternative methods of funding or ad hoc small quantity purchases using SBIR and R&D funds. These strategies are a work-around to a convoluted system that is not conducive to the rapid adoption of new technology; while admirable and understandable, they don't solve our bigger problem that this new world of rapid change and diverse threats is here to stay.

## Challenges

**The problem of innovation may be too large and complex for any single, or even set of efforts.** It is likely that these efforts are necessary but insufficient to tackle the much larger and more complex problems—or even that these efforts are not all that helpful, are not necessary, are ill-structured, or are too fragmented. Many of the concerns appear to be less a question of innovation, or specific improvements within any one specific silo of the strategy, R&D, acquisition, sustainment and operational communities, but perhaps more questions of action across the *interfaces* of the siloes. Ultimately, we should likely stop using innovation reform interchangeably with acquisition reform. However, there is overlap. Many of the processes required for acquisition, the procedures required to provide accountability to Congress and the taxpayer, are in direct conflict with what lies at the heart of innovation.

**Innovation often means very different things among different stakeholders.** The word has become so overused that it now generates confusion rather than solutions. Innovation in the DoD may mean a completely new concept at the research stage, an upgrade to software or a component within an existing program, or even a new way to achieve an operational outcome. Innovation may be tech-centric or simply tech-supported and may arise from any community across the DoD or the commercial space.

Innovation has become so commonplace in our lexicon that it almost seems like we believe it is a discrete "thing" that can be recognized in the moment, that processes can be created to achieve innovation consistently and predictably, and that innovation is standardized and regularized. It seems we believe everyone can—and what's more SHOULD—be innovative, all of the time.

Innovation is not a formula and attempting to create a standardized innovation process is likely an oxymoron. There is a temptation to look towards the private sector—and ignore the significant differences in structure, goals, oversight and flexibilities available to those organizations, as well as the dramatically limited scope of responsibility relative to the DoD—and believe that the DoD would suddenly be fine if we simply emulated industry. While many lessons from the private sector are valuable, their direct application to the DoD has not worked to drive change at scale. In the DoD, the customer does not in fact control resource allocation, which is a complex web of internal requirements rolled up from the components and combatant commands that feed into the planning, programming, budgeting, and execution (PPBE) process that ultimately leads to a budget request from the President and a budget decision by

Congress. That budget is then held to strict oversight, often preferring that the money is spent in exactly the way it was originally planned, even if the world and the threat has changed significantly in intervening years. No private sector company would accept this, therefore we must be realistic in how we translate lessons learned from industry.

In the DoD, accountability is a primary driver of resource allocation, not outcome-based innovation that takes into account a rapid pace of global technological change. How do we stay relevant? How do we leverage technological change and adapt to ensure we serve our outcomes?

**Innovation Requires Thinking Differently.** At the end of the day, innovation is a set of skills and a way of thinking. It is the ability – and the willingness– to challenge the status quo and create new ideas or ways of working. This could be as small as a new way to do a very specific thing within an existing program, or it could be new approaches to warfighting or strategy. Ultimately, the ability to innovate must be learned. We must help people understand how to conceive of a fundamentally new way of doing something and to construct the necessary scenarios, experimentation or testing to understand what aspects work and what aspects fail and to fold that new knowledge back into the improvement process and continue towards success. And we must learn how to reward that skillset.

## Methodology

**In-depth stakeholder discussions.** Fact gathering on this project was conducted around a set of central questions of interest that provided a holistic assessment of the types of innovation and brought focus on how the DoD fields capabilities. Research on this project was carried out using a qualitative research method based on in-depth discussions with stakeholders and subject-matter experts coupled with thorough background research and literature reviews, which focused on processes and outcomes associated with defense innovation. The project met with approximately 20 stakeholders who are currently closely involved with or participating in innovation practices. These individuals come predominantly from the U.S. DoD, though non-DoD U.S. government, U.S. commercial, and non-U.S. government entities were also included in the discussions. The insights from the discussions were used to inform a consolidated narrative describing the innovation processes and capabilities, summarized in this report.

**Literature review.** The traditional literature review helped form the basis of the research and interview approach. There is an extensive literature around acquisitions reform that is not only about what changes the reform hopes to bring, but also the barriers and challenges that work against the reform. Of interest about the barriers is that independent of the reform, many of the barriers are common and are never addressed in full. Some of these barriers are as follows: processes developed are optimal for previous time periods and are now fractured and may not be appropriate for a technology innovation system (Under Secretary of Defense for Acquisition and Sustainment, 2021); one size does not fit all programs, organizations need to be empowered for change, experimentation and learning should be the priority, and the human element needs to be addressed (Christensen, 1997); and we need to prioritize good leadership over process (Lewis, 2021).

**Qualitative analysis.** The team performed qualitative analysis on the inputs from SMEs, primarily coding for like groups and then developing additional structure based on the content of data, allowing the themes to emerge organically rather than starting with an expected framework. The results of these qualitative analyses will be presented and explored in more detail later in this report.

# Themes from Stakeholder Discussions

A significant takeaway from our conversations highlighted that defense innovation appears to have some clear hallmarks. A primary one is that innovation is *outcome driven*. *Innovation is not technological superiority*. It is also not having the ability to purchase every latest technological advancement immediately and deploy it at scale to the entire fleet/force. Ideas (i.e., thinking differently) must improve our ability to achieve outcomes in order to really be *defense innovation*, and not simply great ideas, or interesting inventions.

Given the scale and decentralized nature of the U.S. DoD, this change in perspective requires strong leaders who can clearly articulate priorities and ensure that those priority outcomes are well-understood at every level. Innovative thinking also requires leaders who can identify, grow, and promote talent at all levels that are comfortable in the dynamic, often ambiguous world of disruption. Finally, innovative thinking requires a tolerance for failure that is tightly coupled with learning from those failures and quickly integrating that knowledge while moving on to the updated experiment, i.e., a culture of continuous experimentation across levels of technological and operational maturity is critical.

The major themes identified from stakeholder discussions include:

- Theme 1: Clarity of Outcomes
- Theme 2: Experimentation
- Theme 3: Productive Failure
- Theme 4: Leadership and People

## Theme 1: Clarity of Outcomes

The need to align innovation activities to mission outcomes is a central characteristic of defense innovation. This does not necessarily require a highly specific pull from an existing customer; this may vary based on the level of technology or process maturity being considered. However, potential value needs to be clearly articulated to mission priorities and customers need to be cultivated over the development cycle through processes such as training exercises, red teaming, gaming, and experimentation. A challenge of the existing system is that incentives are often tied to convoluted definitions of transition that can easily be measured and quantified rather than to the more difficult measure of impact on mission outcomes. This differs dramatically from the incentives of scale and profit in the private sector and establishes a point of friction when the DoD wants to collaborate with industry or imitate successful commercial practices. However, given the radically changed technology landscape and the new position of defense within that landscape, we must find ways to at least understand and manage this friction. This means getting more comfortable with a level of radical honesty: knowing and communicating our goals and the reality of our likely scale and timelines.

The general consensus throughout the DoD at the moment seems to be that we need to adopt as much emerging technology as possible to ensure we sustain the U.S. competitive military advantage against adversaries. Technologies are often pushed

forward based on novelty, or a feeling that we must always have total technological superiority; however, with no clearly prioritized outcome in mind, the decision is often based more on emotion than winning wars. There is a myriad of technologies with a wow factor but are neither the force multiplier nor the tactical advantage that the vendor believes them to be, and they may not be advantageous to the warfighter or even feasible for use. Not every new piece of technology that is interesting, and even funded and pursued, should make it across the proverbial “Valley of Death.” Harnessing emerging technology matters, but expectations need to be managed. So, a series of questions needs to be asked that make technology acquisition mission oriented and end user focused.

Current DoD efforts focus heavily on using R&E funding sources such as SBIRs to fund novel technology from non-traditional vendors in an attempt to transition those technologies to programs of record. Many recipients of this funding believe it is a guarantee of technology adoption and long-term contracts. However, in most cases, this approach to tech transition has a low success rate. This generates confusion amongst non-traditional vendors that echoes throughout the commercial sector and the resultant effect is a worsening relationship with the DoD over time.

Use cases for these new technology concepts are often not developed in partnership with warfighters and perpetuate the belief that uses for these ideas will make themselves apparent as they develop. In these cases, the “Valley of Death" should be celebrated but also documented. We need repositories of knowledge that address the conscious choice not to pursue ideas at a specific time and why, thus allowing us to refer to those ideas later. This approach should not be seen as problematic or a failure of the system. Focus should be on learning from experimentation and clear identification of what the outcome of a technological adoption would mean in terms of mission and outcome. Mission and national strategic alignment are paramount: It is time to refocus on what we actually need to fight and win wars.

Resistance to change or the adoption of new technologies and approaches is common in large organizations with a track record of success. Some aspects of this are predictable. In the case of the DoD, when the warfighter (or customer) has little say in how a new capability will be used, the chances of failure increase. Additionally, when operators are engaged but feedback and lessons learned are ad hoc and not integrated into user improvements that accrue over time, successful scaling from small venues and user groups to larger deployment is challenged. Finally, sometimes great ideas simply do not translate to the mission. When warfighter feedback is clear and the capability cannot be used in an effective way, or when the threat environment fundamentally changes, we lack clear ways to integrate feedback and either change requirements or kill programs. Processes to incentivize feedback loops from users and intelligence that allow improvement on the fly are challenging in our rigid structures of programs of record.

Another theme that emerged from stakeholder discussions is that knowledge exists in islands, and we do not understand what the other islands know. In the DoD, this reality was created on purpose. There is a deep belief in a “need to know” system that protects classified information and values secrecy around strategic programs above all else. This made sense during the Cold War when the U.S. had global technology dominance, there was a single, strategic adversary, and two players controlled the technological pace of change.

Today, the technological landscape is dispersed, proliferated, and beyond any government's control. The annual R&D investment globally is over $2.2 trillion, with 50% of that coming from outside of either the U.S. or China, and the pace of change is being driven by a dispersed network of public and private actors globally. Secrecy slows innovation: If you are not in control of the pace of change and are responding with a slower approach, this will be problematic. Leadership is critical in setting out the clarity of outcomes needed to fight and win wars, however that vision cannot simply reside at the top. There is a huge disconnect between leadership and execution, certainly in acquisition and technology space. There is a trickle down of knowledge and priorities around certain things such as budget, but for the most part, there is no sustained flow-down of the clear priority that will be considered success. Historically, we had clear messaging – mitigate this specific foreign threat, make products more affordable, and create surprise for adversaries–that staff could understand and articulate well. Today, the messiness of the environment is challenging the ability of leadership to distill their goals into priorities, and those priorities into a clarity of mission. When these disconnects happen, they often change with each rotation. Effective innovation in this complex system relies on clarity of communication: how well a leader can both know what they want and communicate that to the entire organization.

If communication relies on the big personality that forces ideas through the system, it will evaporate as soon as they depart. Communication needs to include an understanding and articulation of how the priorities are valuable – and rewarded – across the system. At the moment, incentives are all about status quo: If incentives are running counter to the outcomes that leadership articulates, ultimately folks revert to performing to the metrics, to the incentives, not to the desired outcomes.

Finally, we must accept variability if we want to be resilient to the whims of a highly dynamic world and a highly unpredictable battlefield. It is imperative that we accept variation in our processes across program types. Some capabilities are simply not needed everywhere but can be extremely useful in targeted places. We will have more than one mission and perhaps the entire fleet/force does not need to be pointed at all missions. Some processes or innovative approaches will be targeted at special operations forces or other small, highly specialized communities or specifically at larger but well-defined communities such as the Submarine community. We will need different approaches for smaller, more attritable programs versus programs that will underpin capabilities across the entire Army.

## Theme 2: Experimentation

Experimentation and prototyping, much like the acquisition process at large, have been the subject of robust discussion in recent decades. However, largely due to budgeting silos and perceived constraints, these efforts are often confined to either disconnected pilot efforts or existing programs of record. Yet, we expect revolutionary ideas and programs to emerge from highly constrained experiments tied to process metrics that drive down risk and disincentive efforts to improve quickly from iterations through failure and learning towards success. It is no surprise that the DoD finds itself tackling this challenge when the majority of incentives and metrics from external oversight by groups such as Congress and GAO enforce the expectation of stability and completion as success, even in a rapidly changing world. We know that we get what we measure, and we need a new culture developed around experimentation and the suite of

activities that encourage iterative learning and creative thinking to ensure we can adapt to shocks and changes in the environment while working quickly through failures toward new and more successful hypotheses and capabilities.

By culture, we refer to the DoD's beliefs and behaviors, and how those proliferate throughout the organization from leadership to the many members that are ultimately decision makers. A culture of experimentation means our view of experimentation, prototyping efforts, red teaming, and gaming as supports to the entire innovation ecosystem. This means supporting and informing not only new technical (materiel) approaches but also new concepts of doctrine, organization, training, leadership and education, personnel, facilities and policy. We need to work toward a world where individual skill development and organizational or institutional memory are invaluable and support leadership who can navigate through iterations of learning and drive the DoD rapidly through and past failure. Experimentation should be a spectrum that encompasses all aspects of acquisition– and these must be addressed in the same conversation, not in siloes separated by powerful lines of authority.

While many of these ideas will feel like heavy lifts in the current system, we cannot ignore that we do not control the pace of change in the world and must start the long hard effort to shift our culture to one that exercises and succeeds in a state of change. Examples of opportunities include:

- Leadership that understands the difference between failure and productive failure, and encourages an iterative learning environment that improves both people and the organization over time.
- Organizations and people that know how to consistently engage a diversity of warfighters in experimentation, prototyping, red teaming, and gaming processes.
- Repositories of knowledge that are created and maintained for lessons learned that span processes, technologies, and operational feedback.
- Data that is viewed as a common resource, not something to hoard, and incentives that ensure rewards and promotions for openness over building fiefdoms.
- Leadership that rewards agility and transparency without a fear of retribution; if there is a result that drives a need for change or deviation from a plan, it is rewarded in order to keep moving towards the outcome at speed.

This change in culture helps realign to an outcome driven mindset where process does not bottleneck innovation to predesignated processes that end in either the Valley of Death or a program of record. Adaptive culture around experimentation should focus on the process of experimentation itself and how to optimize for it and most especially, how to learn from it. This builds the skills we need to lead in a dynamically shifting technology landscape.

Additionally, red teaming and wargaming have a complementary role to play in evaluating innovative concepts, approaches, and technologies based on outcomes, early and continuously. This improves our ability to fight through shocks and is the underpinning of the much discussed and coveted idea of agility. These processes provide invaluable training opportunities for operators, and also allow rapid testing and

feedback in a competitive environment. In an ecosystem so fearful of failing, failure can once again be thought of as a step in a process of productive failure, where lessons are learned, documented, and incorporated into new approaches that overcome the failure.

Additionally, these efforts support increased warfighter engagement and lead to improved trust. In a traditional acquisition process, the operator often feels they have no voice in the development of capabilities they will be asked to use. These recommended efforts allow interaction with new technologies early and with transparent feedback loops that ensure the interaction is seen and valued, which sustain an open-minded end user who is critical to the pathway to adoption. Iteration, whether it is through physical technology experimentation or scenario-based games, can inform a virtuous cycle of incremental changes that, in itself, creates opportunity to innovate through each iteration. There is tremendous value in getting comfortable with a state of constant flux in the world, illustrating the need for both incremental innovation and the occasional foundational disruption. The key is to have the people that can recognize the difference and have the skills to execute.

An example is seen in one of the big successes during Desert Storm: the training center. Red-teaming approaches were used that accelerated learning in exciting ways. During these red-teaming exercises, people started working with new or existing capabilities and the learning was captured and integrated—adhering to the conceptual side of using the technology to deliver outcomes in a fast-paced, competitive environment. Over time, the importance of red teaming diminished; it was viewed as a side effort, the top cover that allowed learning had diminished. We no longer see continuous red teaming to failure that encourages learning and trying again – and ensures our military can learn about all aspects of a threat or a problem and provide insight on what approaches may fail and what options may be on hand to overcome that failure in real time. Red teaming can be brought into technology experimentation, however it is important to remember that the threat is adapting as well. We need red teams that also keep iterating against us to provide a better understanding of how resilient specific capability investments are to the evolving threat and development of new concepts of operation for those capabilities to improve that resilience. To leverage these changes as opportunities is challenging, but it can be done by shifting incentives in the way we operate. We must foster a holistic need for a culture of experimentation. We do this by being supportive of the things that are done right as well as allowing failure to happen and view it as a positive outcome. We drive for more experimentation and reward behavior that does this. We amplify processes that are inherent to experimentation, such as feedback loops and iteration. Most importantly, we move with speed and with the mindset of creating as much sustained value as we can for both individuals and organizations.

We may not like the scale of change that this implies, however, our current approaches for both understanding the technology landscape and assessing the actual importance of specific advances to our ability to fight and win wars are insufficient. This is beyond simply speeding adoption of technologies that matter: First, we must understand what matters, why, and will it still matter if and when the threat changes. This dynamism is not supported in our current system. Continuous red teaming, gaming, prototyping and experimentation can ensure we have the talent to understand how to lead in this

environment of change and that we have organizations building the knowledge bases over time to allow improved prioritization for technology adoption.

A culture of experimentation provides opportunities for individuals to learn the skill of productive failure (discussed below). Most positions within the DoD simply do not tolerate failure: Congress, GAO, budget analysts, and many others tasked with oversight want consistent metrics that are easily quantified and maintained over time to seek perfection and identify failures (rather than lessons). Whether through red teaming against the adversary, gaming out radically new technology concepts in the battlespace, or through experimenting with new tactics for old technology with warfighters, we must have spaces that are incentivized to learn, not simply to sustain a process.

## Theme 3: Productive Failure

There is a mantra across the defense community that we need to go fast, fail fast—but there is little discussion of how to turn failing into learning, and ultimately into new approaches or capabilities that can succeed. People talk about being tolerant of, even celebrating failure, but the incentive on the mission side is fear of failure. Failure does not lead to promotion. This alignment of incentives to fear of failing can hold an organization back from innovation and is deeply ingrained in our perspectives and organizational culture, largely driven by the oversight realities of the DoD. However, failing fast is also not a goal in and of itself; it is a step in a process of learning and iterating quickly through the option space to succeed, or kill the program. There needs to be incentive for taking risk, failing early and cheaply, and most importantly learning something from failure to ensure the organization gets smarter over time. Incentives for risk-taking cannot simply be placed at the individual level; they need to be codified, measured, and rewarded at the organizational level as well. Productive failure requires more freedom for people to fail, and simultaneously a much more strenuous documentation of what is learned along the way. This ensures both that the people gain skills and grow, and the organization also gains more systematic knowledge and improves over time, even as individuals rotate out.

The DoD has no true notion of corporate or institutional memory; the Department values expertise, but not the lessons learned through that expertise and the organization-level knowledge that could be accrued over time from failures and experimentation. Imagine a place with tens of thousands of scientists and engineers, hundreds of thousands of warfighters, and tens of thousands of policy experts, among others, all working on some of the most challenging and complex problems on earth, but without mechanisms for compiling that knowledge over time. When someone rotates or leaves, the entire chain of knowledge leaves with them.

Institutional memory not only allows for productive failure, what we used to just call learning, and ensures the next experiment builds on that foundation; it also allows an organization to bring back a past idea that may work in a current moment. For example, the primary patents for advanced manufacturing were made in the 1980s but needed other breakthroughs in materials and computing that have occurred since before the technology could really be applied in a meaningful way to military problems. Interestingly, we are learning that there are now challenges around understanding consistency of material characteristics and certification of parts that have emerged,

and we may need a third try at advanced manufacturing before it can make the envisioned impact at scale. This is productive failure: pushing an idea to its limits, learning when and how it can be used and where more work must occur for utility.

This approach is only productive if the experiments are crafted with rigor and the learning is documented for future use. Our defense labs and operational commands don't have shared repositories for documenting and passing on what they learned one, five, ten years ago. The person who was involved must be known and it must be hoped they happen to still be accessible to the system. This is even more challenging with our active-duty members or at places such as DARPA where rotations are mandatory but there is no mechanism for documenting lessons learned. These mechanisms are also critical for compiling and developing user feedback profiles and user ideas for new concepts of use for technologies they try out.

## Theme 4: Leadership and People

Cultivating an environment where failure is not only rewarded but part of the educational ecosystem of the organization and ingrained into the learning pathway of individuals requires leaders and leadership who are comfortable with navigating change. However, leaders who are comfortable with change, and who understand how to wield "failure" as a process of iterative learning and quickly integrate that understanding into more successful pathways, do not simply appear. They are grown. We must create organizations that develop strong leaders through training, sustainment, and promotion based on these skills and characteristics.

In fact, leadership came up in every conversation with stakeholders. We cannot avoid tackling the challenge of growing and promoting a cadre of leaders that are comfortable with change and operating in uncertainty. However, the current organizations, selection processes and performance metrics tend to focus on skills accrued in the last war, on sustainment of existing programs, knowledge of process, and not rocking the boat. Even external analysis of DoD programs by groups such as GAO tend to focus on sticking to a plan, regardless of the pace of external innovation and the shifting trajectory of the threat. If it was said 10 years ago that a specific thing was to be created and 50 of those things were to be bought, then that specific thing should be made and bought at that number, even if it is now a bad idea. Innovation fundamentally means change, and if we only promote based on the stability of existing programs and favorable reviews by others who value stability metrics, we will rarely develop leaders who are comfortable with change. We need leaders who can exercise the process, but right now we are solely developing and promoting for stability. We must create a channel of talent that can exercise change.

Bringing in individuals such as "straddlers", people who can work across stovepipes easily, is important in these types of environments. These straddlers understand more than just a single technology; they also understand the associated context and policy needs. These individuals are rare, and breadth is generally not promoted equally to deep expertise. This skill needs to be nurtured in the DoD and leveraged to see the connections among the science, engineering, test and evaluation, and operational utility.

The characteristics of the environment also matter. Examples of leaders that were successful pushing through innovative programs in the DoD tended to be fully

embedded in the organization. They had the authority to remove roadblocks across functional and operational lanes, and the time in the position to champion the idea to completion. This type of authority and responsibility is rare, and rotation cycles are short. It makes these leadership examples rare and requires significant luck in having the right person available for a specific rotation at the right time to fully complete a project within their 3-year cycle.

This challenge of developing people, and ultimately leaders, requires a suite of changes. We need new organizations resident across the Services and OSD that support critical thinking and experimentation. These organizations must exercise the ability to clarify desired outcomes and learn productive failure through experimentation, red teaming, and variations of gaming. This is a challenge that needs to be addressed both in the civilian and military workforce. For civilians, the ability to draw on historical talent pools exists, at least as a bandaid; these people are dispersed but sometimes still resident in think tanks, labs, war colleges, and industry. It may also be possible to create new advisory groups that sunset on 5-year time horizons and possibly shift around to different “home institutions” to avoid fiefdoms while pairing rigorous approaches to corporate memory and ‘alumni’ networks. This is a bigger challenge on the military side. We need both selective schooling and continuing education throughout the career of military officers to ensure that skills are learned, as well as developed and used over time. We need new incentives and rewards that lead to promotion and rigorous selection processes that ensure we are identifying and rewarding truly qualified candidates. Most importantly, those identified candidates must have a real promotion path to flag officer positions.

Specific organizations across the Services and OSD are needed to develop these skills of working through ambiguity and failure, taking feedback from users and iterating on better ways to operationalize concepts to capabilities, rapidly integrating lessons learned and feedback, killing ideas as needed and growing those that clearly improve outcomes. These organizations cannot simply be ad hoc task forces; they need sustained support, and they must control the selection processes, incentives, and promotion paths of the people chosen to participate. These organizations must be protected and sustained, exercise and train through outcome-based cultures of experimentation, be critical if we want to connect strategy and outcomes to our technology and talent in this new environment of change. In order to ensure that leadership drives clarity into the way we prioritize our desired outcomes, these organizations must learn through and lead to help determine what problem we are actually trying to solve and help define our critical technology needs through the lens of accrued knowledge about when those technology solutions are likely to work, and when they are likely to fail. This often simply turns into a bureaucratic fight for power over process, rather than a collaborative engagement among groups of expertise in policy, warfighting, and research and engineering. We need all of the stakeholders in the debate, and we need warfighters at the table, learning about technology and pushing back with feedback on the realities of war being pushed hard to consider new concepts of operation.

Artificial intelligence (AI) is a great example here. There is not a lot of training on what AI actually is, how it can be used, or feedback on what approaches are the best cultural fit for the U.S. military. Warfighting is still a very human activity, yet we will always be interacting with technology, so we need strategic and tactical spaces with a range of

perspectives being hashed out, red-teamed, pushed to failure while updating our approaches with new knowledge gained through those failures. To succeed, these organizations must attract top notch talent, and this only happens if they own the people, there are rigorous selection processes in place, and promotions happen as a result.

A critical aspect of ensuring the success of organizations such as the ones described is a pipeline of top-notch talent. This pipeline requires ensuring that our training and education system is capable of providing the discussed skills in a meaningful way within the military. An example of a model that might be emulated for developing skills in innovation and a cohort that understands a culture of experimentation is the School of Advanced Military Studies or SAMS planner school. In the 1980s, a gap was identified in the operational planning skills that Services needed; SAMS was created to fill that gap. Essentially, as a Major, an individual arrives at the Command and General Staff College (CGSC) and in order to become a SAMS planner, that individual starts the process by applying and providing a recommendation from a faculty at the CGSC. After this point, an online exam is completed, and if completed successfully, the individual progresses to an interview at SAMS for suitability. Finally, if selected, they must be approved by their Service/Branch. Following completion, the individual receives an additional skill identifier (ASI) as a SAMS graduate and can seek out positions that designate that ASI.

Beyond Majors, there are additional war college opportunities such as the Advanced Strategic Leadership Studies Program (ASLSP) at the O-6 level, a two-year program wherein the second year the O-6 joins PhDs as faculty teachers in the SAMS program. An additional model that might be considered for adaptation to this innovation topic that could continue building knowledge and skills, as well as build a rapport between military officers and civilians, is the Seminar XXI course. This year-long activity is also highly selective, but allows minimal disruption. It requires one evening each month for a lecture and discussion over dinner, and requires three weekends over the year where the cohort gathers for three days of lectures and discussion. This ensures that the war college is not the last intellectual update that an officer has in their career.

Finally, incentives and promotions are perhaps the difference between success and failure over the long haul. If the focus is only on education, but not accompanied by incentive or promotion, officers will simply leave and provide their skillset to the private sector. Incentives are the lynchpin in creating and maintaining alignment with leadership priorities. If the priority of these organizations is to develop outcome-focused environments that teach and protect a culture of experimentation, embrace iterations of learning, and develop more agile individuals and smarter organizations, then we must ensure the incentives align actions to those outcomes. If incentives are aligned to perfect process, the result is folks who are invested in perfect process, on time and on schedule, as opposed to a program that dies because it no longer aligns to the threat or a program that shifts in order to meet the changed external technology and threat landscape. Rotation schedules are often blamed as they ensure that leaders are not around long enough to be invested in the outcome over the process since they will not be there to take credit for the outcome. But the challenge is less the rotation and more the metrics of their success, and the incentives they are given; they are managed on process because it is easier to quantify. The primary incentive should never be “I managed a great process” or “I didn’t go to jail.” While both are objectively

fine, they should not be primary goals; we want the primary incentive to be aligned to outcomes such as “I ensured that the program is adapting to the threat” or “I found a legal way to execute the mission today.”

### Current Examples

While the DoD has not overhauled its use of experimentation to fully support innovative thinking, there are current efforts to expand technological prototyping and experimentation beyond programs of record. We provide two examples of programs attempting to leverage innovative technology and concepts for transition to new weapons systems. The first example accesses technology from non-traditional vendors, and the second example accesses high-end, hard-technology (involving deep scientific advances) from and through traditional vendors.

***Example 1: Blue Unmanned Aerial System (UAS)***

The commercial sector is currently leading the DoD in developing powerful technology in certain sectors, especially those that are software heavy. The common consensus is that adoption of commercial technology is key to sustaining a technological advantage over adversaries and requires integrating commercial emerging technologies into the DoD at speed and at scale. To do this, we cannot wait for wholesale overhauls of the system; these technologies must be brought into the existing procurement processes. The current system is not optimized for non-traditional vendors who need rapid purchase decisions with access to long-term production contracts or agreements for sustained, long-term work with the DoD. Incentives for non-traditional vendors to do long-term work are only present when there is an award of contract for the adoption of their technology. So, new and creative ways are being developed to attract non-traditional vendors to work with the DoD.

An example that attempts to address this issue is the Defense Innovation Unit (DIU), which has implemented a new practice to incentivize non-traditional vendors to do business with the DoD even when a sustained award is not provided. In this example, an autonomy portfolio named Blue UAS was created that brings a holistic approach to rapidly prototyping and scaling capable and secure commercial UAS technology for the Department.

A specific response was initiated under the Blue UAS portfolio when the Army released a requirement for small drones. Several vendors were chosen to develop the capability; in the end, one was selected. However, the creative aspect of this program within Blue UAS was to ensure that the rest of the government had access to the knowledge produced from this prototyping effort. The vendors that weren’t selected still had viable products that met the strenuous requirements outlined in the Procurement of Unmanned Aircraft Systems to Implement Section 848 of The National Defense Authorization Act (NDAA). These systems were qualified as cyber-hardened drones and had been rigorously evaluated. DIU navigated the process of placing the drones that were not selected onto the General Services Administration (GSA) schedule, allowing the products to be purchased by other government agencies, (e.g., the Department of Homeland Security, its Customs & Border Protection agency, and the Department of the Interior), and thus rewarding all the participants with additional visibility and improved ease of other long-term funding even though they did not “win” the competition.

This example illustrates how the DoD can use instruments and processes already at their disposal to ensure knowledge generated from prototyping efforts is not lost, and to improve access for small companies to federal agencies beyond DoD. Additionally, these solutions do not require big policy overhauls, congressional intervention, or new funding, and can be accomplished today. This demonstrates people working to the outcome and developing creative solutions, not simply working to metrics on a process.

***Example 2: Directed Energy Maneuver-Short Range Air Defense system (DE M-SHORAD)***

It is unlikely that small companies or those focused primarily on the commercial space will be able to provide the high-end hard-tech solutions needed to bring new weapon concepts into reality. With increased efforts by U.S. adversaries to bring key strategic technology from the lab to the battlefield, we need new ways of quickly experimenting with prototypes to bring new technologies into the hands of warfighters so new concepts of operation are being developed as the technology continues to improve. Unfortunately, speed and the agility to iterate are not easily supported within the current acquisition framework.

The Army's Rapid Capabilities and Critical Technologies Office (RCCTO) is working to challenge that idea. An example is their work to bring vehicle-mounted laser technology to fruition through the experimental prototype Directed Energy Maneuver-Short Range Air Defense system (DE M-SHORAD). They successfully developed and purchased four prototypes that were delivered to the Army in 2022. The mission-oriented structure of the organization was critical to their success: Every decision was tied to the outcome of RCCTO's mission, not to a higher echelon command or agency. From the start, staff were hand-picked and the people who joined the organization believed in the mission and wanted this assignment. In order to move fast, people matter.

Another critical aspect is the support. RCCTO has a support node called the "Octagon" that brings in the key stakeholders from across the Army necessary for future adoption of the capability. It is a quarterly meeting in which everyone outside of the prototype effort is present to discuss progress on support they are providing or are forecasted to provide in the future. This is critical because we cannot rapidly adopt unless aspects such as sustainability, training, material, facilities, policy, organization, and doctrine are not acting in parallel. The Octagon is a concerted effort to avoid the "Valley of Death." The meeting is an executive summary out-brief at the 2- and 3-star flag officer level where impending challenges can be discussed and solved before they become bigger impediments. Other aspects of organization that are not unique to RCCTO, but are important to note, include: the 3-star in command gives unilateral authority to subordinates to say yes more often and not impede efforts to move technology through milestones because of bureaucracy. With new weapons concepts, we need prototypes in the hands of operators to begin experimentation and provide feedback. Perfection often keeps us from access to useful versions of high-end hard technology and slows the uptake by operators.

RCCTO is also free from the standard requirements process and works with design characteristics informed by the user community. This is usually a 70-80% solution to what the product will need to do and allows the end user to make informed decisions about iterations to a more mission focused capability centered around how the technology will be used in the field. This integration of the end user in the prototyping and experimentation steps is critical to rapidly moving technology to adoption as well, ensuring only critical changes are made and no fluff is added, and saving money over the prototyping phase. While the users are critical, RCCTO does not focus on giving the end user a capability they ask for; rather they provide Army senior leaders with decision points, e.g., do you like this capability? Do you want to purchase this capability? Do you think there is merit but it needs changes? For new weapon concepts, this balance between end user feedback and leadership vision is critical.

Finally, RCCTO has created a competitive environment that brings in multiple vendors that move quickly to achieve clearly articulated milestones. Vendors are graded on performance, cost, and schedule. For DE-MSHORAD, performance at the range was the biggest differentiator among vendors. Unfortunately, the range performance resulted in only one vendor making it through to the end. An important takeaway is that once competition was no longer on the line, costs began to balloon, proving that competition is preferable and that in high-end technology areas, especially those highly restricted to defense, finding sufficient competition is challenging. Competitive experimentation and prototyping may be more effective on lower price point systems.

Through these internal organizational policy and rapid prototyping efforts, RCCTO was able to field four DE M-SHORAD in an unprecedented timeframe. They even went on to mirror all these policies on a smaller scale rapid prototyping effort working with counter UAS, in which they are seeing similar results with some of the lessons learned. It is possible that the adoption of this case's efforts across other programs could alleviate some of the issues the traditional acquisition system and the larger DoD ecosystem face today.

## Moving Forward

Innovation fundamentally requires change and disruption, and the pace and geographic breadth of technological advancement globally is equally unrelenting. However, this does not mean that every person and process within the DoD should be innovating and changing all the time. This tendency for our reactions to lack nuance and to take every concept to its (rather absurd) extreme is unfortunate. Disruption is a concept that should always be weighed in a relative space. We need people and organizations that can help us understand both when we need to innovate, and (frankly) when the status quo is likely sufficient if we have the right tactics, techniques, and procedures. We must have the skills to innovate—but also have the good sense to distinguish when innovation is actually helpful and when it is just change for the sake of change.

Balancing these ideas requires strong leadership, which means both leaders who have proven experience in prior wars, and leaders with the skills, foresight, and perspective to navigate the unknown and uncertain terrains of future wars with prudence to inform priorities. The uncomfortable reality is that the selection criteria, incentives, and organizations that made the DoD the most powerful military on earth may not, in fact, be the right ones that can sustain that position into the future.

Finally, we must accept that these are major shifts in a large, highly complex system. There will be unintended consequences. Iterative learning and experimentation are needed as much in our approach to changing policies and doctrine as it is in our attempt to improve our defense posture within this new era of technological and rapid threat changes.

Our discussions and analysis have identified other approaches that should help in moving forward. To navigate the need for iterative policies, policy test simulators and readiness levels could be created**.** Innovations can involve not only technical (materiel) capabilities but also the development of non-materiel improvements in doctrine, organization, training, leadership and education, personnel, facilities and policy. Experimentation can inform innovations in most of these, but testing and measuring policies requires more specific approaches. Thus, simulators (policy test laboratories) to test DoD policies before implementation seem like a critical capability to ensure that the United States understands (as best as possible) what the potential impacts will be for any policy change as well as the level of certainty or the maturity of a policy change. A complimentary idea of establishing a “policy readiness level” metric scale (analogous to technical readiness assessments and levels [Government Accountability Office, 2020]) was raised, and a brief review of the topic shows that both the concept of levels that indicate the maturity of the policy as well as tools that establish the ability of an organization to actually leverage a given policy change have both been considered, primarily in the EU and Canada. This could be a useful approach in concert with the policy test laboratories and (perhaps) with some of the defense education organizations. Next steps may include the development of a policy test laboratory and associated policy readiness level scale for innovating solutions for a strategic objective of interest. For example, the leadership incentives and promotion recommendation above could be first examined in a simulation before piloting.

There are no silver bullets. As appealing as single actions are, prior actions do not appear to be moving us towards a better readiness posture. Full progress is likely a 20-year problem. Yet, it will always be a 20-year problem if we do not act now. At some point we must map the complex problem space, craft a strategy for forward progress, and take initial steps. That time should be now.

We must begin to intentionally create the innovation ecosystem we collectively talk so much about. This goes beyond our process-oriented reforms of the system we created to serve the Cold War. This means recognizing that innovation is not simply acquisition. To succeed in this dynamically shifting technology landscape, we must move beyond simply reforming the existing acquisition framework and processes to provide innovation. Organizations, experimentation, and people must be cultivated and protected. This concept cuts across major lines of authority and requires that the DoD craft the skills and critical thinking necessary for leadership and workforce in a new reality of rapidly emerging, widely proliferated technology.

## Recommendations

Based on our research, we propose the following recommendations and next steps to move toward achieving these strategic goals:

1. ***Create organizations that teach and sustain red teaming and experimentation activities and that report directly to leaders with the authority to move money and influence and support functions to field innovations critical to operational needs.*** These organizations must be protected organizations (not processes) that serve leadership. They must be organizations, not a process, where a culture of experimentation is embodied and rewarded. Historically, we had strategic cells and empowered groups within the Military Services and war colleges that reported directly to the Chiefs and Secretaries with deep expertise in red teaming, wargaming and experimentation activities, but these have degraded in independence and influence over time.
2. ***Craft experimentation and iteration opportunities within those organizations that directly engage warfighters to expand concepts for use of both novel and existing technologies as well as complementary changes in doctrine, organization, training, materiel, leadership, personnel, facilities, and policy (DOTMLPF-P).*** Examples might be either virtual game environments for the pre-prototype stage of emerging technology concepts (e.g., quantum sensing capabilities) or direct experimentation with technologies given to warfighters without instructions for use, or in iterations that move from existing uses with instructions to incentivizing creative uses that go beyond our imagined tactics, techniques, and procedures (TTPs). This widened range of engagement with technology can provide an invaluable feedback loop for developers and increased confidence and buy-in among operators.

**Next Step Options for Recommendations 1–2:** Prototype such approaches in either an applied experimentation or acquisition organization such as the Army Futures Command or a Rapid Capability office in one of the military services.

3. ***Develop repositories of learning across these organizations that create long-term corporate memory for both the innovating office and the DoD, making the institution smarter while decreasing negative impacts of high personnel rotation tempos.*** If we want organizations that learn over time, we must institutionalize the idea of a strong corporate memory. No one should be rewarded for being the only source of a piece of information. We need folks who rotate, learn about the DoD from many perspectives, and stay fresh in their expertise, but we also need organizations that survive and thrive in an environment of perpetual rotation and change. We must stop incentivizing organizations that keep "learning" the same lessons over and over again and start rewarding organizations that get demonstrably smarter over time. This requires processes and knowledge management systems for every office that can be federated for larger institution-level questions. This should extend beyond innovation to all of acquisition, but here we discuss its criticality at least for innovation. Offices must start with identifying their core outcomes and responsibilities then create repositories with digitized input mechanisms for capturing both positive and negative results over time. Anything negative should be framed as what the office learned, and there should be information accompanying the entry to advise the future office inhabitants of changes that might warrant another look at the approach or technology. This can be developed as a layered and federated approach that ensures interoperability without dictated single solutions top down. Layered approaches can increase the ability to do strong access control at the individual level while ensuring sharing can occur across offices, organizations, Services & Agencies, as well as externally to other agencies and with contractors and grantees. After-action reports and lessons learned are prevalent across the Services and provide a way for military operators to refine not just TTPs but also ways that they can better use the equipment that they are given. Such after-action reports could be a key element in a more structured feedback loop and institutional memory for innovation. By giving operators technology in the early stages of development, developers can provide feedback on technology shortfalls or successes.

**Next Step Options for Recommendation 3:** A pilot project could review existing and prior practices for institutional memory, then propose and test a structure with an existing innovation organization (e.g., a Rapid Capability office in one of the military services). Example practices include after-action reports, lessons-learned repositories, the Defense Innovation Marketplace,[1] organizations chartered to preserve lessons through workforce retention and tenure (e.g., the defense laboratories and federally funded R&D centers), the knowledge repositories at the Defense Acquisition University (DAU) Knowledge Repository,[2] the Defense Technical Information Center's technical reports archive,[3] and various short-lived lessons-learned repositories at DAU.[4] Newer technical options could be reviewed, such as the recent AIRC incubator study on knowledge representation and preservation.

[1] Defense Technical Information Center, Defense Innovation Marketplace (undated).
[2] Defense Acquisition University (2017).
[3] Defense Technical Information Center, Technical Reports (undated).
[4] See, for example, Kobren (2015).

4. ***Attract and retain people and leaders with the skills incentives, and empowerment to navigate this dynamic new world*.** Current recommendations tend to focus on process, but the idea of standardizing innovation and making the staffing generalist so that anyone can rotate in and do the job effectively without education and practice is unrealistic. This is especially true in a system that generates and promotes generalists that are highly tuned to accountability and stability over long internal requirements and budget cycles rather than rewarded for adapting to rapidly evolving external conditions. Our stakeholder interviews suggest that success largely happens when you have strong, empowered leadership, which especially in DoD active-duty military must be grown not acquired externally. Aspects of leadership, and the pipeline of talent that must be fostered in order to develop a strong leadership pool with these skills and characteristics, appear to include "training grounds" or a host of organizations that reward and promote on these skills and ensure a pipeline of development for leadership, expanded use of experimentation, red teaming, and gaming to foster iterative approaches that exercise to failure, learn, and re-engage with updated approaches, thus ensuring a talent pool that is comfortable with change, and rigorous selection processes, incentives, and promotions that reward agility.

    4.a. ***Develop and apply education and training plans and programs to staff and leaders.*** Build on models such as the School of Advanced Military Studies (SAMS)[5] and Seminar XXI[6] to create detailed recommendations for education that go beyond a simple focus on buying more technology and improve the comfort and ability of officers and civilians to work in dynamic environments and become comfortable operating through iteration to push change where needed.

**Next Step Options for Recommendation 4.a.** Develop, implement, and test and educational and training plan with a relevant cadre of promising candidates at a relevant war college or DAU. Alternatively, an assessment of the careers of students attending existing models such as SAMS and continuing education activities such as Seminar XXI could be conducted to assess their strengths, weaknesses, and effectiveness.

    4.b. ***Apply outcome-aligned incentives and promotion criteria to leaders and staff to motivate and enable innovation.*** It is clear that incentives that align to desired outcomes are critical for success. Ultimately, when it comes to our military talent pool, if innovative leadership is the desired outcome, promotions are the ultimate incentive. Right now, risk-taking in an acquisition job is a career killer. Organizations that develop this workforce channel must be empowered to apply rigorous selection processes and focus on attracting top notch talent, while simultaneously ensuring there is a promotion path for those that are learning and effectively managing risk. It is clearly understood that certain types of commands ensure promotion, but on the flip side, the absence of those command positions tends to block promotion. We do not need to change

[5] U.S. Army (2019)
[6] Massachusetts Institute of Technology (undated)

the entire process, but if we do not add this new skillset to the mix as a high priority, we will greatly diminish our ability to fight in this new world. Old processes simply do not consider the new pace of change.

**Next Step Options for Recommendation 4.b.** A pilot program could be pursued to create and test a set of incentives and promotion criteria for a cadre of military and civilians, especially those identified as having potential for future advancement or for a particular focus organization. The first step here is diagramming the process in detail, breaking down the military selection process at various levels, especially the O-5 to O-6 and the O-6 to flag officer levels or their civilian equivalents, to see where and how many changes would need to be made to ensure enough talent make it through to provide talent options for leadership. Special promotion authorities might be used during the transition period. Civilian performance and promotion criteria could include specific innovation-outcome metrics beyond their immediate organizational goals to pilot and test how best to incentivize the desired performance.

4.c. ***Empower organizational environments structured to enable innovation, testing, learning, selection, and fielding of operationally critical ideas.*** Such empowerment is as critical as training leaders with the right skills. Without it, the DoD runs the risk of merely frustrating innovative leaders and watching them leave the department early for successful careers in industry.

**Next Step Options for Recommendation 4.c.** Study and assess existing and historical environments (e.g., the historical Joint Forces Command) to identify lessons, best practices, issues, and value propositions to apply to organizational environments. Understanding what worked and why past environments were eliminated is crucial for avoiding past issues and establishing a longer-term approach that can both endure and produce value. As part of this effort, build simulators to test innovation incentives policies (i.e., test before broadly implementing new policies) and develop policy readiness levels to inform policy decision making.

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