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INNOVATING FOR GREAT POWER COMPETITION

AN EXAMINATION OF SERVICE AND JOINT INNOVATION EFFORTS

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Cover Graphic: Sailors and Boeing team members prepare to move an unmanned MQ-25 Stingray aircraft into the hangar bay of the aircraft carrier USS George H.W. Bush in Norfolk, Va., Nov. 30, 2021. Photo by Navy Petty Officer 3rd Class Noah J. Eidson.

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Executive Summary

The United States military is currently attempting to adapt to the operational challenges presented by China and Russia. After nearly two decades of counterinsurgency in the Greater Middle East, the Department of Defense finds itself looking to the Cold War for lessons on high-intensity conflict. To modernize its platforms, doctrine, and force structure to compete with and defeat 21st-century great power competitors, the military services and the Department of Defense as a whole are seeking to promote conceptual, organizational, and technological innovation within the U.S. armed forces. With the Cold War as a guide, this monograph examines current U.S. military innovation efforts at the service and joint levels and provides viable lessons for fostering innovation at both echelons.

Military innovation refers primarily to evolutionary and potentially revolutionary warfighting innovation undertaken during peacetime or wartime. Although technology is often the most visible form of innovation, it encompasses technological, operational, and organizational innovation, whether separately or in combination, intended to enhance the military's ability to prepare for, fight, and win wars. The theory and history of innovation show that several factors play a crucial role in bringing major advancements to fruition, including recognition of the threat environment, senior-leader sponsorship and support, innovators and their advocates and networks, and organizational culture. Additionally, military innovation typically occurs in three stages: speculation, experimentation, and implementation. Should these elements of innovation be missing or insufficient, failure can occur in any of these three stages, as well as during employment on the battlefield. These ingredients and phases combine to yield a framework for diagnosing innovation in historic and contemporary military organizations.

Applying this framework to the innovation efforts of the U.S. military during the Cold War reveals the importance of operational challenges that defy a conventional solution in driving the development of new ways of war. The Army's implementation of the Pentomic Division in the 1950s failed due to inadequate testing and refinement during the experimentation phase. With the technology of the era unable to support these concepts, the Pentomic Division should alert today's innovators to the dangers of embracing concepts that are completely reliant on ambitious technological progress.

In the 1970s and 1980s, the Army and Air Force's successful development and implementation of the AirLand Battle doctrine offers numerous insights for contemporary innovators. Just as post-Vietnam Army leaders studied the 1973 Arab-Israeli War for lessons on how modern technologies would change the battlefield, today's conflicts in Ukraine and beyond may offer important lessons for the U.S. military. Moreover, innovations like AirLand Battle, which play to the organization's existing culture, can expedite the implementation of new ideas and systems. Ultimately, AirLand Battle stands as an example of new concepts and doctrine successfully driving the development and procurement of new technologies.

The Navy's Maritime Strategy of the 1980s largely supports these lessons and insights. The development of the *Tomahawk* cruise missile displays the value of compromise between joint and service-level requirements, as well as the need for joint leadership to push the military services to work together to avoid unnecessary redundancy and speed development timelines. *Tomahawk* also provides a case study in follow-on innovations achieving more success than initially unpopular programs, often because the threat environment, requirements, or the organization's culture shifts over time.

Moving to the U.S. military's current efforts to address the challenges presented by China and Russia, the framework can be applied to current initiatives in the services and at the joint level in two key areas: the development of new operational concepts and the maturation and implementation of the Joint All-Domain Command and Control (JADC2) concept. Beginning with the armed services, our examination shows that, with some variation between them, the services appear to possess the ingredients for successful military innovation. Alongside new operational concepts like Multi-Domain Operations, Agile Combat Employment, Distributed Maritime Operations, and Expeditionary Advanced Base Operations, each of the services has created new organizations intended to develop, refine, and implement innovative concepts and programs to overcome operational challenges and support JADC2. Although many concepts remain in their early stages and the services lack much of the mature tissue connecting platforms, organizations, and concepts, these linkages can be developed over time and through continued experimentation and wargaming. Overall, when given a clear vision and guidance from senior leadership, the military services appear to be moving through the stages of innovation. Although grading the efforts of the services depends greatly on the chosen metric of success, the information available indicates that the conditions for continued innovation are present.

At the joint level, the application of our innovation framework creates a more concerning snapshot of contemporary joint innovation efforts. Although the Joint Warfighting Concept (JWC) was written as an "aspirational" document to be further refined, conceptual and organizational innovation at the joint level struggles from ill-defined concepts and poorly supported approaches that hinder senior leader buy-in, experimentation, and the development of the intellectual capital needed for transformative change. Like the previous development of AirLand Battle, the current JWC and JADC2 efforts must overcome a culture of stovepiping and resistance to change.

The Department of Defense can improve joint innovation through more robust guidance and coordination, as well as the consistent involvement of senior civilian DoD leadership from conception to implementation of further iterations of the JWC. After its initial development, the concept will require experimentation at all levels with a variety of stakeholders. Innovation efforts would benefit from a genuine discussion and debate over the effectiveness of alternative concepts as well as an extensive program of gaming and experimentation. Service efforts need to be augmented by joint experimentation. With current joint and service concepts hindered by a lack of clarity, a clear unclassified summary would help to explain the JWC to the majority of servicemembers, the defense analysis community, Congress, and the American public. JADC2 would also benefit from greater joint direction and a realistic definition of its objectives beyond simply "linking *everything* together." DoD officials appear to be moving toward the creation of a joint office to oversee JADC2, which could help set requirements and establish key JADC2 nodes in each service.

Ultimately, the structure of the Department and the bifurcation of innovation efforts between the Pentagon and the military services create several potential outcomes for current innovation efforts. Simplifying innovation results to "success" and "failure" at the joint and service level creates four possible outcomes should one organization innovate more effectively or at a faster pace than the other.

- The first outcome represents the best-case scenario, in which innovation succeeds at both the service and joint levels. Joint institutions provide concepts and drive technological requirements for each service. Because these innovations are effectively overseen at the joint level, the services develop mutually supporting and enabling capabilities, doctrine, and force structures. As a result, the whole is greater than the sum of its parts, as the Joint Force capability exceeds each service's capabilities.

- The second outcome results from individual services implementing military innovations more effectively or quickly than the Pentagon. This case is the second-best outcome; each service develops solutions to its perceived operational challenges. The risk, however, is that each service works towards innovations that are disjointed, uncoordinated, or duplicative with its counterparts. As a result, the services may produce concepts and programs that rely on joint capabilities that never materialize due to a lack of synchronization. Still, many issues between the services in this outcome could be less serious—relative to the following two scenarios—and could be resolved through ad hoc and bilateral coordination.

- In the third outcome, joint efforts succeed but service-level efforts fail, limiting military innovation for the U.S. military as a whole. Although DoD plays an essential guidance and oversight role, innovation primarily relies upon the individual services to develop and field new capabilities. Even with a clear JWC and supporting concepts, one or more of the armed services could limit the effectiveness of those concepts, resulting in overall innovation failure as legacy forces lack the capabilities required to implement forward-looking joint concepts tailored to the challenges of great power competition.

- Finally, failure at both levels constitutes the worst-case outcome. Both strategic and operational challenges pose barriers to the United States' chances for success in great power competition and conflict. The U.S. military would be left with legacy concepts and platforms at all levels, facing adversaries who have specifically tailored their strategies and weapons to defeat those warfighting methods.

Although successful joint and service innovation is the desired outcome, our examination of DoD innovation finds that service efforts may outpace joint efforts. Should this outcome manifest in the near future, each service must prepare to operate with its new concepts and technologies absent a solid joint framework or the all-encompassing joint connectivity promised by JADC2. Several options exist for operating in this manner, including a functional separation of roles and missions, dividing geographic sectors of responsibility between the services, or temporally separating service efforts by operation phase.

Our examination reveals cause for both optimism and concern regarding the Department's ongoing innovation efforts. Recent events in Ukraine, the Taiwan Strait, and the Sea of Japan add to the urgent need to address the strategic and operational challenges presented by contemporary great power competition. The seeds of innovation are present, albeit unevenly, within the U.S. military. Innovation is never a simple or fast process, but every step of progress made in the present will save lives in the opening moves of tomorrow's war.

CHAPTER 1

Introduction

The United States military is currently attempting to adapt to the operational challenges presented by China and Russia. After nearly two decades of counterinsurgency in the Greater Middle East, the Department of Defense finds itself looking to the Cold War for lessons on high-intensity conflict. One topic of intense interest is that of military innovation—how can the U.S. Department of Defense (DoD) modernize its platforms, doctrine, and force structure to compete with and defeat 21st-century great power competitors? Using the Cold War as a guide, this monograph seeks to examine current military innovation efforts at the service and joint levels and provide viable lessons for policymakers moving forward.

Both the individual military services as well as the Department of Defense as a whole are seeking to promote conceptual, organizational, and technological innovation within the U.S. armed forces. Each of the armed services is developing new concepts and programs to address existing operational challenges. The Army is pursuing Multi-Domain Operations (MDO) and is fielding task forces centered around the concept. The Air Force has been supportive of MDO and is continuing to develop a concept it calls Agile Combat Employment (ACE) to increase the resiliency of its airbases and forces. The Navy, for its part, is implementing Distributed Maritime Operations (DMO) as a concept to enhance its survivability and lethality in the face of anti-access/area denial (A2/AD) threats. The U.S. Marine Corps is pursuing Littoral Operations in Contested Environments (LOCE) and Expeditionary Advanced Base Operations (EABO), which emphasize using hard-to-target forward bases, a wider range of maritime platforms, cross-domain fires, distributable units, and lighter and more agile forces for offensive operations in support of sea control. Each of the services is investing in programs and organizations to support these new concepts.

At the top, the Office of the Secretary of Defense (OSD) and the Joint Staff lead joint innovation through conceptual endeavors such as the Joint Warfighting Concept (JWC) and Joint All-Domain Command and Control (JADC2). These centralized efforts attempt to guide, synchronize, and integrate the initiatives of each military service.

Although the need for new concepts and platforms is clear, it is uncertain whether current service and joint efforts reflect the best practices of past innovation efforts. Given limited resources, policymakers require the ability to discern which proposed initiatives have the greatest potential for success. How can civilian and military leaders in the Department of Defense and legislators in Congress discern which innovation efforts are worthy of support? How can they best bolster and support such efforts? To aid this process, this monograph offers a snapshot of current service and joint innovation efforts against the backdrop of successful innovation efforts of the past, with a particular focus on the Cold War. Along with this examination, this report explores the relationship between service and joint-level innovation and offers lessons for U.S. military innovation efforts moving forward. Specifically, it addresses the following questions:

- *What efforts are the U.S. armed services currently undertaking to develop innovative technologies and concepts of operations? What efforts is DoD undertaking at the joint level?*
- *Do they reflect the best practices of past successful innovation efforts? If not, what elements appear to be missing?*
- *What is the relationship between decentralized service-level and centralized joint innovation efforts?*
- *Should service and joint-level innovation efforts progress unequally or at varying rates, how should the U.S. military make the most of innovation successes?*

This monograph uses case studies of U.S. military innovation during a previous period of great power competition—the Cold War—to develop a unique framework that can be used to diagnose current U.S. military innovation efforts. The study focuses on the Cold War because the bureaucratic institutions and organizational culture of the Defense Department and armed services approximate those of today more than more historically distant cases. We further refined the framework through a series of virtual workshops devoted to individual service innovation efforts.

The study then proceeds by applying this framework to current service and joint-level innovation initiatives to produce initial impressions of DoD's efforts. Based on our examination, the monograph explores the interaction between service and joint-led innovation, including potential outcomes if either endeavor is less than successful. We propose options for the DoD moving forward to achieve the most advantage, regardless of the individual innovation success of any one service or joint initiative. These considerations are key as the Department of Defense grapples with the challenges presented by great power competitors. History often shows that war does not come at our time and place of choice, so the U.S. military must be prepared to fight and win no matter the progress of modernization efforts.

How We Examine Service and Joint Innovation

The monograph begins in the next chapter by establishing a framework for assessing military innovation throughout three phases of development. The chapter also offers a look at potential barriers to innovation as warning signs for future efforts. Chapter three then examines several historical cases of conceptual, organizational, and technological innovation during the Cold War and applies the framework to draw lessons on U.S. military innovation during eras of great power competition.

Chapters four and five bring us to the present day, with chapter four examining service innovation and chapter five evaluating joint innovation. We explore contemporary innovation in DoD by applying our framework to two efforts: new operational concepts and each organization's support of JADC2. Operational concepts and JADC2 are valuable measures of current innovation because they each include conceptual, organizational, and technological elements.

The 2018 National Defense Strategy advocated the creation of new operational concepts at the service and joint levels to confront the challenges of great power competition. The NDS argued the United States "must anticipate how competitors and adversaries will employ new operational concepts and technologies to attempt to defeat us, while developing operational concepts to sharpen our competitive advantages and enhance our lethality."[1] The Congressionally mandated National Defense Strategy Commission endorsed this view and highlighted the urgent need to address eroding military balances and growing operational challenges through the development of innovative joint operational concepts. The Commission noted in its report to Congress:

> The United States needs more than just new capabilities; it urgently requires new operational concepts that expand U.S. options and constrain those of China, Russia, and other actors. Operational concepts constitute an essential link between strategic objectives and the capability and budgetary priorities needed to advance them. During the Cold War, the United States developed detailed operational concepts to overcome the daunting challenges in Europe and elsewhere. Innovative concepts are once again needed because Russia and China are challenging the United States, its allies, and its partners on a far greater scale than has any adversary since the Cold War's end. The unconventional approaches on which others rely, such as hybrid warfare (warfare combining conventional and unconventional elements), gray-zone aggression (coercion in the space between peace and war), and rapid nuclear escalation demand equally creative responses. In other words, maintaining or reestablishing America's competitive edge is not simply a matter of generating more resources and capabilities; it is a matter of using those resources and capabilities creatively and focusing them on the right things. Unfortunately, the innovative operational concepts we need do not currently appear to exist. The United States must begin responding more effectively to the operational

1 Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America* (Washington, DC: Department of Defense, 2018), p. 7, https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

> challenges posed by our competitors and force those competitors to respond to challenges of *our* making.[2]

Operational concepts such as those recommended by the NDS Commission should serve two primary purposes.[3] First, they represent the link between "inputs" (such as personnel and equipment) and "outputs" (namely battlefield performance) by influencing the broad parameters of force employment. Without concepts that account for a state's strengths, an opponent's weaknesses, the likely character of a potential conflict, and the various constraints and opportunities that stem from factors such as geography, technology, and strategic culture, even the largest and best-equipped forces might fall short during a contingency. Second, operational concepts can be catalysts for change across a range of areas, including force development, doctrine, organizational structures, and research and development. By offering a vision of future warfare and how it should be fought, they can help to guide the many lines of effort that, in at least some notable cases, converge to produce a genuine military innovation.

The military services began exploring new operational concepts in the early 2010s. These efforts have now matured into the aforementioned MDO, ACE, DMO, and LOCE/EABO concepts of the Army, Air Force, Navy, and Marine Corps. Chapter four provides a brief snapshot of each of these initiatives and uses our framework to examine innovation at the service level.

At the joint level, then-Secretary of Defense Mark Esper responded to the recommendations in the 2018 National Defense Strategy by calling for the development of "a modern Joint Warfighting Concept and, ultimately, doctrine, to enable our transition to All-Domain Operations by aligning our personnel, equipment, organizations, training, and doctrine."[4] Although Secretary Esper's original goal was to produce the Joint Warfighting Concept by December 2020, Chairman of the Joint Chiefs of Staff (CJCS) General Mark A. Milley signed the first version of the concept, JWC 1.0, in March 2021.[5] Secretary of Defense Lloyd Austin approved the document shortly thereafter. Chapter five offers a look at joint innovation by exploring the development of the JWC through our innovation framework.

In addition to operational concepts, both chapters four and five examine innovation through service and DoD efforts to support the JADC2 concept. The Pentagon describes JADC2 as

2 National Defense Strategy Commission, *Providing for the Common Defense: The Assessment and Recommendations of the National Defense Strategy Commission* (Washington, DC: United States Institute of Peace, 2018), p. viii, https://www.usip.org/sites/default/files/2018-11/providing-for-the-common-defense.pdf.

3 The following sentences draw on Evan Braden Montgomery, *Defense Planning for the Long Haul* (Washington, DC: Center for Strategic and Budgetary Assessments, 2009), chap. 2.

4 Mark T. Esper, *Implementing the National Defense Strategy: A Year of Successes* (Washington, DC: Department of Defense, 2020), p. 3, https://media.defense.gov/2020/Jul/17/2002459291/-1/-1/1/NDS-FIRST-YEAR-ACCOMPLISHMENTS-FINAL.pdf.

5 Theresa Hitchens, "SecDef OKs Joint Warfighting Concept; Joint Requirements Due Soon," *Breaking Defense*, June 16, 2021, https://breakingdefense.com/2021/06/secdef-oks-joint-warfighting-construct-joint-requirements-due-soon/.

"a coherent approach for shaping future Joint Force C2 capabilities," and "an approach for developing the warfighting capability to sense, make sense, and act at all levels and phases of war, across all domains, and with partners, to deliver information advantage at the speed of relevance."[6] As such, JADC2 is one of four "supporting concepts" for the JWC.[7]

Joint command and control concepts have their roots in various types of battle networks dating back to World War One and the invention of the radio.[8] As technological advancement increased the volume of information collected by sensors, enabled faster communication speeds, and enhanced the advantage gained through superior information, battle networks evolved into the "net-centric approaches" of the 1990s and 2000s.[9] Early programs related to net-centric operations included DoD's Global Information Grid (GIG), the U.S. Air Force's Advanced Tactical Targeting Technology (AT3) and Theater Battle Operations Network Environment (T-BONE), the U.S. Navy's Cooperative Engagement Capability (CEC) and Naval Integrated Fire Control (NIFC), and the U.S. Army's Force XXI Battle Command Brigade and Below (FBCB2), Warfighter Information Network (WIN-T), and Command Post of the Future (CPOF) programs. Although many of these systems proved their tactical worth during operations in Afghanistan and Iraq, DoD recognized that its early C2 networks were organizationally and functionally stovepiped.[10] The continuing drive to link these separate networks and programs evolved into the overarching JADC2 concept. Chapter four provides an overview of the services' individual contributions to JADC2 and chapter five examines how the Department has attempted to lead the development and integration of these efforts at the joint level.

Together, new operational concepts and JADC2 allow chapters four and five to apply the innovation framework to service and joint-level innovation efforts, respectively. Each chapter provides a brief snapshot of current service and joint innovation and assesses

6 Department of Defense, *Summary of the Joint All-Domain Command & Control (JADC2) Strategy* (Washington, DC: Department of Defense, March 2022), pp. 2–3, https://media.defense.gov/2022/Mar/17/2002958406/-1/-1/1/SUMMARY-OF-THE-JOINT-ALL-DOMAIN-COMMAND-AND-CONTROL-STRATEGY.PDF.

7 The other three supporting concepts are joint fires, contested logistics, and information advantage. Theresa Hitchens, "The Joint Warfighting Concept Failed, Until It Focused On Space And Cyber," *Breaking Defense*, July 26, 2021, https://breakingdefense.com/2021/07/the-joint-warfighting-concept-failed-until-it-focused-on-space-and-cyber/.

8 CSBA has previously described a battle network as "a combination of target acquisition sensors, target localization sensors, command and control (C2) elements, weapons, weapon platforms, and the electronic communications linking them together." For more information on the evolution of battle networks, see John Stillion and Bryan Clark, *What it Takes to Win: Succeeding in 21st Century Battle Network Competitions* (Washington, DC: Center for Strategic and Budgetary Assessments, 2015), https://csbaonline.org/research/publications/what-it-takes-to-win-succeeding-in-21st-century-battle-network-competitions/publication/1.

9 Todd Harrison, *Battle Networks and the Future Force Part 1: A Framework for Debate* (Washington, DC: Center for Strategic and International Studies, 2021), p. 1, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/210805_Harrison_BattleNetworks_PartOne.pdf?JZHYyCAk5zZnL4a5C38ZbIZ70f..bDeL.

10 Department of Defense Chief Information Officer, "Department of Defense Global Information Grid Architectural Vision," June 2007, p. 1, https://www.acqnotes.com/Attachments/DoD%20GIG%20Architectural%20Vision,%20June%2007.pdf.

the degree to which the ingredients for successful military innovation are present at each echelon.

Finally, chapter six examines the current relationship between service and joint-level innovation and explores potential outcomes given varying success between the efforts. The examinations in chapters four and five indicate that although the armed services have laid the foundations for successful innovation and are in the early stages of experimentation and implementation, the Department struggles to develop and implement innovative concepts and technologies in a centralized, joint manner. As such, the study concludes with several recommendations for better supporting joint innovation efforts. Should these efforts fail to be implemented in time, chapter six provides lessons and options for the DoD to compensate for unbalanced innovation progress at different levels. The U.S. military must be prepared to confront its great power adversaries regardless of varying service and joint advancements. Our snapshot analysis shows that despite the challenges of innovating at the various levels of complex organizations such as the Department of Defense, there is much reason for optimism moving forward.

CHAPTER 2

Thinking About Military Innovation

In order to examine past and present innovation, we first require a framework to evaluate the various requirements, aspects, and phases of military innovation. This chapter builds on the foundation of existing military innovation literature to construct such a framework. It first describes the three realms of innovation—conceptual, organizational, and technological—and then examines the necessary ingredients of successful innovation in each of these areas. These ingredients combine with the stages of innovation to produce our assessment framework. Before proceeding, the chapter concludes by exploring potential barriers to innovation and causes of innovation failure.

Understanding Military Innovation

There is a considerable body of scholarship on military innovation.[11] Scholars have developed a set of four broad explanations for why and how military innovation occurs. One approach, advanced by Barry Posen, holds that civil-military dynamics, and particularly the intervention of civilian policy makers, determine whether militaries innovate.[12] Specifically, Posen argues that military resistance to change may be so entrenched that civilian intervention is required to bring it about. A second argument, whose proponents include Harvey Sapolsky and Owen Coté, holds the relationship between military services determines military

11 This voluminous literature is discussed in Tai Ming Cheung, Thomas G. Mahnken, and Andrew Ross, "Frameworks for Analyzing Chinese Defense and Military Innovation" in Tai Ming Cheung, ed., *Forging China's Military Might: A New Framework for Assessing Innovation* (Baltimore: Johns Hopkins University Press, 2014), from which the below paragraphs are drawn. See also Adam Grissom, "The Future of Military Innovation Studies," *The Journal of Strategic Studies* 29, no. 5, October 2006, pp. 905–934 and Stuart Griffin, "Military Innovation Studies: Multidisciplinary or Lacking Discipline?," *The Journal of Strategic Studies* 40, no. 5, February 2017, pp. 196–224.

12 Barry R. Posen, *The Sources of Military Doctrine: France, Britain, and Germany between the World Wars* (Ithaca: Cornell University Press, 1984).

innovation. They argue specifically that intra-service competition for roles, missions, and resources drives innovation.[13] A third line of reasoning, which includes work by Stephen P. Rosen, contends that competition between branches of the same military service drives innovation. In his view, change is the result not of civilian intervention but of the work of singular military visionaries, or mavericks, willing, eager even, to break the eggs needed to make an omelet.[14] A final school of thought, associated with Theo Farrell, Terry Terriff, and others, focuses on the culture of military organizations as the key determinant of military innovation.[15] James Russell's account of how bottom-up, in-theater operational and tactical adaptation and innovation during wartime drove top-down doctrinal innovation—the development, or perhaps redevelopment, of U.S counterinsurgency doctrine—in response to the insurgency that emerged following the March 2003 U.S. invasion of Iraq demonstrates that no one approach sufficiently captures the complexity of peacetime and wartime defense and military innovation.[16]

For the purposes of this monograph, military innovation refers primarily to evolutionary and potentially revolutionary warfighting innovation, undertaken during peacetime or wartime.[17] It encompasses both product innovation and process innovation, technological, operational, and organizational innovation, whether separately or in combination, intended to enhance the military's ability to prepare for, fight, and win wars. Following Adam

13 Harvey M. Sapolsky, "On the Theory of Military Innovation," *Breakthroughs* 9, no. 1, Spring 2000, pp. 35–39; Owen R. Coté, "The Politics of Innovative Military Doctrine," (PhD diss., Massachusetts Institute of Technology, 1996).

14 Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military* (Ithaca: Cornell University Press, 1991). Williamson Murray, *Military Adaptation in War: With Fear of Change* (New York: Cambridge University Press, 2011) and Michael Barzelay and Colin Campbell, *Preparing for the Future: Strategic Planning in the U.S. Air Force* (Washington, D.C: Brookings Institution Press, 2003) also point to the importance of leaders.

15 Theo Farrell and Terry Terriff, eds., *The Sources of Military Change: Culture, Politics, Technology* (Boulder and London: Lynne Rienner, 2002); Thomas G. Mahnken, *Technology and the American Way of War since 1945* (New York: Columbia University Press, 2008); Thomas G. Mahnken and James R. FitzSimonds, *The Limits of Transformation: Officer Attitudes Toward the Revolution in Military Affairs* (Newport: Naval War College Press, 2003). Murray, *Military Adaptation in War*, too, emphasizes the importance of military culture, particularly in facilitating innovation, or what is termed "adaptation," during wartime.

16 James A. Russell, *Innovation, Transformation, and War: Counterinsurgency Operations in Anbar and Ninewa Provinces, Iraq, 2005–2007* (Stanford: Stanford Security Studies, Stanford University Press, 2011).

17 There is a burgeoning literature on the complexities of wartime innovation, or what Murray, *Military Adaptation in War*, refers to as strategic, operational and tactical "adaptation." For a survey of the various definitions of military innovation, see Michael C. Horowitz and Shira E. Pindyck, "What is a military innovation and why it matters," *The Journal of Strategic Studies*, March 22, 2022, https://doi.org/10.1080/01402390.2022.2038572. On the topic of military innovation, see David E. Johnson, *Fast Tanks and Heavy Bombers: Innovation in the U.S. Army, 1917-1945* (Ithaca: Cornell University Press, 1998); Raphael D. Marcus, *Israel's Long War with Hezbollah: Military Innovation and Adaptation Under Fire* (Washington, D.C.: Georgetown University Press, 2018); James A. Russell, *Innovation, Transformation, and War: Counterinsurgency Operations in Anbar and Ninewa Provinces, Iraq, 2005–2007* (Stanford: Stanford Security Studies, Stanford University Press, 2011); Lazar Berman, "Capturing Contemporary Innovation: Studying IDF Innovation against Hamas and Hizballah," *The Journal of Strategic Studies* 35, no. 1, 2012: 121–147; Adam J. Jungdahl and Julia M. Macdonald, "Innovation Inhibitors in War: Overcoming Obstacles in the Pursuit of Military Effectiveness," *The Journal of Strategic Studies* 38, no. 4, 2015: 467–499; Raphael D. Marcus, "Military Innovation and Tactical Adaptation in the Israel–Hizballah Conflict: The Institutionalization of Lesson-Learning in the IDF," *The Journal of Strategic Studies* 38, No. 4, 2015: 500–528; Nina A. Kollars, "War's Horizon: Soldier-Led Adaptation in Iraq and Vietnam," *The Journal of Strategic Studies* 38, no. 4, 2015: 529–553.

Grissom, we consider military innovation to be change that affects military effectiveness and how a force operates in the field rather than purely administrative or bureaucratic changes.[18]

Varieties of Innovation

Technology is the most visible dimension of military innovation, but military innovation is not to be equated with, or reduced to, technological innovation. Technology is far from the be-all and end-all of military innovation. The conceptual and organizational components of military innovation are no less significant than technology.[19] As Nina Kollars emphasized, "The fundamental fabric of military practices—doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy—must be re-crafted before a change can be considered actual innovation."[20]

Technology, in the form of weapons and weapons systems, serves as the source of the hardware dimension of military innovation and its concrete products.[21] Organizational and conceptual or doctrinal changes, the software of innovation, provide what is characterized in the broader literature as process innovation.[22] Realizing new technology's potential typically requires organizational adaptation and doctrinal development. As Williamson Murray put it, "What matters in technological adaptation as well as technological innovation is how well new and improved technologies are incorporated into effective and intelligent concepts of fighting…."[23] Although military organizations are inclined to pursue technological developments that are in accord with their culture, it is not unusual for new technologies to encounter spirited organizational and bureaucratic resistance.[24] Institutional and organizational restructuring or even the development of new organizations with new skills may be necessary, such as the post-World War II creation of the Department of Defense and the Air Force in the United States and the post-9/11 establishment of the Department of Homeland

18 Adam Grissom, "The Future of Military Innovation Studies," *The Journal of Strategic Studies* 29, no. 5, October 2006, pp. 905–934.

19 A point emphasized in Andrew L. Ross, "The Potential Import of New, Emerging, and Over-the-Horizon Technologies," in Richard A. Bitzinger, ed., *Emerging Critical Technologies and Security in the Asia-Pacific* (New York: Palgrave Macmillan, 2016), 22–36.

20 Nina Kollars, "Genius and Mastery in Military Innovation," *Survival* 59, No. 2, 2017:126.

21 On technology and the technological component of innovation, see Colin S. Gray, "Technology as a Dynamic of Defense Transformation," *Defense Studies* 6, no. 1 (March 2006): 26–51; and Andrew L. Ross, "The Dynamics of Military Technology," in *Building a New Global Order: Emerging Trends in International Security*, eds. David Dewitt, David Haglund, and John Kirton (Toronto: Oxford University Press, 1993), 106–140.

22 The distinction between "hardware" and "software" employed here is drawn from Ross, "The Dynamics of Military Technology," 106–140.

23 Murray, *Military Adaptation in War*, 317.

24 As Fred Iklé noted, "Military services cling to the types of weapons to which they have become accustomed, seeking marginal improvements rather than radical innovation." Fred Charles Iklé, "Can Nuclear Deterrence Last Out the Century?" *Foreign Affairs* 51, no. 2 (January 1973): 384. For an insightful examination of the relationship between organizations, or institutions, and technology, see Timothy Moy, *War Machines: Transforming Technologies in the U.S. Military, 1920–1940* (College Station: Texas A&M University Press, 2001).

Security and Office of the Director of National Intelligence.[25] Similarly, new technologies, particularly those that qualify as breakthroughs, may well require revising the principles that shape or guide the employment of military force. Together, these three flavors—technological, organizational, and conceptual—comprise successful military innovation.

These three components of defense and military innovation rarely change simultaneously; most often, one tends to lead while the others follow. Technology—information technology today, for instance—may leap ahead, requiring organizations and concepts to play catch up, perhaps for decades. Warfighting, or doctrinal, visions such as the transformation enterprise's network-centric warfare can drive organizational change and technological development. The extent to which hardware and software innovation, product and process innovation—technology, organization, and doctrine—are effectively integrated can determine whether change is likely to be continuous or discontinuous, sustaining or disruptive, incremental or transformational, evolutionary or revolutionary.

Innovation is often an unnatural act for organizations that are, by their very nature, meant to routinize rather than innovate. For example, the need to defend U.S. territories in the Western Pacific in the face of a growing threat from Imperial Japan drove the Navy and Marine Corps to develop carrier aviation, amphibious warfare, and expeditionary logistics.[26] Similarly, the Soviet conventional threat in Central Europe during the 1970s and 1980s led the U.S. military to pursue new operational concepts, including AirLand Battle and Follow-on Forces Attack (FOFA for short), which demonstrated how new technologies could be used to blunt a Soviet invasion of Western Europe.[27] These efforts attempted to use the U.S. lead in information technology to counter the Soviet edge in heavy industry, producing system advances that included advanced precision strike systems, stealth bombers, battlefield intelligence and information processing, automated target detection, and night vision technology.

A Framework for Innovation

Elements of Innovation

How, then, should these facets be fashioned into a credible framework for examining military innovation? The theory and history of innovation show that several factors play a crucial role in bringing major innovations to fruition:

25 On the significance of institutional innovation, see William A. Galston and Elizabeth H. McElvein, *Institutional Innovation: How it Happens and Why it Matters* (Washington, D.C: Center for Effective Public Management at Brookings, April 2015), available at https://www.brookings.edu/research/institutional-innovation-how-it-happens-and-why-it-matters/

26 See, for example, Williamson Murray and Allan R. Millett, eds., *Military Innovation in the Interwar Period* (New York: Cambridge University Press, 1996).

27 John L. Romjue, *From Active Defense to AirLand Battle: The Development of Army Doctrine, 1973–1982* (Ft. Leavenworth, KS: U.S. Army Training and Doctrine Command, 1984).

First, the threat environment plays a key role. Most major innovations have come about because of the perception of an operational or strategic problem that defied a conventional solution. The urgency of action and the absence of incremental, routine alternatives are often necessary to break the strong preference of existing bureaucracies to apply their standard solutions to the problem.

Second, top-level leadership support is crucial to the success of major innovation. Leaders often must ensure that innovation efforts receive the economic, technological, and human resources they need to be successful and also defend them against those who would seek to kill or sideline them.

The actual innovators and their supporters and networks comprise a **third** key ingredient. Regardless of the challenge or senior-level support, successful innovation requires a bench of intellectual capital to develop new technologies, envision innovative concepts, and lead new organizations. These innovators and their networks must be supported and rewarded for their achievements.

Finally, organizational culture plays an important role in determining both the innovations a military organization pursues as well as their shape.[28] History is replete with ground-breaking technologies being sidelined by militaries because of existing biases and flawed assumptions about the nature of future warfare. Military organizations must be willing to adopt new concepts and platforms in order to successfully adapt to the challenges of tomorrow's battlefield.

Stages of Innovation

Major innovations do not spring forth overnight. Indeed, the process of developing novel ways of war may span several decades.[29] Carrier aviation first saw combat in the closing phases of World War I, but only became the dominant arm of naval warfare in World War II. The first precision-guided munitions (PGMs) saw service in World War II and were widely employed during the Vietnam War, but it was not until after the 1991 Gulf War that their full effectiveness became manifest.

Past cases of military innovation show that military services tend to develop new approaches in three distinct but often overlapping phases: speculation, experimentation, and implementation. Each phase yields indicators that can give us an estimation of the pace and scope of innovation.

28 Thomas G. Mahnken, *Technology and the American Way of War since 1945* (New York: Columbia University Press, 2008).

29 See, for example, Thomas G. Mahnken, *Uncovering Ways of War: US Military Intelligence and Foreign Military Innovation, 1918–1941* (Ithaca, NY: Cornell UP 2002) and Thomas G. Mahnken, "Uncovering Foreign Military Innovation," *The Journal of Strategic Studies* 22/4 (Dec. 1999), 26–54. Thomas G. Mahnken, "China's Anti-Access Strategy in Historical and Theoretical Perspective," *The Journal of Strategic Studies* 34, no. 3 (June 2011).

In the first stage of the process, which may be termed **speculation**, military innovators identify novel ways to solve existing operational problems or exploit the potential of emerging technology. The most visible indicators of innovation during this phase are often books, journal articles, speeches, and studies advocating new approaches to warfare. These sources may offer the first warning that a state is interested in acquiring new capabilities.

There are a host of potential barriers that can hinder innovation during the speculation phase and block it from progressing further. Some innovations, however desirable, are either impossible or unfeasible given the current state of technology. During the early nuclear era, for example, the Army postulated a whole family of innovations that would help it survive and fight on a nuclear battlefield, including jeeps that could hover and fly and "universal vehicles" capable of fast cross-country speed and road mobility that could also fly by means of modified rotors.[30] However, these systems lay outside the realm of existing science and technology. More recently, the Defense Department has spent considerable effort to develop compact, light, high-capacity power sources—with little success to date.

Of course, technology can change. Whereas intercontinental cruise missiles appeared to be a dead end in the 1940s due to the inaccuracy of existing inertial navigation units, they are now possible due to the existence of space-based precision navigation and timing networks such as the Global Positioning System.[31] Oftentimes, technological advancements in seemingly unrelated realms can lead to breakthroughs in military innovation.

If the seeds of innovation fall on fertile soil, then speculation regarding emerging warfare areas may grow into **experimentation** with organizations and doctrine to carry them out. During this phase, military services often establish experimental organizations and hold war games to explore new ways of war. During the 1920s and 1930s, for example, the British, French, German, Soviet, and American armies all held maneuvers to explore the effectiveness of armored formations.[32]

Wargaming represents another form of experimentation. During the interwar period, for example, wargames at the U.S. Naval War College explored the role of carrier aviation in future conflicts. One exercise held in the fall of 1923 depicted an engagement between a U.S. naval force with five aircraft carriers—more than any navy possessed at the time—against an opponent with four. During the game, the U.S. force launched 200 aircraft armed with

30 MAJ Marvin L. Worley, Jr., *A Digest of New Developments in Army Weapons, Tactics, Organization, and Equipment* (Harrisburg: Stackpole, 1959), 193–202.

31 Kenneth P. Werrell, *The Evolution of the Cruise Missile* (Maxwell AFB, AL: Air University Press, 1996), 82–85.

32 On the development of armored warfare during the interwar period, see Capt. Jonathan M. House, U.S. Army, *Toward Combined Arms Warfare: A Survey of 20th- Century Tactics, Doctrine, and Organization*, *Combat Studies Institute Research Survey* No. 2 (Fort Leavenworth, KS: US Army Command and General Staff College 1984); Richard M. Ogorkiewicz, *Armor: A History of Mechanized Forces* (New York: Frederick A. Praeger 1960).

bombs and torpedoes in one strike at the enemy fleet and succeeded in crippling its carriers and a battleship.[33]

Of course, the experimentation phase also presents its own set of obstacles that often prevent innovation. Even with successful experimentation, it is not certain that military organizations will adopt new concepts, however promising. Indeed, both the British and American armies chose to disband their experimental mechanized forces, even though they had enjoyed considerable success. It is therefore important to understand the level of bureaucratic support for experimentation within a foreign military organization.

A second obstacle is capabilities that are technologically possible but problematic due to engineering considerations. For example, in the early 1950s, the Navy and defense industry explored the possibility of using nuclear-armed seaplanes to form a Seaplane Striking Force using aircraft such as the Convair XF2Y-1 *Sea Dart* and the Martin P6M *SeaMaster*.[34] However, aeronautical engineers had difficulty overcoming the corrosive effect of seawater on jet engines, as well as other design challenges inherent in sea-based jet aircraft. Similarly, early boost-glide vehicles proved difficult to engineer,[35] and high-powered lasers have yet to be deployed despite decades of effort.

Here again, however, technology can and does evolve. Just because high-power lasers have yet to appear on the battlefield, it does not follow that they cannot or will not appear. Such technological developments can occur rapidly—often more rapidly than accompanying changes in organizations and bureaucracies.

During the **implementation** phase, militaries establish new units and frequently establish new service branches and career paths. Following the British Experimental Mechanized Force's maneuvers, for example, Colonel C.N.F. Broad wrote *Armoured and Mechanized Formations*, the British Army's first doctrinal publication to discuss armored warfare. In 1931, he assumed command of the 1st Brigade of the Royal Tank Corps to test methods for conducting deep penetrations of an adversary's lines.[36] In November 1933, the Army authorized the permanent formation of the 1st Tank Brigade and appointed Brigadier Percy Hobart as its commander. Hobart, an advocate of independent tank operations, used the opportunity to test and refine concepts of armored warfare. Mechanized infantry and artillery brigades and supporting units joined the tank brigade to form what was, in essence, an armored division.

33 Rosen, *Winning the Next War*, 69.

34 William F. Trimble, *Attack from the Sea: A History of the U.S. Navy's Seaplane Striking Force* (Annapolis, MD: Naval Institute Press, 2005).

35 William Yengst, *Lightning Bolts: First Maneuvering Reentry Vehicles* (Mustang, OK: Tate Publishing, 2010).

36 Capt. B.H. Liddell Hart, *The Tanks: The History of the Royal Tank Regiment and its Predecessors Heavy Branch Machine-Gun Corps, Tanks Corps, and Royal Tank Corps, 1914–1945, Vol. I, 1914–1939* (London: Cassell 1959), 292–4.

The establishment of new military formations and the promulgation of doctrine to govern their employment demonstrate a service's commitment to pursuing novel combat methods. In some cases, services may establish new branches, specialties, and career paths to support them. They may also hold exercises and conduct training in these areas. The curriculum of professional military education institutions may change to reflect new doctrine as well.

In some cases, the processes of experimentation and doctrinal development overlap. In 1934, for example, the U.S. Marine Corps issued the first draft of its *Tentative Manual for Landing Operations*. Beginning in 1936, it began holding fleet landing exercises to examine a range of new amphibious tactics, techniques, and technology. The Corps used the results of these exercises to refine the *Tentative Manual*.[37]

Failure during the implementation phase often involves capabilities that appear promising in experimentation but do not work when exposed to real-world conditions. During the 1950s, for example, the Army adopted the Pentomic Division as its organizational principle in an attempt to survive and fight on the nuclear battlefield.[38] As it turned out, the Pentomic Division represented a dead end, in part because contemporary technology was not up to the task of allowing a commander to communicate with dispersed units on the nuclear battlefield. This case will be further explored in the next chapter.

But again, the state of technology often changes—whether rapidly after new breakthroughs or over decades of research. Commanding, controlling, and communicating with dispersed formations is feasible today whereas it was not seventy years ago.

Creating a Framework to Assess Military Innovation

Combining the key elements of innovation with the stages described above yields a framework for diagnosing innovation, displayed in Table 1. The columns are associated with each stage of innovation, while the elements of successful innovation are listed in four rows. Each box in the matrix contains questions for evaluating military innovation efforts in each phase.

37 Allan R. Millett, 'Assault from the Sea: The Development of Amphibious Warfare Between the Wars – the American, British, and Japanese Experiences', in Murray and Millett, *Military Innovation in the Interwar Period* (Cambridge: Cambridge UP 1996), 76–7.

38 A.J. Bacevich, *The Pentomic Era: The U.S. Army Between Korea and Vietnam* (Washington, D.C.: NDU Press, 1986).

TABLE 1: A FRAMEWORK FOR ASSESSING MILITARY INNOVATION EFFORTS

	Speculation	Experimentation	Implementation
Threat Environment	• Has the military identified a concrete strategic or operational challenge that defies a conventional solution and thus demands innovation? • Does the military use realistic war games and simulations to explore ways of solving strategic and operational challenges? • Do we understand competitors' doctrine and capabilities?	• Is the previously identified problem the focus of experimentation? Is it refined and modified as appropriate? • Does the military use realistic war games and exercises to experiment with new doctrine and capabilities? • Do experiments feature an opposing force (OPFOR) that mirrors current and expected competitor doctrine and capabilities?	• Are the solutions to this problem enshrined in doctrine and organization? • Does the military use realistic war games and exercises to implement new doctrine and capabilities? • Do forces regularly train against an OPFOR that mirrors current and expected competitor doctrine and capabilities? • Does the adversary make changes to its behavior based on the implementation of the innovation?
Senior Leadership Sponsorship	• Do senior leaders actively promote the development of new concepts?	• Do senior leaders protect experimentation with new concepts? • Do they protect innovators?	• Do senior leaders support tradeoffs in favor or new concepts? • Are they willing to take on established interests?
Innovators & Networks	• Are innovators willing to explore innovative concepts? • Do they have a realistic appreciation of technology?	• Are innovators sufficiently funded to experiment? • Do they have the support of senior leaders?	• Are innovators rewarded? • Are they given opportunities to implement their innovations? Lead innovative units?
Culture	• Does the culture predetermine solutions? • Does the service publish concept papers, books, journal articles, speeches, and studies speculating about new combat methods? • Do individual service members publish outside of official outlets? How are they treated? • Does the service form groups to study the lessons of recent wars?	• Does the culture tolerate the new concepts? • How does the organization treat failure? • Does the service establish an organization charged with innovation and experimentation? • Does it establish experimental organizations?	• Does it establish new branches or re-define existing ones? • Does it establish new career paths and other incentives? • Does the service stand up new units to exploit new mission areas? • Does it revise doctrine to include new missions? Does it discard any existing missions? • Does it change the curriculum of professional military institutions? • Does it conduct exercises to practice and refine concepts?

This framework and its questions will be used throughout this monograph to evaluate past and present innovation efforts, with an eye toward deriving lessons for confronting great power competition.

Barriers to Innovation Throughout the Framework

Before proceeding, it is important to examine why innovation initiatives might fail to progress through the above framework. Innovations can and do fail at each of these stages, for various reasons. In addition, innovation can "succeed" in peacetime only to fail on the battlefield—the ultimate test of any military effort.

The study of military innovation is biased in favor of large, successful innovations that have a powerful impact on the battlefield, such as Germany's use of combined-arms armored warfare against France in May 1940 or the United States' use of the atomic bomb to end World War II.[39] However, there is much to be learned from the study of failed innovations. In particular, an understanding of why innovations fail to survive the bureaucratic gauntlet from speculation through experimentation to implementation can provide insight into how the U.S. armed forces can innovate more effectively. The following section examines some causes of innovation failure within the framework.

Missing the Ingredients for Successful Military Innovation

Failed innovations often lack one or more of the four elements described in our innovation framework. Most successful efforts at innovation are driven by a combination of need and threat. That is, innovations arise in response to an operational or strategic challenge that defies a conventional solution. Most successful innovations also enjoy a high-level sponsor or champion who helps them navigate the bureaucratic rapids. Finally, most successful innovations either find a comfortable home within the existing culture of the organization that adopts them or find themselves placed in a new community within the organization.

First, innovations that are premised on opportunity rather than challenge often fail. For example, beginning in the 1990s, military analysts such as Admiral William Owens argued that improvements in sensor and communication technology would produce "Dominant Battlespace Knowledge," which he defined as the ability "to 'see' virtually everything of military significance [within a 200-by-200-mile box] in all weather conditions, and regardless of terrain."[40] Owens' view of future warfare was driven by technological possibilities rather than strategic or operational challenges. That is, he believed the adoption of new technology, doctrine, and organization would allow the United States to be more effective, not because

39 See, for example, Tai Ming Cheung, Thomas G. Mahnken, and Andrew Ross, "Frameworks for Analyzing Chinese Defense and Military Innovation" in Tai Ming Cheung, ed., *Forging China's Military Might: A New Framework for Assessing Innovation* (Baltimore: Johns Hopkins University Press, 2014).

40 Admiral Bill Owens and Ed Offley, *Lifting the Fog of War* (New York: Farrar Strauss Giroux, 2000), p. 119.

the United States would lose if it failed to do so. Not surprisingly, the rationale for defense transformation in the 1990s proved to be less than compelling.[41]

Second, innovations that lack high-level champions often fail. Bureaucracies are by their nature conservative. To the extent that they innovate, they tend to create sustaining rather than disruptive innovations. As Joseph Bower and Clayton Christensen have observed, this is because they pay too close attention to what their current customers value and too little to the needs that the marketplace has yet to acknowledge.[42] This tendency is abetted by the fact that the benefits of innovations are theoretical compared to those of existing ways of war. Moreover, bureaucracies tend to measure the performance of new technology and concepts according to existing metrics. The example of the assessment of early machine guns according to the standards of artillery is telling.[43] More often than not, innovations under-perform in established metrics, at least initially. The history of Unmanned Air Systems such as the *Predator* illustrates this vividly.[44] Similarly, innovations can, and often do, appear to fail on the battlefield because they see widespread use before the technology has matured and military organizations have figured out how best to employ them. The previously mentioned use of early precision-guided munitions and unattended ground sensors in the Vietnam War falls into this category.[45] Their critics then seize upon this under-performance to justify their opposition to the innovation.

Without senior leader support, even incremental innovations can succumb to "experts" devoted to maintaining the status quo. The story of the U.S. Navy's adoption of aimed naval gunfire is an apt case study of this. Aimed naval gunfire was the most incremental of innovations, in that it required only minor changes to naval guns and modest changes to procedures. It required no organizational change, nor did it call into question the Navy's existing approach to warfare; if anything, it offered to make the Navy much more effective at its existing missions. Yet Lieutenant William S. Sims faced dogged opposition to his efforts to demonstrate the feasibility, let alone effectiveness, of aimed naval gunfire from the Navy's "experts" in the Bureau of Ordnance. This opposition was only overcome when President Theodore Roosevelt personally intervened to appoint Sims Inspector of Naval Gunnery.[46]

41 Thomas G. Mahnken, *Technology and the American Way of War since 1945* (New York: Columbia University Press, 2008), chapter 6.

42 Joseph L. Bower and Clayton M. Christensen, "Disruptive Technologies: Catching the Wave," *Harvard Business Review* (January-February 1995), pp. 43–53.

43 See James G. Roche and Barry D. Watts, "Choosing Analytic Measures," *The Journal of Strategic Studies* 14, no. 2 (June 1991), pp. 165–209.

44 See Richard Whittle, *Predator: the Secret Origins of the Drone Revolution* (New York: Henry Holt, 2014).

45 See Thomas G. Mahnken, *Technology and the American Way of War since 1945* (New York: Columbia University Press, 2008), chapter 3.

46 Elting E. Morison, *Men, Machines, and Modern Times*, Ch. 2, "Gunfire at Sea: A Case Study of Innovation," pp. 17–44. A key part of the story that Morison omits from his telling is the fact that Roosevelt was previously acquainted with Sims from the president's previous service as Assistant Secretary of the Navy, at which time Sims was U.S. Naval Attaché in Paris.

Finally, innovations that do not align with a service's organizational culture often fail. For example, in the early 1950s, the Navy and defense industry explored the possibility of using nuclear-armed seaplanes to form a Seaplane Striking Force. However, the concept lacked institutional support, as the seaplane community represented a minority within the aviation community, which was itself only one of three main communities within the Navy. As a result, it enjoyed a low funding priority relative to carrier aviation and submarines.[47] Similarly, the Army's effort to field the M712 *Copperhead* laser-guided artillery shell, along with other precision-guided cannon munitions, was hampered by the "fire-and-forget" culture of the field artillery.[48]

Failure During Employment

Finally, even innovations that garner the necessary ingredients and make their way through the three stages can and often do fail on the battlefield. Some innovations fail during employment because they appear on the battlefield "too soon" (that is, before the technology has matured and military organizations have figured out how best to employ them), while others arrive "too late" (that is, after an adversary figures out a way to counter them). The use of early precision-guided munitions and unattended ground sensors in the Vietnam War are examples of the former;[49] there are numerous examples of the latter.

This chapter constructed a framework for assessing military innovation in the technological, conceptual, and organizational realms. Our framework examines the four prerequisites for successful innovation across the speculation, experimentation, and implementation phases: threat environment, senior leader sponsorship, innovators & networks, and organizational culture. The following chapters utilize this framework to assess past and present cases of military innovation—from the Cold War to current great power competition.

47 William F. Trimble, Attack from the Sea: A History of the U.S. Navy's Seaplane Striking Force (Annapolis, MD: Naval Institute Press, 2005).

48 Barry D. Watts, *Six Decades of Guided Munitions and Battle Networks: Progress and Prospects* (Washington, DC: Center for Strategic and Budgetary Assessments, March 2007), p. 209, https://csbaonline.org/uploads/documents/2007.03.01-Six-Decades-Of-Guided-Weapons.pdf.

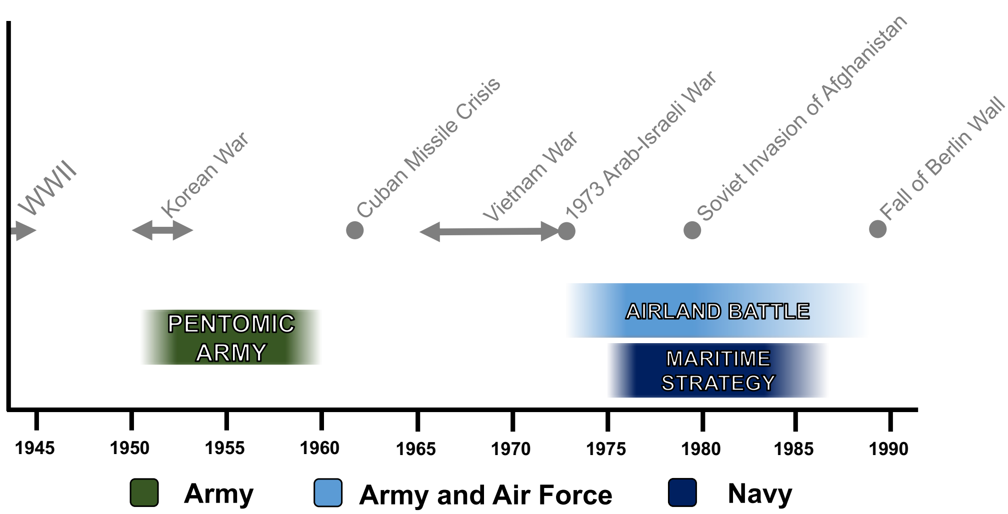
49 Thomas G. Mahnken, *Technology and the American Way of War since 1945* (New York: Columbia University Press, 2008), chapter 3.

CHAPTER 3

Historical Cases of Military Innovation

This chapter uses the framework developed in chapter two to diagnose major U.S. innovation efforts during a previous period of great power competition—the Cold War. It focuses upon this era because the bureaucratic institutions and organizational culture of the Defense Department and armed services approximate those of today more than more chronologically distant cases such as the Second World War. Moreover, the cases to be examined—the Army's Pentomic operations in the 1950s, the Army and Air Force's development of AirLand Battle in the 1970s and 1980s, and the Navy and Marine Corps' development of the Maritime Strategy in the 1980s—span the U.S. armed services and the decades of the Cold War.

FIGURE 1: TIMELINE OF COLD WAR INNOVATION EFFORTS



Source: Graphic created by CSBA.

The Pentomic Army of the 1950s

The Army's efforts to adapt to the nuclear battlefield, including the development of "pentomic" units, represented a major push to transform the service to meet the serious operational challenges of the 1950s as well as a bureaucratic threat. In the years that followed World War II, the service faced the challenge of adapting its organization and doctrine to rapid technological change. The advent of nuclear weapons threatened the Army more than any other service because the Army played no role in the delivery of early air-dropped atomic bombs, and ground combat traditionally relied on massed formations that were extremely vulnerable to nuclear effects. It responded by adopting nuclear weapons for land warfare and even competing with the Air Force in the development of long-range missiles, space, and strategic air defense. It also undertook a radical—though ultimately unsuccessful—restructuring of its forces in a bid to retain its relevance on the nuclear battlefield.

Despite the ultimate failure of the pentomic reorganization, it remains worthy of study for three reasons. First, the depth and breadth of the changes were all-encompassing for the U.S. Army and had massive implications for the organization from top to bottom. The changes occurred across the organizational, conceptual, and technological realms. Second, the case's failure offers a revealing look at an unsuccessful attempt to overcome operational challenges. As noted in chapter two, examining the causes of innovation failure is of equal importance to studying success. Finally, the developments surrounding the pentomic army did bear some fruit, such as the creation of air-mobile units and doctrine, which went on to play a key role in later U.S. military operations.

Threat Environment

Army innovation in the first decade after the Second World War was driven by a major change in the threat environment. The advent of nuclear—and particularly thermonuclear—weapons forced Army leaders to radically revise their view of warfare in the years following the Second World War.

The advent of nuclear weapons and strategic air power appeared to call into question the utility of traditional ground forces.[50] At the very least, it demanded a fundamental reconsideration of Army weapons, doctrine, and organization. As John K. Mahon wrote in 1954, "It may be that atomic power coupled with air power has changed [the role of armies]. So lethal a combination may at last have altered the basic role of land armies. No one can be sure. It is certain, however, that the experience of the last war cannot be relied on to any great extent in preparing for the next (should the nations be foolish enough to permit one to start."[51]

50 Brian McAllister Linn, *Elvis's Army: Cold War GIs and the Atomic Battlefield* (Harvard University Press, 2016), p. 73.

51 John K. Mahon, "The Army's Changing Role," *Current History* (May 1954), p. 263.

The existence of large numbers of nuclear weapons created a growing possibility that they would not merely be reserved for targets far behind front lines, but would be used, potentially in large numbers, on the battlefield. This possibility seemed to make obsolete the sort of mechanized assaults that had featured prominently in World War II. Armies now faced the challenge of remaining dispersed enough to avoid posing a target for nuclear weapons, but also cohesive enough to rapidly coalesce and deliver a decisive blow. As General James Gavin put it, the challenge was to learn "how to control the amorphous mass of men who must be dispersed over an entire zone, an entire tract of land, dispersed thinly enough not to invite bomb blast, yet strongly enough to tackle the enemy."[52]

The Army was also the biggest loser in the organizational and fiscal battles brought on by the development of nuclear weapons. It ended the Korean War with 20 combat divisions; by 1961, it had been reduced to 14 divisions, including three training formations. Throughout the Eisenhower administration, the Army enjoyed the smallest share of the defense budget of any service.[53] One officer believed that the Army had been reduced to the status of "an auxiliary service."[54] Major (later Lieutenant General) John H. Cushman candidly admitted in 1954, "I do not know what the Army's mission is or how it plans to fulfill its mission. And this, I find, is true of my fellow soldiers. At a time when new weapons and new machines herald a revolution in warfare, we soldiers do not know where the Army is going and how it is going to get there."[55] Clearly, Army leaders identified the changed threat environment and operational challenges of the nuclear era shortly after the Korean War.

Senior Leader Sponsorship

In such an environment, a group of generals led by Matthew Ridgway, who had performed superbly as commander of the Eighth Army in Korea, spearheaded an effort to transform the Army. Although Army leadership rejected the premises of the New Look with its assumption that nuclear weapons and long-range air power would be the primary instruments of deterring (and, if necessary, fighting) future wars, they nonetheless embraced technology as the principal determinant of how wars would be fought. At the heart of this approach was the belief that although strategic nuclear weapons were insufficient to guarantee American security, tactical nuclear weapons would be sufficient to decide future wars.[56] Strategic nuclear weapons, they believed, were too destructive to be useful; their utility was confined to deterrence. Tactical nuclear weapons, by contrast, could be used to good effect on the battlefield without fear of escalation.

52 Quoted in A.J. Bacevich, *The Pentomic Era: The U.S. Army Between Korea and Vietnam* (Washington, DC: National Defense University Press, 1986), pp. 68–69.

53 Ibid., p. 20.

54 Ibid., pp. 19–20.

55 Ibid., p. 21.

56 Ibid., pp. 53–54.

Innovators & Networks

The advent of nuclear weapons thus created a need for mobile, hard-hitting combat organizations tailored to fight and survive on the atomic battlefield. In April 1954, the Chief of Staff of the Army, General Matthew B. Ridgway, directed the Army to develop more mobile and flexible organizations that exploited new technology and could disperse to avoid nuclear effects. In November of the same year, he commissioned a second study of army organization, the PENTANA study. In June 1955, General Maxwell D. Taylor succeeded Ridgway as Army Chief of Staff. He took an intense personal interest in the PENTANA study and used it to inform his structural reform of the Army.

Taylor outlined the new organizational structure, the Pentomic Division, in October 1956. In search of units that were capable of fighting independently yet were expendable, the Army moved from triangular organizations with three subordinate commands to pentomic organizations with five subordinate commands. In pentomic units, the Army replaced its battalions with battle groups, each of which was to be capable of independent operations. The pentomic infantry division, for example, was composed of five infantry battle groups, an armored battalion, and a cavalry squadron. A transportation battalion controlled armored personnel carriers (APCs). The Army also formed pentomic airborne divisions, outfitted almost entirely with equipment that could be transported by air.[57] The design of the armored division, by contrast, changed relatively little.

The nuclear age led the Army to reevaluate other areas of technology as well. Some officers felt the best way to survive a nuclear attack was to dig in or disperse forces; two wrote in 1958, “We must produce a device which will permit an individual to dig a deep foxhole in a matter of minutes, so that a unit could disappear underground as quickly as those sand crabs which live on the edge of the beach.”[58]

Others sought to dramatically increase the mobility of conventional ground forces. They were particularly interested in technologies to increase the speed, range, and precision of ground forces. The Army explored “universal vehicles” capable of fast cross-country speed and road mobility that could also fly by means of modified rotors.[59] It pursued several tilt-rotor aircraft, including the Bell XV3 and Vertol VZ2. It also investigated “individual lift devices” designed to move a single soldier safely over the nuclear battlefield. One such design, the De Lackner Aerocycle, was a platform equipped with a 43-horsepower engine and two counter-rotating propellers. The Army also let contracts to Chrysler, Piasecki Aircraft Corporation, and Aerophysics Development Corporation to develop a jeep that could

57 Theodore C. Mataxis and Seymour L. Goldberg, *Nuclear Tactics, Weapons, and Firepower in the Pentomic Division, Battle Group, and Company* (Harrisburg, PA: Military Services Publishing Company, 1958), p. 177; Robert A. Doughty, *The Evolution of U.S. Army Tactical Doctrine, 1946-76* (Fort Leavenworth, KS: U.S. Army Command General Staff Combat Studies Institute, 1979), p. 17.

58 Ibid., p. 240.

59 Ibid., p. 241.

hover and fly.[60] Even more exotic ideas included disposable uniforms of "non-woven film," maintenance-free trucks that would be driven 1,000 miles and then discarded, and the use of cargo rockets for battlefield supply.[61]

Still, other officers predicted the end of traditional tanks and APCs. Tanks of the 1950s were slow and heavy, while existing APCs did not provide sufficient protection against radiation. For example, in 1958, two officers argued that "The logistical requirements of the present heavy and medium tanks and the greatly increased range and penetrating power of small, direct-fire weapons will write finis to the fascinating career of these unwieldy giants." To them, the Army needed to develop an armored vehicle of no more than 20 tons that could move like a passenger vehicle and protect its crew from high levels of radiation. They speculated that it might be possible to create an electric field strong enough to protect the occupants from radiation.[62]

Contemporary officers argued that the pentomic organization was a "tremendous improvement … over the old triangular division."[63] Officers extolled the Pentomic Division as lean, powerful, and versatile. According to advocates, such units would be more easily able to disperse on the battlefield and capable of semi-independent operations over extended distances on a fluid battlefield for prolonged periods with minimal control or support from higher headquarters. They argued that "Technological developments are occurring too rapidly for us to stand still or even to slow down. We must not only keep abreast of these developments, but we must try to anticipate them if we are to build a combat force that will be victorious on the battlefield of the future."[64] The Pentomic Division also helped the Army compete with the Air Force and justified new weapons and additional personnel.

Culture

Many elements of the nuclear battlefield and the pentomic organization paired well with Army culture. Tactical nuclear weapons comported with the Army's historical reliance on firepower. In many ways, the service was predisposed to nuclear weapons by its tradition of using technology to increase its volume of fire. The Army viewed tactical nuclear weapons not so much as small strategic bombs, but more as a natural improvement of artillery.[65] To many Army officers, nuclear weapons were the ultimate expression of battlefield firepower. As General Willard G. Wyman, the Commander of Continental Army Command, put

60 Marvin L. Worley, *A Digest of New Developments in Army Weapons, Tactics, Organization and Equipment* (Harrisburg, PA: Military Services Publishing Company, 1958), pp. 193–202.

61 Bacevich, *The Pentomic Era*, pp. 72–73.

62 Mataxis and Goldberg, *Nuclear Tactics*, pp. 242, 240.

63 Worley, *A Digest of New Developments in Army Weapons*, p. 88.

64 Mataxis and Goldberg, *Nuclear Tactics*, p. 100.

65 Bacevich, *The Pentomic Era*, p. 65.

it, thanks to nuclear weapons, "tactical firepower alone can now accomplish the purpose of maneuver."[66]

At the same time, the idea that technology was a critical element of war ran counter to the Army's belief that the soldier stood at the center of battle. Not all Army officers believed that nuclear weapons provided an absolute guarantee of victory. Major Marvin Worley voiced this view when he wrote in 1959, "Many senior Army officers do not subscribe to the theory that there is an ultimate weapon, and certainly don't subscribe to the theory that an intercontinental ballistic missile is such a weapon."[67]

The Army also had bureaucratic motives for pursuing nuclear weapons. The Eisenhower administration and Congress both showed greater enthusiasm toward nuclear arms than traditional weapons. To the extent that the Army needed to justify its budget, it was in nuclear terms. As Major General John B. Medaris, head of the Army Missile Office, put it, "If you put all your energy and effort into justifying these conventional weapons and ammunition … I think you are going to get very little money of any kind. It is far easier to justify a budget with modern items that are popular … Why don't you accentuate the positive and go with that which is popular, since you cannot get the other stuff anyway?"[68]

The Army initially attempted to fit nuclear weapons into its traditional organizational culture and force structure. The service's first nuclear program focused on fielding an atomic shell for a 280mm cannon, the smallest cannon that could fire an atomic projectile at the time. The cannon was immense; 85 feet long, it weighed 50 tons in firing position and 86 tons on its transporters and had a maximum road speed of 35 miles per hour.[69] As an evolutionary development of traditional artillery, the atomic cannon possessed none of the qualities the Army needed. It was road-bound and cumbersome, and its 17-mile range gave it little ability to reach deep targets. To strike beyond the front lines, it would need to be deployed far forward, where it would be vulnerable to attack and capture. In short, the cannon more resembled the unwieldy railway guns of the Second World War than the mobile and dispersed platforms ideal for the nuclear battlefield. Nevertheless, the Army fired its first nuclear projectile at the Nevada Test Site in May 1953. Within months it had deployed six of the massive cannons to Europe.[70]

Assessing the Pentomic Army

Although implemented, the Pentomic Division represented a dead end for military innovation. Much of the Pentomic Division concept was contingent upon the development of

66 Ibid., p. 56.

67 Worley, *A Digest of New Developments in Army Weapons*, p. 44.

68 Bacevich, *The Pentomic Era*, p. 72.

69 Worley, *A Digest of New Developments in Army Weapons*, pp. 17–18.

70 Bacevich, *The Pentomic Era*, p. 82.

new technologies and capabilities. Most of these requirements, however, would go unmet as the Army had neither the technology nor the money to fully implement them. Despite advancements, communications technology was simply not up to the task of enabling communications between a commander and dispersed units on the nuclear battlefield. Similarly, the rapid airlift capabilities needed to resupply the dispersed battle groups failed to emerge. Moreover, the Pentomic Division had not been tested in maneuvers before its implementation, and as a result many flaws only became apparent after its adoption.[71] Even when commanders could communicate with their units, the difficulty of simultaneously managing five battle groups hindered their ability to make rapid and effective decisions. As General Paul Freeman, the former commander of the Continental Army Command, later recalled, "Every time I think of the … Pentomic Division, I shudder. Thank God we never had to go to war with it."[72] As a result of these issues, the Army began undoing its pentomic organization in 1960.

Ultimately, the Pentomic Division was supported by many of the ingredients required for successful innovation, but was inadequately tested and refined during the experimentation stage. Despite a clear identification of the threat environment, strong senior leader support, and a plethora of innovative concepts and developmental technologies, the organization was unfeasible with the technology of the time. Had the Army experimented further with maneuvers and exercises, issues such as the inadequacy of communications technology and overburdening of commanders may have become apparent before the implementation phase and led Army leaders to refine or modify the Pentomic Division into a more successful effort.

The failure of the Pentomic Division offers two prescient lessons for today's innovators. First, leaders must be wary of embracing innovative concepts that are over-reliant on technology that has yet to mature into operationally functional systems. From highly-mobile vertical takeoff vehicles to advanced communications equipment, the pentomic organization was held back by technologies that failed to deliver the capabilities required for the concept to be successful. The balance between conceptual, organizational, and technological innovation is delicate. Although pushing ahead in one or two areas can force development in the other realms, innovators must be careful not to exceed the realistic limits of any one aspect of innovation. This lesson is particularly relevant as today's military leaders embrace concepts and organizations which rely on the total connectivity and enhanced situational awareness provided by concepts like Joint All-Domain Command and Control (JADC2).

Second, military leaders must ensure new concepts, organizations, and technologies are thoroughly tested and refined throughout all stages of innovation. The Army's failure to adequately exercise the Pentomic Division during the experimentation phase led to the implementation of a concept doomed to fail because of immature technology. Today's Department of Defense and armed services must ensure new doctrine, units, and equipment

71 Linn, *Elvis's Army*, p. 225.

72 Bacevich, *The Pentomic Era*, pp. 131–132.

are experimented with during realistic exercises and improved through continuous feedback and refinement.

Still, the pentomic experiment yielded some successful and fruitful innovation efforts. A related but longer-lasting development was the advent of airmobile forces in the Army, which grew out of the need to concentrate forces rapidly on the nuclear battlefield. Writing in *Harper's* magazine in April 1954, Major General James M. Gavin argued that only through the widespread adoption of helicopters could the U.S. Army be effective on the modern battlefield. As a veteran of the campaigns in Sicily, Salerno, Normandy, and Holland, Gavin spoke with considerable authority. In his view, the mechanization of the Army had decreased its ability to perform traditional cavalry functions:

> Cavalry is not a horse, nor the crossed sabers and yellow scarves. These are the vestigial trappings of a gallant great arm of the U.S. Army, whose soul has been traded for a body. It is the arm of Jeb Stuart, and Custer, and Sheridan, and Forrest. It is the arm that as late as World War II got there (in Forrest's phrase) the "fustest with the mostest" but is now rapidly becoming, in terms of firepower and mobility, lastest with the leastest … With the motorization of the land forces, and the consequential removal of the mobility differential, the cavalry has ceased to exist in our Army except in name.[73]

On the modern battlefield, he argued, cavalry functions needed to be performed more rapidly and at a greater distance than had heretofore been possible. Only through the widespread use of helicopters could the Army pursue the traditional cavalry roles of screening, reconnaissance, exploitation, and pursuit. Just as tanks had replaced horses, Gavin now argued that helicopters should succeed tanks. Gavin thus made a case for radical change—the development of airmobile units—through an appeal to traditional army missions.

In June 1956, Brigadier General Carl I. Hutton, the Commandant of the Army Aviation School, organized a series of tests of armed helicopters. He gave Colonel Jay T. Vanderpool the assignment of developing a "fighting helicopter." In two weeks, Vanderpool's team of five armed a Bell H-13, the smallest helicopter available, with two .50 caliber aircraft guns and launch rails for 80mm rockets. They then assembled an experimental company-sized air cavalry organization manned by military and civilian volunteers. The unit tested various types of ordnance and developed air cavalry tactics, culminating in a demonstration in 1957. It also wrote the Army's first air cavalry manual, drawing heavily on a 1936 cavalry manual as a way of portraying the new organization in terms that were intelligible to senior officers.[74]

Army leaders saw mobility as vital to the ability of the United States to fight numerically superior enemies. As Secretary of the Army Wilber Brucker wrote in 1956, "Tactical victory will belong to the army with the superior mobility on a rolling battlefield; in the sense

73 James M. Gavin, "Cavalry, and I Don't Mean Horses," *Harper's Magazine* 208 (April 1954), p. 55.

74 J.A. Stockfisch, *The 1962 Howze Board and Army Combat Developments* (Santa Monica, CA: RAND Corporation, 1994), pp. 9–10.

defined by future wars, aviation is the most important form of mobility."[75] In this respect, the Pentomic Division led to airmobile capabilities and platforms that would soon prove their worth in the jungles of Southeast Asia.

The Army and Air Force's AirLand Battle in the 1970s and 1980s

In contrast to the Army's Pentomic reforms of the 1950s, the development of AirLand Battle doctrine in the 1970s and 80s represented a success, one that bolstered conventional deterrence against the Soviet Union and laid the groundwork for U.S. operational success in the 1991 Gulf War.

Threat Environment

After the U.S. withdrawal from Vietnam, the Army's leadership turned away from counterinsurgency and focused once again on the confrontation with the Soviet Union in Central Europe. In part, this was the result of the painful memory of the war in Southeast Asia. It was also the product of the Army's desire, barely concealed even during the height of the Vietnam War, to plan for high-intensity conventional operations. Soviet military modernization also contributed to this trend. The Soviet Union's deployment of a new generation of weapons and development of revised operational concepts led many leaders to doubt NATO's ability to fight, let alone win, a conventional war in Europe. Several of NATO's military leaders in the 1970s predicted that the alliance would be able to hold out for no longer than ten days before it would be forced to escalate to nuclear use.[76]

In response, a generation of Army officers set about rebuilding the service, both physically and intellectually, to prevent a future replay of Vietnam and confront the operational challenges posed by the Soviets in central Europe. They rediscovered strategy, bringing the study of Clausewitz back to the Army War College. They also kindled interest in doctrine and the operational level of war, leading to a renaissance in Army thinking. The result was the development of the AirLand Battle doctrine, which drove the acquisition of new technology, as well as the procurement of a new generation of weapons such as the M1 *Abrams* main battle tank and the M2/M3 *Bradley* fighting vehicle.

The development of AirLand Battle was predicated upon a dedicated effort to understand the Soviet threat through their military doctrine and operational art.[77] This effort yielded a sophisticated understanding of Soviet strengths and weaknesses, as well as predilections and proclivities, that the U.S. military could exploit. In particular, Soviet military leadership

75 Department of Defense, *Semiannual Reports, Jan.-June, 1956*, p. 83, quoted in Christopher C. S. Cheng, *Air Mobility: The Development of a Doctrine* (Westport, CT: Praeger, 1994), p. 93.

76 Donn A. Starry, "Reflections" in *Camp Colt to Desert Storm: The History of U.S. Armored Forces*, edited by George F. Hofmann and Donn A. Starry (Lexington, KY: University Press of Kentucky, 1999), p. 546.

77 John A. Battilega, "Soviet Military Thought and the U.S. Competitive Strategies Initiative," in *Competitive Strategies for the 21st Century*, edited by Thomas G. Mahnken (Palo Alto, CA: Stanford University Press, 2012).

depended upon tightly scripted operations, which proved to be a significant vulnerability that NATO forces sought to use deep strikes to exploit. In this way, AirLand Battle reflected a thorough understanding of the contemporary threat environment.

Senior Leader Sponsorship

AirLand Battle was largely the brainchild of General Donn Starry, who served as the head of Training and Doctrine Command (TRADOC) between 1977 and 1981. The doctrine sought not only to halt an initial Soviet thrust in Central Europe, but also extend the battle deep into enemy territory. The fact that the Soviets envisioned employing their army in echelons opened opportunities for NATO commanders to use tactical air power and long-range artillery to destroy Soviet armored formations before they made contact with NATO forces.[78] Starry felt that it was crucial for commanders to see deep into Warsaw Pact territory to locate the follow-on echelon, strike it before the initial assault could break through the NATO defense, and defeat it before it could reach the main body of NATO forces.[79] As a result, he envisioned allocating responsibilities to different echelons of command in time rather than distance: brigades would be responsible for attacking all enemy forces within 12 hours of the forward line of troops, divisions within 24 hours, and corps within 72 hours.[80]

Innovators & Networks

Soldiers spend most of their careers studying and exercising rather than practicing the profession of arms. This was particularly true during the Cold War, when the superpower confrontation, reinforced by nuclear deterrence, dampened the possibility of a major war. It was thus natural that those wars that did break out received close scrutiny. The 1973 Arab-Israeli War was of particular interest to Army officers. It seemed to offer a close surrogate for a NATO-Warsaw Pact conflict because the Israelis were largely equipped with U.S. arms against the Egyptians and Syrians who possessed Soviet weapons. Moreover, it saw the widespread use of a series of new weapons, such as surface-to-air missiles (SAMs), anti-tank guided missiles (ATGMs), and anti-ship cruise missiles (ASCMs). Observers from across the globe tried to discern the shape of future wars through the lens of the conflict.

Officers at U.S. Army TRADOC studied the war closely. They were struck by the lethality of modern weapons, particularly modern tank guns, ATGMs, and SAMs.[81] As one study concluded:

78 John L. Romjue, *From Active Defense to AirLand Battle: The Development of Army Doctrine, 1973-1982* (Fort Monroe, VA: Historical Office, U.S. Army Training and Doctrine Command, 1984), p. 33.

79 Richard Swain, "AirLand Battle" in *Camp Colt to Desert Storm: The History of U.S. Armored Forces*, edited by George F. Hofmann and Donn A. Starry (Lexington, KY: University Press of Kentucky, 1999), p. 379.

80 Ibid., p. 383.

81 Romjue, *From Active Defense to AirLand Battle*, p. 3.

> During the past several decades, the nature of warfare has changed significantly. Great numbers of weapons with increased lethality are found in the armies of both large and small nations. The war in the Middle East in 1973 might be well representative of the nature of future battle. Arabs and Israelis were armed with the latest weapons, and the conflict approached a destructiveness once attributed only to nuclear weapons … In clashes of massed armor such as the world had not witnessed for 30 years, both sides sustained devastating losses, approaching 50 percent in less than two weeks of combat.[82]

In the aftermath of the 1973 War, the Army Chief of Staff, General Creighton Abrams, dispatched Donn Starry, then-Commander of the Armor Center and School at Fort Knox, and Brigadier General Bob Baer, the program manager for what became the XM1 main battle tank, to Israel to study the conflict. Among the lessons that Starry and Baer drew were that modern battlefields would be deadly, with greater lethality at greater range and highly lethal air defenses; the result would be enormous equipment losses in a short span of time. Victory would require close cooperation between all combat arms. Perhaps most crucially, they were struck by the importance of seizing and maintaining the initiative.[83]

The 1976 edition of the Army's Field Manual (FM) 100-5, *Operations*, reflected the lessons the Army had drawn from the 1973 war. It contained a stark view of modern warfare, arguing that modern conflicts would be characterized by high firepower and attrition.[84] It articulated a new doctrine, dubbed Active Defense, for a future war (more specifically, a future war against the Warsaw Pact in Central Europe). The doctrine codified conventional thinking about a NATO-Warsaw Pact war: during the initial phase, NATO forces would be forced onto the defensive, after which they would have to hold out long enough to be reinforced before launching a counter-attack.

Dissatisfaction with this approach led to the development of a more offensive doctrine, known as "AirLand Battle," which was codified in the 1982 edition of FM 100-5. The manual abandoned Active Defense's focus on direct-fire engagements in favor of strikes deep behind enemy lines. It also emphasized the role of offensive action, maneuver, and surprise.

The need to defeat first- and second-echelon Soviet armored forces, day or night, in all types of weather, served as the engine of innovation. In 1977, the Defense Advanced Research Projects Agency (DARPA) established ASSAULT BREAKER, a program that envisioned using aircraft equipped with radar to detect and track vehicular traffic deep in Eastern Europe from high above NATO territory. The aircraft would pass this targeting information to units that would destroy enemy forces with air-launched standoff weapons. The goal of

82 Headquarters, United States Army Training and Doctrine Command, "Net Assessment of U.S. and Soviet Tank Crew Training," January 29, 1977, p. 2-1.

83 Starry, "Reflections," p. 549.

84 Romjue, *From Active Defense to AirLand Battle*, p. 7.

ASSAULT BREAKER was to field a system capable of destroying 2,000 vehicles operating between 20 and 100 kilometers behind the front lines in a span of 10 hours.[85]

Culture

As noted, the Army's initial attempts to update its doctrine conflicted with the existing culture preferring offensive operations. The appearance of Active Defense in the 1976 FM 100-5 triggered a spirited and often heated debate. Critics decried what they saw as an emphasis on defensive operations and firepower, characterizing Active Defense as "attrition warfare," in contrast to their preferred model of "maneuver warfare." In fact, the political imperative of not surrendering any NATO territory to the Warsaw Pact did much to shape doctrine. More justified was the charge that Active Defense concentrated on the initial battle of a future war and said nothing about follow-on operations.[86] Nevertheless, AirLand Battle found fertile ground in the offensive-focused culture of the U.S. Army maneuver branches.

Assessing AirLand Battle

The invention and implementation of AirLand Battle offers numerous insights for contemporary innovators. The following section highlights three lessons useful for confronting modern great power competition. First, ongoing conflicts may offer hints as to the changing nature of warfare or the utility of certain technologies and operational concepts. Post-Vietnam Army leadership closely studied the 1973 Arab-Israeli War for lessons as to how modern technologies such as anti-tank guided missiles and improved surface-to-air missiles would change the battlefield calculus in central Europe. Like the 1973 war, today's conflict in Ukraine involves new weapons such as loitering munitions and the pervasive use of small UAS. Learning from contemporary conflicts is key, although also important is gleaning the correct lessons and avoiding confirmation bias.[87]

Second, innovations that play to an organization's existing culture expedite the implementation of new ideas and systems. Whereas Active Defense ran counter to Army culture, AirLand Battle embraced the U.S. military's preference for aggressive offensive operations. Organizations are more likely to quickly adopt concepts, procedures, and technologies that are closely related to existing identities and roles. Of course, some strategic and operational challenges require wholesale changes in organizational culture, and this sentiment is not meant to excuse military organizations for failing to innovate or resisting

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85 Kenneth P. Werrell, *Chasing the Silver Bullet: U.S. Air Force Weapons Development from Vietnam to Desert Storm* (Washington, DC: Smithsonian Books, 2003), p. 200.

86 Swain, "AirLand Battle," p. 378; Romjue, *From Active Defense to AirLand Battle*, ch. 2.

87 One danger of examining ongoing conflicts is the potential for military organizations to selectively choose evidence to support preconceived concepts and programs. In this way, militaries run the risk of "innovating against themselves" rather than confronting the actual threat environment. For example, see David Johnson, "The Army Risks Reasoning Backwards in Analyzing Ukraine," *War on the Rocks*, June 14, 2022, https://warontherocks.com/2022/06/the-army-risks-reasoning-backwards-in-analyzing-ukraine/.

change. Instead, innovators should note that molding or matching innovation to align with existing organizational culture can reduce barriers to implementation. This lesson was also demonstrated in the previous case by Colonel Vanderpool's experimental air cavalry unit basing their air cavalry manual on an original cavalry manual from 1936. Using terms and framing already familiar to an organization's culture can lead to innovations being adopted at a more expeditious rate.

Finally, AirLand Battle stands as an example of new concepts and doctrine successfully driving the development and procurement of new technologies. From the Army's Big Five to the offspring of DARPA's ASSAULT BREAKER program, AirLand Battle shaped the force structure of the U.S. military for decades after its implementation. Despite these successes, it is also important to recall that many of the systems and technologies required to fully support AirLand Battle were not fielded throughout the force until the late 1980s or early 1990s—almost a decade after the release of the 1982 FM 100-5. Even with solid concepts and successful experimentation, progressing through the stages of innovation and completing implementation may take many years, particularly during peacetime.

The Navy's Maritime Strategy in the 1980s

Like AirLand Battle, the Navy's Maritime Strategy, which foresaw operations close to Soviet territory early in a future war, was another manifestation of a shift to a more offensive mindset. As part of this shift, the Navy exploited the potential of networking to defend U.S. ships from the Soviet naval threat.

Threat Environment

The Navy, like the other services, faced the prospect of sharp cuts in the years following the Vietnam War. This manifested itself most vividly in its shipbuilding program. Between 1968 and 1975, the construction of new ships fell by more than two-thirds. At the same time, by 1975, the Navy anticipated having to retire 4% of the active fleet each year. Budget cuts also led to a reduction in the planned size of the fleet. In 1975, Secretary of Defense James Schlesinger set a goal of a fleet of 575 ships; the following year, his successor, Donald Rumsfeld, planned for 600 ships. Both were based upon the requirements of a world war with the Soviet Union. However, the Carter administration questioned the need for such a large fleet, arguing that the Navy's primary use would be in peacekeeping missions and lesser contingencies. Such missions would require a fleet of only 425 to 500 ships.[88]

The Navy also faced more concrete challenges. The growth of the Soviet Navy—particularly of Soviet naval aviation—threatened the ability of the U.S. Navy to operate near the Soviet Union's shores. This challenge forced the Navy to explore networking as well as highly

88 John B. Hattendorf, *The Evolution of the U.S. Navy's Maritime Strategy, 1977–1986* (Newport, RI: Naval War College, 2004), p. 9, https://scholar.harvard.edu/files/zhukov/files/19.pdf.

advanced defensive systems such as the AEGIS combat system. Such innovations were fundamentally conservative, meant to preserve the Navy's existing approach to war at sea in the face of an evolving Soviet threat rather than exploring new ways of war.

During the 1960s, the Soviets deployed a series of increasingly capable ships and submarines. Also of concern were the bombers of Soviet naval aviation, such as the Tu-16 *Badger*. Paired with long-range air-launched cruise missiles such as the SS-N-3 *Shaddock*, these bombers posed a potent threat to the carrier battle groups (CVBGs) that formed the core of the Navy.

The Navy exploited the potential of networking to defend U.S. ships from the Soviet naval threat. In the 1960s, the Navy began developing the Ocean Surveillance Information System (OSIS), an effort to develop a comprehensive system for processing ocean surveillance information. OSIS would collate disparate pieces of information on Soviet naval operations into a coherent maritime picture. The system tracked Soviet submarines and developed information to help carrier battle groups spot Soviet bombers and ships early enough to engage them before they could launch their missiles.

The effort benefited from the debut of a new U.S. electronic intelligence (ELINT) collection system in the autumn of 1976. According to one history, this new source provided a veritable "flood of data" on Soviet naval activity. At roughly the same time, the U.S. Navy embarked on a program to correlate the sound characteristics of individual Soviet ships and submarines, a process that became known as hull-to-emitter correlation, or HULTEC.[89] These advantages gave the U.S. Navy a much better understanding of the location and operational patterns of Soviet naval vessels.

To utilize this and other information, the Navy established an OSIS center at Suitland, Maryland; subsidiary Fleet Ocean Surveillance Information Centers at Norfolk, Virginia; London and Pearl Harbor; and Fleet Ocean Surveillance Information Facilities at Rota, Spain and Kamiseya, Japan.[90] At these locations, sailors entered data on Soviet naval movements in a computer network known as the Navy Tactical Data System; the data were then correlated and transmitted to the fleet.[91] The aircraft carrier's Tactical Flag Communication Center (TFCC) merged these data with real-time information from the battle group's sensors.[92]

The combination of long-range bombers and ASCMs drove other innovations as well. In 1976, the Soviets began deploying the Tu-22M *Backfire* bomber, an aircraft with twice the range and a much greater payload than the *Badger*. Naval planners assumed that U.S.

89 Christopher Ford and David Rosenberg, *The Admirals' Advantage: U.S. Navy Operational Intelligence in World War II and the Cold War* (Annapolis, MD: U.S. Naval Institute Press, 2005), pp. 61–62.

90 Norman Friedman, *Seapower and Space* (London: Chatham, 2000), p. 175.

91 Ford and Rosenberg, *Admirals' Advantage*, ch. 4.

92 Friedman, *Seapower and Space*, p. 188.

carrier battle groups would face one or more regiments of 18 to 24 bombers supported by reconnaissance and electronic warfare aircraft. Ideally, U.S. ships would detect the approach of these bombers in sufficient time to launch fighters and destroy the inbound bombers before they could fire their missiles. The F-14 *Tomcat*, with its AN/AWG-9 fire control system and the AIM-54 *Pheonix* air-to-air missile, was designed to intercept and destroy the bombers before they came in range of the battle group. However, the Soviet deployment of the 500 kilometer Kh-22 (AS-4 *Kitchen*) ASCM gave Soviet bombers the ability to launch their missiles well outside the U.S. air defense envelope.[93]

In 1963, the Navy inaugurated a research program to design an air defense ship to protect CVBGs against the Soviet bomber threat. The result was the AEGIS combat system. AEGIS, named after the shield of the Greek god Zeus, was designed to protect battle groups against anti-ship missiles that might leak through a fighter screen. The heart of the system was an automatic multi-function phased-array radar, the AN/SPY-1. Unlike mechanically-steered radars, phased-array radars are steered electronically. As a result, they are able to perform search, track, and missile guidance functions simultaneously. The SPY-1, for example, can track over 100 targets. AEGIS's computer-based command and decision element allowed it to operate against air, sea, and submarine threats.

The AEGIS system was first tested at sea aboard the trial ship USS *Norton Sound* (AVM-1) in 1973. The Navy's first AEGIS ships, the *Ticonderoga*-class cruisers, combined the hull and machinery designs of the *Spruance*-class destroyers with the AEGIS combat system. Additional upgrades were introduced with the USS *Bunker Hill* (CG-52), the first AEGIS ship outfitted with the Vertical Launching System (VLS), which allowed for carrying greater firepower. The USS *Princeton* (CG-59) went to sea with the improved AN/SPY-1B radar.

In 1980, the Navy began designing a smaller AEGIS ship with better sea-keeping characteristics, reduced radar and infrared signatures, and an upgraded AEGIS system. The first such destroyer was the 8,400-ton USS *Arleigh Burke*, commissioned in 1991. The Navy subsequently purchased more than 50 *Arleigh Burke*-class destroyers.

Senior Leader Sponsorship

The Maritime Strategy also benefited from the support of senior leaders, ranging from President Ronald Reagan, to Secretary of the Navy John F. Lehman, to uniformed Navy leaders. Fielding a 600-ship Navy as a tangible sign of a revitalized U.S. military was an important plank in Reagan's platform for the 1980 presidential election. As President, Reagan took a key interest in the Navy and was a strong advocate of the expansion of the U.S. Navy. Reagan's first Secretary of Defense, Caspar Weinberger, was similarly an advocate of the expansion of the Navy. Secretary of the Navy John F. Lehman, a Navy Reserve aviator and former congressional staff member, was a particularly forceful advocate not only of the

93 Ibid., pp. 237, 234.

expansion of the Navy, but also of the development of the Maritime Strategy as both a plan for the Navy's contribution to war with the Soviet Union, but also as a political justification for the Navy.[94] The Maritime Strategy also benefited from the support of senior Navy leaders such as ADM Tom Hayward, who advocated the strategy as Commander of U.S. Pacific Fleet and then as Chief of Naval Operations, and VADM Hank Mustin, who helped develop the operational and tactical foundations of the Maritime Strategy.[95]

Innovators & Networks

The Navy's networking efforts coincided with the acceleration of the information revolution. Traditional Navy information systems were custom-built to military specifications. However, the burgeoning commercial market made more powerful computers available at a lower cost. The first senior officer to exploit the potential of commercial information technology was Rear Admiral Jerry O. Tuttle. In 1981, while serving as a carrier battle group commander, Tuttle developed a tactical decision aid using a package of software applications that were hosted on a commercial desktop computer. The resulting Joint Operational Tactical System, or JOTS, was, in essence, a TFCC hosted on a commercial computer, providing the same service without requiring the ship to undergo an expensive overhaul and installation.[96] As the Navy's Director of Space and Electronic Warfare from 1989 to 1993, Tuttle was a vigorous advocate of "commercial off-the-shelf," or COTS, technology. In his view, it was pointless for the Navy to spend large sums of money developing computers to military specifications when commercial industry could produce better and cheaper machines. He felt that the Navy should use its resources to develop software, not hardware.

By the early 1990s, virtually all U.S. surface combatants had received JOTS and its associated terminals. The result was a fleet-wide command and control system known as the Naval Tactical Command System—Afloat Element (NTCS-A). The adoption of COTS technology marked a significant change not only in the way the Navy purchased information systems, but also in the flow of information among naval forces. The Navy's traditional approach to networking had been hierarchal and passive: OSIS would develop a picture of the maritime environment and distribute it to the battle group. With JOTS and its successor, the Joint Maritime Command Information System, a distributed network of computers would cooperatively develop the picture. The Navy's networking efforts were thus the precursor to networking throughout the U.S. armed forces. Indeed, it is hardly a coincidence that the most prominent advocates of networking and "network-centric warfare"—ADM William Owens and VADM Arthur Cebrowski—were naval officers.

94 John Lehman, *Oceans Ventured: Winning the Cold War at Sea* (New York: W.W. Norton, 2018).

95 Dmitry Filipoff, "1980s Maritime Strategy Series," *CIMSEC*, https://cimsec.org/1980s-maritime-strategy-series/.

96 Friedman, *Seapower and Space*, p. 220.

Culture

Not all of the Navy's technological innovations were accepted by the cultures of its distinct communities. The Navy also sought to improve its striking power through the development of the *Tomahawk* family of cruise missiles. The *Tomahawk*, which eventually became a favored method of conducting long-range strikes, had its origins as an anti-ship cruise missile and nuclear strike system. To their advocates, cruise missiles had a number of attractive characteristics, including low cost, their ability to be launched from a variety of platforms, and high effectiveness. However, they garnered opposition from each of the U.S. armed services, including the Navy. As former Secretary of the Navy John Lehman has written:

> The professional submariners were uncomfortable because [the cruise missile's] primary means of deployment was to be on fleet fast attack submarines. Rightly, the professional focus of submariners today is on Soviet submarines and not on surface ships, and certainly not on land battles. Therefore, the mission of the Tomahawk was a distraction from their primary responsibilities. Moreover, every Tomahawk aboard left them with one less torpedo to do their primary job, and if it was a nuclear Tomahawk, they greatly feared that they would be tied to specific firing positions in the event of nuclear alert, frustrating their basic pelagic instincts. The aviators certainly had no love of any system that did not carry a pilot and yet could do some things that carrier aircraft could do. The destroyermen, the surface warfare officers, saw no great benefit from Tomahawk in helping their primary missions of antisubmarine warfare and anti-air warfare.[97]

Initially, the Navy's cruise missile program resulted from the threat environment—namely, the need to counter the Soviet surface fleet. Shortly after becoming Chief of Naval Operations, Elmo Zumwalt appointed Admiral Robert Kaufman to chair a panel to explore the possibility of developing a submarine-launched ASCM. While the Defense Department explored a range of options for nuclear-armed submarine-launched cruise missiles (SLCMs), the Navy, which really wanted an ASCM, pressed for another option: a family of cruise missiles with both tactical and strategic applications that would be compatible with existing platforms. The Navy's view prevailed.

The Air Force had its own cruise missile program, which aimed at fielding a nuclear-armed air-launched cruise missile (ALCM). In December 1973, OSD ordered that the services cooperate: it directed the Air Force to share its turbofan engine and high-energy fuel with the Navy, and it told the Navy to share terrain contour matching guidance technology, or TERCOM, with the Air Force.[98] In March 1976, the Defense Department selected General Dynamics as the manufacturer of the SLCM. The Navy set July 1980 for the

97 John F. Lehman, *Command of the Seas* (Annapolis, MD: Naval Institute Press, 2001), p. 169.

98 Kenneth P. Werrell, *The Evolution of the Cruise Missile* (Maxwell Air Force Base, AL: Air University Press, September 1985), p. 154.

initial operational capability of the conventional land attack and anti-ship variants of the *Tomahawk*, and January 1981 for the surface-launched conventional variant.[99]

The conventional BGM-109B *Tomahawk* Anti-Ship Missile (TASM), which was designed to identify and destroy Soviet warships over the horizon, was the missile the Navy wanted. The 460-kilometer missile, equipped with a 1,000 lb. warhead, used an inertial navigation system (INS) for navigation and passive and active terminal seekers to home in on targets. It would be launched in the general direction of its target, search it out, identify it, and attack it. However, because it might take the missile half an hour to reach its target, it required in-flight targeting updates. Although the U.S. Navy developed an extensive targeting infrastructure to support TASM, over-the-horizon targeting remained the Achilles' heel of the system and never gained acceptance within the fleet.[100]

Whereas the Navy favored a conventional anti-ship cruise missile, OSD and Congress favored the nuclear land-attack version of the *Tomahawk*, the BGM-109A. Equipped with a W-80 nuclear warhead, the 2,500-kilometer missile would be launched from submarines and ships against shore targets. As the missile's accuracy became apparent, the Navy decided to field a conventional version of the missile, the BGM-109C. Another version, the BGM-109D, carried bomblets to strike airfields. The development of the *Tomahawk* as a family of cruise missiles with assorted launch platforms and payloads illustrates the effects of varied and incongruent organizational and bureaucratic cultures on military innovation.

Assessing the Maritime Strategy

The story of the Navy's Maritime Strategy largely supports previously identified lessons and insights. The development of the *Tomahawk* missile, on the other hand, offers unique insights into the modern interaction between the joint and service-level bureaucracies. First, varying demands between Department leadership and the services often result in compromises to satisfy the needs of both parties. DoD wanted to develop a nuclear SLCM, while the Navy preferred an ASCM. This disagreement ultimately resulted in the creation of a family of Tomahawk missiles that included both the BGM-109A TLAM-N and the BGM-109B TASM.

Second, involvement of civilian and uniformed defense leaders is sometimes required to resolve differences between the services or push the services to work together. OSD oversight was required to make the Navy and Air Force work together on the *Tomahawk* program. Although both services needed weapons with similar characteristics, it was only with DoD intervention that the services shared missile components. Ultimately, OSD involvement improved both programs, avoided unnecessary redundancy, and likely sped up development timelines.

99 Werrell, The Evolution of the Cruise Missile, p. 155.

100 Friedman, *Seapower and Space*, p. 211.

Third, follow-on innovations can, at times, achieve more success than initial developments because requirements and cultures can shift over time. Although the Navy initially resisted the land-attack role and the nuclear-equipped BGM-109A, the eventual creation of the conventional BGM-109C/D would lead to the Tomahawk becoming a mainstay in the Navy's inventory of submarine and surface-launched missiles. Despite the Navy's favored TASM being withdrawn from service shortly after the end of the Cold War, the conventional land-attack *Tomahawk* went on to become one of the Navy's major contributions to operations in the Persian Gulf, Afghanistan, Iraq, Libya, and Syria.

Lessons on Military Innovation

In each case, civilian and military leaders had to grapple not only with geopolitical and fiscal realities, but also with uncertainties associated with the emergence of new ways of war. For example, the development of pentomic operations was crucially dependent upon the ability to command and control geographically dispersed units on the nuclear battlefield, something that proved to be an insurmountable challenge. Similarly, the operational effectiveness of AirLand Battle was bound up in how the information revolution shifted—or might shift—the balance between offense and defense. Many of these issues resonate in today's discussions of new ways of war.

The history of innovation during the Cold War reveals the importance of operational challenges that defy a conventional solution in driving the development of new ways of war. The cases examined in this chapter highlight how important it is for senior civilian and uniformed leaders to promote, guide, and oversee innovation efforts. They also show the central role of innovators and their networks in bringing new operational concepts and capabilities to fruition. Finally, they emphasize the role of organizational culture in shaping innovation efforts.

CHAPTER 4

Current Service Innovation Efforts

As in the Cold War, today's military services have each begun to articulate new operational concepts for waging war against a contemporary great power adversary such as China or Russia. Moreover, each has also embraced concepts of operations in and across multiple domains and is developing capabilities to enable those concepts. These efforts, however, remain at relatively early stages of development.

How do these initial efforts of the military services compare to each other when evaluated with our innovation framework? How do they compare to their historical counterparts from the Cold War? This chapter seeks to answer these questions by examining contemporary service-led innovation efforts against the framework established in chapter two.

A Brief Look at the Innovation Efforts of Each Service

Each service has developed its own concepts that will ultimately support the Joint Warfighting Concept (JWC) and Joint All-Domain Command and Control (JADC2). These concepts are supported by programs which focus on developing and implementing technological innovation. Some of these concepts and programs are supported by organizational changes to encourage innovation. Before beginning our assessment, this section will briefly describe the major conceptual, organizational, and technological elements of the military services' modernization initiatives.

U.S. Army

In 2017, the Army and Marine Corps together first articulated the "Multi-Domain Battle" concept, and the Army currently espouses the concept of "Multi-Domain Operations" (MDO), which is meant to describe how:

> the U.S. Army, as part of the joint force, can counter and defeat a near-peer adversary capable of contesting the U.S. in all domains, in both competition and armed conflict. The concept describes how U.S. ground forces, as part of the joint and multinational team, deters adversaries and defeats highly capable near-peer enemies in the 2025-2050 timeframe.[101]

In December 2018, the Army's Training and Doctrine Command (TRADOC) published *The U.S. Army in Multi-Domain Operations 2028* to "provide a foundation for continued discussion, analysis, and development" of the MDO concept. In it, the authors state the central idea:

> Army forces, as an element of the Joint Force, conduct MDO to prevail in competition; when necessary, Army forces penetrate and dis-integrate enemy anti-access and area denial systems and exploit the resultant freedom of maneuver to achieve strategic objectives (win) and force a return to competition on favorable terms.[102]

The concept also outlines three core tenets: calibrated force posture, multi-domain formations, and convergence, which it defines as "the rapid and continuous integration of all domains across time, space and capabilities to overmatch the enemy."[103] Whereas AirLand Battle's bumper sticker was to "Fight outnumbered and win," by attacking the rear echelons of Soviet forces before they could arrive to reinforce the front line, MDO can be summarized as "Defeat layered standoff and win a short conflict."

To accelerate the adoption of programs and technologies to support MDO and modernize the force, the Army established Army Futures Command (AFC) in October 2017.[104] AFC then created eight Cross-Functional Teams (CFTs) to enable modernization priorities by gathering major requirements and acquisition, science and technology, testing, and logistics stakeholders to work together to develop systems to support MDO.[105] The CFTs align with the service's six modernization priorities and two enabling areas: long-range precision fires, next-generation combat vehicles, future vertical lift, network technologies, air and missile defense, soldier lethality, assured positioning, navigation, and timing (PNT), and the synthetic training environment.

In addition to these administrative organizations, the Army has created new operational force structures to test and execute MDO. It stood up two Multi-Domain Task Forces

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101 U.S. Army Training and Doctrine Command, "Multi-Domain Operations," October 4, 2018, https://www.army.mil/standto/archive/2018/10/04/.

102 *The U.S. Army in Multi-Domain Operations 2028* (Fort Eustis, VA: U.S. Army Training and Doctrine Command, December 6, 2018), p. 17, https://api.army.mil/e2/c/downloads/2021/02/26/b45372c1/20181206-tp525-3-1-the-us-army-in-mdo-2028-final.pdf.

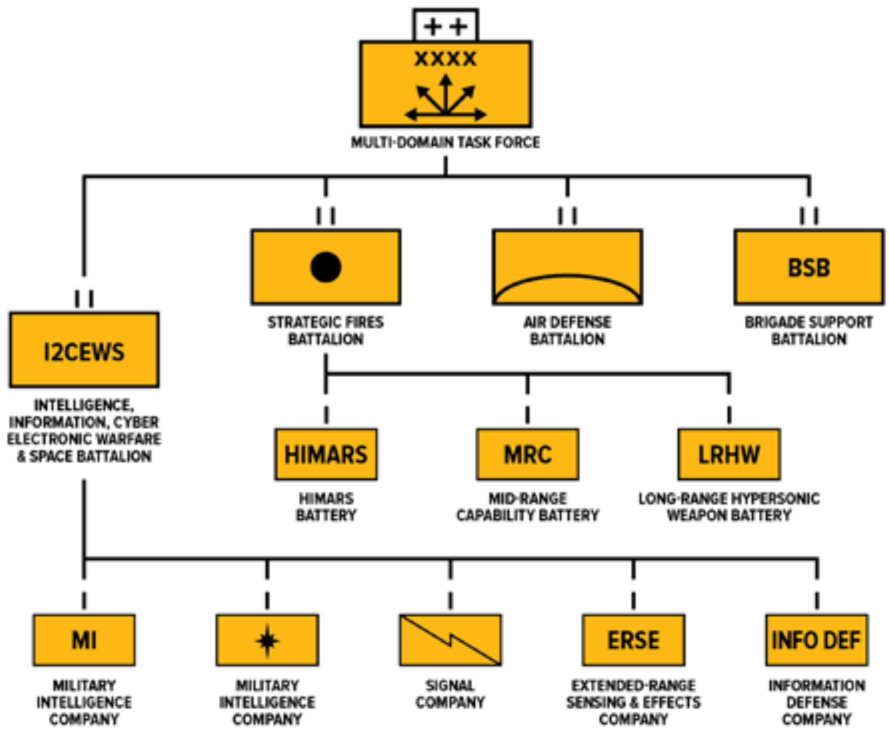
103 Ibid, p. iii.

104 Joe Lacdan, "Establishment of Army Futures Command Marks a Culture Shift," *Army News Service*, August 27, 2018, https://www.army.mil/article/210371/establishment_of_army_futures_command_marks_a_culture_shift.

105 Ryan D. McCarthy, James C. McConville, and Michael A. Grinston, *Army Modernization Strategy: Investing in the Future* (Arlington, VA: United States Army, 2019), p. 7, https://www.army.mil/e2/downloads/rv7/2019_army_modernization_strategy_final.pdf.

(MDTFs), one in the continental United States and one in Europe, as experimental units intended to be "the organizational centerpiece" of MDO.[106] The initial MDTFs consist of long-range fires units, intelligence and signal units, air defense units, and supporting elements, although the Army intends to establish five MDTFs and tailor each to the requirements of individual combatant commands.[107] Beyond the MDTFs, the Army is more broadly considering refocusing its structure away from Brigade Combat Teams (BCTs) and back to higher echelons such as the division and corps.[108]

FIGURE 2: NOTIONAL MULTI-DOMAIN TASK FORCE STRUCTURE



Source: *Army Multi-Domain Transformation: Ready to Win in Competition and Conflict* (Arlington, VA: Headquarters, Department of the Army, March 16, 2021), p. 12, https://api.army.mil/e2/c/downloads/2021/03/23/eeac3d01/20210319-csa-paper-1-signed-print-version.pdf.

The aforementioned modernization priorities and CFTs form a foundation for the Army's innovation programs. The majority of these programs and technologies are contained in the service's 31 "signature efforts," which are displayed in Figure 3. To further develop MDO and

106 Charles McEnany, "Multi-Domain Task Forces: A Glimpse at the Army of 2035," Association of the United States Army, March 2, 2022, https://www.ausa.org/publications/multi-domain-task-forces-glimpse-army-2035.

107 Andrew Feickert, *The Army's Multi-Domain Task Force (MDTF)* (Washington, DC: Congressional Research Service, May 31, 2022), https://sgp.fas.org/crs/natsec/IF11797.pdf.

108 Todd South, "The Army's Transformation Begins with These New Units," *Army Times*, April 11, 2022, https://www.armytimes.com/news/your-army/2022/04/11/the-armys-transformation-begins-with-these-new-units/.

lead the service's contributions to JADC2, AFC established Project Convergence—an effort bringing together all the AFC CFTs and Combat Capabilities Development Center (CCDC) labs in one place to conduct annual exercises and combined demonstrations.[109] Over the past few years, these events have showcased various JADC2-related technologies and capabilities, including joint fires using cross-service sensors, air and missile defense, and artificial intelligence-enabled reconnaissance and attack.[110]

TABLE 2: U.S. ARMY CROSS-FUNCTIONAL TEAMS AND SIGNATURE EFFORTS

Cross-Functional Team	Signature Efforts
Long Range Precision Fires	• Strategic Fires • Precision Strike Missile • Extended Range Cannon Artillery
Next Generation Combat Vehicle	• Optionally Manned Fighting Vehicle • Armored Multi-Purposed Vehicle • Mobile Protected Firepower • Robotic Combat Vehicle
Future Vertical Lift	• Future Attack Reconnaissance Aircraft • Future Long Range Assault Aircraft • Future UAS • Modular Open Systems Architecture
Network	• Unified Network • Command Post Common Environment • Joint Interoperability/Coalition Accessible • Command Post Mobility/Survivability
Assured Positioning, Navigation, and Timing *Enabling Area*	• Assured Position, Navigation, and Timing • Tactical Space • Navigation Warfare
Air and Missile Defense	• Army Integrated Air and Missile Defense • Maneuver – Short Range Air Defense • Indirect Fire Protection Capability • Lower-Tier Air and Missile Defense Sensor
Soldier Lethality	• Next Gen Squad Weapon – Automatic Rifle • Next Gen Squad Weapon – Rifle • Enhanced Night Vision Goggle – Binocular • Integrated Visual Augmentation System
Synthetic Training Environment *Enabling Area*	• Synthetic Training Environment Information System • Reconfigurable Virtual Collective Trainers • Squad Immersive Virtual Trainer • Squad/Soldier Virtual Trainers • One World Terrain

Source: Author re-creation of graphic from 2019 *Army Modernization Strategy*, p. 7. See McCarthy, McConville, and Grinston, *Army Modernization Strategy*, https://www.army.mil/e2/downloads/rv7/2019_army_modernization_strategy_final.pdf.

109 Army Futures Command, "Project Convergence," https://armyfuturescommand.com/convergence/.

110 Andrew Feickert, *The Army's Project Convergence* (Washington, DC: Congressional Research Service, June 2, 2022), https://sgp.fas.org/crs/weapons/IF11654.pdf.

U.S. Air Force[111]

The Air Force has joined the Army in endorsing MDO as a centerpiece of its force, capability, and concept development efforts. Whereas the Army has emphasized the concept's demand for long-range precision fires, the Air Force has highlighted the critical importance of battlespace connectivity and advanced C2, historically one of the service's core concerns.[112] To this end, the Air Force has implemented JADC2 through its Advanced Battle Management System (ABMS). ABMS initially began as a replacement for the E-8C Joint Surveillance Target Attack Radar System (JSTARS) and the E-3 Airborne Warning and Control System (AWACS), but has since evolved into a more comprehensive C2 program led by the Air Force's Rapid Capabilities Office.[113] ABMS seeks to create "a secure, military digital network environment leveraging proven commercial technologies, infrastructure, and applications to provide 21st Century warfighting capability."[114] As shown in Table 3, the program focuses on six attributes: sensor integration, data management, secure processing, connectivity, applications, and effects integration. The Air Force has conducted several major demonstrations of ABMS capabilities since 2019, including utilizing the network and joint platforms to defeat an incoming cruise missile threat, sharing information across assets and with partner nations, and testing enterprise communications architectures between various commands and installations.[115]

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111 As of this monograph's writing, the innovation efforts of the U.S. Space Force remain in their infancy and are closely linked to the existing efforts of the U.S. Air Force. Accordingly, this study accounts for the U.S. Space Force in the U.S. Air Force section.

112 Sydney J. Freedberg Jr., "'A Computer That Happens To Fly': USAF, RAF Chiefs On Multi-Domain Future," *Breaking Defense*, April 16, 2018, https://breakingdefense.com/2018/04/a-computer-that-happens-to-fly-usaf-raf-chiefs-on-multi-domain-future/.

113 Brian W. Everstine, "USAF's Rapid Capabilities Office to Oversee ABMS Development, Procurement," *Air Force Magazine*, November 24, 2020, https://www.airforcemag.com/usafs-rapid-capabilities-office-to-oversee-abms-development-procurement/; John R. Hoehn, *Advanced Battle Management System (ABMS)* (Washington, DC: Congressional Research Service, 2021), https://sgp.fas.org/crs/weapons/IF11866.pdf.

114 Air Force Rapid Capabilities Office, "ABMS Industry Day," March 3, 2021, https://www.wpafb.af.mil/News/Article-Display/Article/2524473/abms-industry-day/.

115 Department of the Air Force, "Fiscal Year 2023 Budget Overview," p. 19, https://media.defense.gov/2022/Mar/28/2002964733/-1/-1/1/FY%202023%20DAF%20BUDGET.PDF; Brian W. Everstine, "'Smart' Bullet Downs Cruise Missile in 2nd ABMS Test," *Air Force Magazine*, September 4, 2020, https://www.airforcemag.com/smart-bullet-downs-cruise-missile-in-2nd-abms-test/; Valerie Insinna, "After the Third Advanced Battle Management System Test, This Is the IT Tool the Head of Pacific Air Forces Put on His Wish List," *C4ISRNet*, October 30, 2020, https://www.c4isrnet.com/global/asia-pacific/2020/10/30/after-the-third-advanced-battle-management-system-test-this-is-the-it-tool-the-head-of-pacific-air-forces-put-on-his-wish-list/; Valerie Insinna, "Air Force Curtails ABMS Demos after Budget Slashed by Congress," *C4ISRNet*, March 17, 2021, https://www.c4isrnet.com/it-networks/2021/03/17/air-force-curtails-abms-demos-after-budget-slashed-by-congress/; Jackson Barnett, "ABMS Test Events Focus on Applying Tech to Enterprise IT," *FedScoop*, July 29, 2021, https://www.fedscoop.com/abms-ade-test-event-focusing-on-new-enterprise-it-air-force/.

TABLE 3: PRODUCT LINES AND FUNCTIONS OF ADVANCED BATTLE MANAGEMENT SYSTEM

ABMS Product Category	Product Line and Function
Sensor Integration	• openRadarONE: Government-owned open architecture radar system & test bed • openMtiONE: Mode to enable air & ground moving target indication on any open RadarONE radar • openIntONE: Common open sensor architectures across domains (e.g. GEOINT, MASINT, etc.)
Data	• feedONE: Cloud-based data feeds from government and non-government sources • wrapONE: CloudONE hosted automated artificial intelligence meta data wrapper for analytics, algorithms & fusion • dataONE: Cloud-based & discoverable data library & data manager
Secure Processing	• cloudONE: Multi-level security cloud at U, S/REL, S, SCI, S/SAR, TS/SAR for development, data & applications • crossDomainONE: Secure solution to move data up & down security levels • platformONE: Cloud-based interoperable software development environment • edgeONE: Edge based cloudONE for local processing data & apps even when disconnected from global cloudONE • boxONE: Edge workstation that seamlessly accesses multi-level secure cloudONE or edgeONE network; zeroized option • tabletONE: Tablet that seamlessly accesses multi-level secure cloudONE or edgeONE network; zeroized option • phoneONE: Smart phone that seamlessly accesses multi-level secure cloudONE or edgeONE network; zeroized option • assistONE: Rapid deployment & configuration team for secure processing & user devices
Connectivity	• gatewayONE: Government-owned open system enabling translation & communication across platforms • radioONE: Government-owned open software-defined radio • meshONE: Government-owned open software-defined mesh network • apertureONE: Government-owned apertures capable of multiple functions (e.g. communications, radar & electronic warfare) • commercialONE: Robust classified capabilities over communications gateways • nationalONE: Robust connectivity of data & intelligence between the IC & tactical edge • link16e: Enhanced legacy link 16 for resilient performance
Apps	• AI/smartONE: Cloud-based algorithm development environment & library • fuseONE: Cloud-based multi-domain intelligence & information fusion environment, enabled by cloudONE • omniaONE: Cloud-based multi-domain common operating picture, enabled by fuseONE • commandONE: Cloud-based multi-domain battle management & machine-to-machine command & control
Effects Integration	• missionDataONE: Cloud-based real time update to mission data files • smartMunONE: Networked smart weapons capable of dynamically retasking 3rd party sensor suites • attritableONE: Multi-role attritable capabilities

Source: Author re-creation from Air Force briefing found at Patrick Tucker, "Toward a War With Fewer Radio Calls," *DefenseOne*, January 21, 2020, https://www.defenseone.com/technology/2020/01/toward-war-fewer-phone-calls/162562/.

More broadly, the Air Force intends to disaggregate its capabilities away from large and expensive multi-mission platforms. While manned aircraft will likely remain a major portion of the desired fleet of 386 operational squadrons, they will be teamed with smaller, more attritable unmanned systems such as the XQ-58 *Valkyrie*.[116]

ABMS and other technologies are primarily intended to support the Air Force's new operational concept, called Agile Combat Employment, or ACE. ACE originated in several of the Air Force major commands (MAJCOMs), such as U.S. Pacific Air Forces (PACAF) and Air Mobility Command.[117] The concept combined the Headquarters Air Force (HAF) concept of Adaptive Basing in Contested Environments to create and leverage "networks of well-established and austere air bases, multi-capable airmen, pre-positioned equipment, and airlift to rapidly deploy, disperse and maneuver combat capability throughout a theater."[118] Acknowledging the challenges Russian and Chinese missiles pose to the Air Force's fixed bases and short-range fighter aircraft, ACE expands the number of points inside the adversary's weapons engagement zone (WEZ) from which air forces can generate combat sorties, increasing the resiliency of its airbases and forces and complicating the adversary's targeting picture.[119] Combined with aircraft refueling, rearming, and maintenance activities, ACE focuses on the ability to disperse, recover, and rapidly resume operations in contested and austere environments. For its part, the U.S. Space Force has released its initial vision on becoming an "interconnected, innovative, and digitally dominant force" by embracing digital modernization.[120]

U.S. Navy

Building off earlier concepts coined Distributed Lethality and Electromagnetic Maneuver Warfare, the Navy developed a new concept in 2017 titled Distributed Maritime Operations (DMO). It described DMO as "a central, overarching operational concept that will weave together the principles of integration, distribution and maneuver to maximize the effectiveness of the fleet Maritime Operations Centers to synchronize all-domain effects."[121] Navy

116 David Axe, "The Air Force's Mysterious XQ-58 Valkyrie Drone Is Almost Ready," *The National Interest*, November 4, 2019, https://nationalinterest.org/blog/buzz/air-forces-mysterious-xq-58-valkyrie-drone-almost-ready-93401.

117 Brian M. Killough, "The Complicated Combat Future of the U.S. Air Force," *The National Interest*, February 9, 2020, https://nationalinterest.org/feature/complicated-combat-future-us-air-force-121226; Terrence J. O'Shaughnessy, Matthew D. Strohmeyer, and Christopher D. Forrest, "Strategic Shaping: Expanding the Competitive Space," *Joint Force Quarterly* 90 (3rd Quarter 2018), pp. 10–15; Steven L. Basham and Nelson D. Rouleau, "A Rebalance Strategy for Pacific Air Forces, " *Air & Space Power Journal* (January-February 2015), pp. 13–17.

118 Scott D. Adamson and Shane Praiswater, "With Air Bases at Risk, Agile Combat Employment Must Mature," *Defense News*, November 12, 2020, https://www.defensenews.com/opinion/commentary/2020/11/12/air-bases-are-at-risk-without-the-agile-combat-employment-approach/.

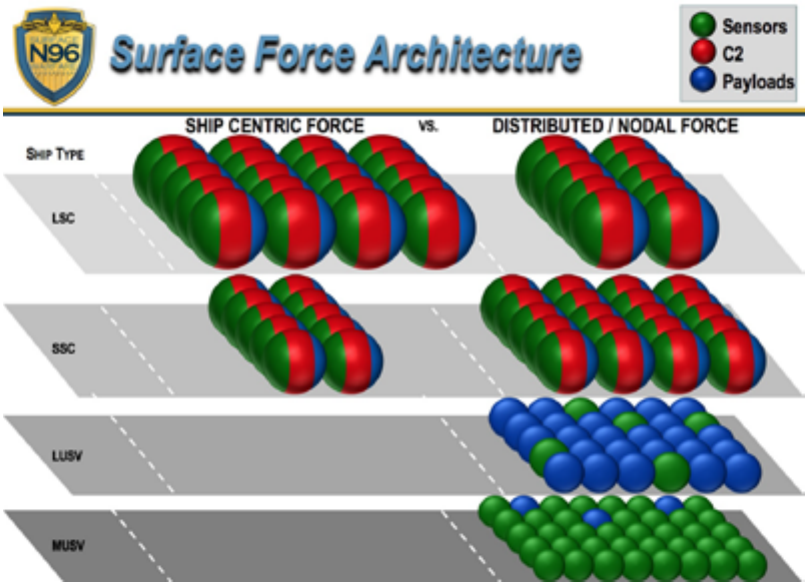
119 Jennifer Hlad and Amy McCullough, "ACE-ing the Test," *Air Force Magazine*, May 1, 2020, https://www.airforcemag.com/article/ace-ing-the-test/; David Dammeier, Meka Toliver, and Logan Smith, "Overcoming a Power Projection Problem," *CE Online*, Spring 2016, https://www.afcec.af.mil/News/CE-Online/Article-Display/Article/1004470/overcoming-a-power-projection-problem/.

120 U.S. Space Force, "U.S. Space Force Vision for a Digital Service," May 2021, https://media.defense.gov/2021/May/06/2002635623/-1/-1/1/USSF%20VISION%20FOR%20A%20DIGITAL%20SERVICE%202021%20(2).PDF.

121 Navy Warfare Development Command, "CNO Visits Navy Warfare Development Command," April 13, 2017, https://www.nwdc.usff.navy.mil/Press-Room/News-Stories/Article/2406186/cno-visits-navy-warfare-development-command/.

watchers expect DMO to serve as the linchpin of the service's force development efforts in the years ahead. Broadly, DMO aims to shift the Navy's force structure away from large vessels and toward a dispersed and networked fleet of smaller manned and unmanned platforms. Doing so will help the Navy reach its stated goal of 355 ships by 2035 and possibly more than 500 ships by 2045.

FIGURE 3: U.S. NAVY FUTURE SURFACE FORCE ARCHITECTURE



Source: Megan Eckstein, "Sea Hunter Unmanned Ship Continues Autonomy Testing as NAVSEA Moves Forward with Draft RFP," *USNI News*, April 29, 2019, https://news.usni.org/2019/04/29/sea-hunter-unmanned-ship-continues-autonomy-testing-as-navsea-moves-forward-with-draft-rfp.

To support this vision, the Navy has stood up new offices and organizations tasked with concept development, innovation, and experimentation. In May 2019, the Navy established Surface Development Squadron (SURFDEVRON) 1 to bring together its three stealthy *Zumwalt*-class destroyers and its first *Sea Hunter* unmanned surface vessels (USVs) for experimentation. SURFDEVRON 1 will take ownership of additional USVs as they enter the fleet.[122] It is also standing up a capability development hub called DEVGRUWEST in San Diego that will fall under U.S. 3rd Fleet and will be principally supported by Space and Naval Warfare Systems Command (SPAWAR), the Naval Postgraduate School, the Naval Warfare Development Command (NWDC), and each of the type commanders' warfare development commands. The Navy will also create a DEVGRUEAST as a concept development hub at U.S. 2nd Fleet in Norfolk to be supported by the Naval War College, the Naval Warfare Development Command, and the warfare development commands. Together, the

122 Megan Eckstein, "Navy Stands Up Surface Development Squadron for DDG-1000, Unmanned Experimentation," *USNI News*, May 22, 2019, https://news.usni.org/2019/05/22/navy-stands-up-surface-development-squadron-for-ddg-1000-unmanned-experimentation.

two commands are intended to "collaborate to exploit the constructive, iterative dynamic between capability and concept development."[123]

More recently, the Navy established the Deputy Chief of Naval Operations (DCNO) for Warfighting Development, or OPNAV N7, a new directorate of four divisions devoted to warfighter development, warfighting development, strategic warfighting innovation, and warfighting integration.[124] Led by a vice admiral, OPNAV N7 is intended to be an integrator of overall Navy strategy that will herd other groups in the Navy tasked with planning, requirements, funding, and operations.[125]

Leading the Navy's innovation program is Project Overmatch.[126] Established in 2020, Project Overmatch is the Navy's contribution to JADC2 and seeks to build the capability to command, control, and communicate with the future force of distributed maritime nodes envisioned in DMO. The Navy charged the project's leader, commander of the Naval Information Warfare Systems Command (NAVWAR) Rear Adm. Doug Small, with "develop[ing] the networks, infrastructure, data architecture, tools, and analytics that support the operational and developmental environment that will enable our sustained maritime dominance."[127] The service recently announced that four of its aircraft carriers will receive upgrades as part of Project Overmatch, with the program's initial capabilities reaching carrier strike groups in fiscal year (FY) 2022 or 2023.[128] Many other details surrounding the programs within Overmatch remain vague or are not publicly available at this time.

123 J.M. Richardson, *A Design for Maintaining Maritime Superiority, Version 2.0* (Arlington, VA: Department of the Navy, December 2018), p. 10, https://media.defense.gov/2020/May/18/2002301999/-1/-1/1/DESIGN_2.0.PDF.

124 Chief of Naval Operations to NAVADMIN, "Establishment of Deputy Chief of Naval Operations (DCNO) for Warfighting Development (OPNAV N7)," Department of the Navy, June 11, 2020, https://www.navy.mil/Resources/NAVADMINs/Message/Article/2277137/establishment-of-deputy-chief-of-naval-operations-dcno-for-warfighting-developm/.

125 N7 will pursue lines of effort "focused on Navy strategy; organizational learning and analysis of lessons learned from wargames, exercises, experiments, tests, and studies; education policy and the development of warrior-scholars; strategic force-development planning; and alignment of efforts across headquarters, the Navy, government, and industry to solve key operational problems." OPNAV N7 Public Affairs, "Navy's New Deputy Chief of Naval Operations on CNO Staff Leading Work on Strategy, Education, Warfighting Development," Department of the Navy, June 11, 2020, https://www.navy.mil/DesktopModules/ArticleCS/Print.aspx?PortalId=1&ModuleId=763&Article=2284125.

126 Yasmin Tadjdeh, "Navy Dedicates More Resources To Secretive Project Overmatch," *National Defense Magazine*, August 10, 2021, https://www.nationaldefensemagazine.org/articles/2021/8/10/navy-dedicates-more-resources-to-secretive-project-overmatch#:~:text=Navy%20Dedicates%20More%20Resources%20To%20Secretive%20Project%20Overmatch,-8%2F10%2F2021&text=The%20Navy%20is%20making%20headway,command%20and%20control%2C%20or%20JADC2.

127 Michael Gilday quoted in Megan Eckstein, "Navy Focused on Strengthening Networks to Support Unmanned Operations," *USNI News*, October 27, 2020, https://news.usni.org/2020/10/27/navy-focused-on-strengthening-networks-to-support-unmanned-operations.

128 Justin Katz, "Four Carriers Being Prepped for Navy's Project Overmatch," *Breaking Defense*, January 25, 2022, https://breakingdefense.com/2022/01/four-carriers-being-prepped-for-navys-project-overmatch/.

U.S. Marine Corps

In 2016, the Marine Corps, under General Robert Neller, released a Marine Corps Operating Concept (MOC) which provided a framework for how the Marine Corps and Navy team should organize, train, fight, and win in future conflicts.[129] Within the MOC framework, the Marine Corps developed subordinate operating concepts in parallel with DMO, including Littoral Operations in Contested Environments (LOCE) and Expeditionary Advanced Base Operations (EABO).[130] These subordinate concepts are shared Navy-Marine Corps concepts which emphasize using hard-to-target forward bases, a wider range of maritime platforms, cross-domain fires, distributable units, and lighter and more agile forces for offensive operations in support of sea control and sea denial. This is a departure from large-scale forcible entry operations and traditional maneuver operations.

The ideas in these documents now guide the service as it procures the tools needed to arm and network small units across distributed areas by the end of the 2020s. The current Commandant of the Marine Corps, General David Berger, stated in his planning guidance:

> It is time to move beyond the MOC itself, however, and partner with the Navy to complement LOCE and EABO with classified, threat-specific operating concepts that describe how naval forces will conduct the range of missions articulated in our strategic guidance.[131]

In March 2020, Commandant Berger released another document titled *Force Design 2030* to begin pushing the Marine Corps in the direction he feels best aligns with these concepts and capabilities.[132] The Marine Corps is attempting to work iteratively rather than definitively to more swiftly test force design, posture, and capability changes. For example, it has developed a tentative manual for EABO to inform live, virtual, and constructive experimentation instead of taking years to develop and release the perfect concept and guidance.

These efforts and others have led the Marines to acquire and experiment with new capabilities, as well as create and field new formations. One such unit is the Marine Littoral Regiment (MLR, displayed in Figure 4), which will be optimized to operate and, if necessary,

129 *The Marine Corps Operating Concept: How an Expeditionary Force Operates in the 21st Century* (Arlington, VA: Headquarters U.S. Marine Corps, September 2016), https://www.mcwl.marines.mil/Portals/34/Images/MarineCorpsOperatingConceptSept2016.pdf.

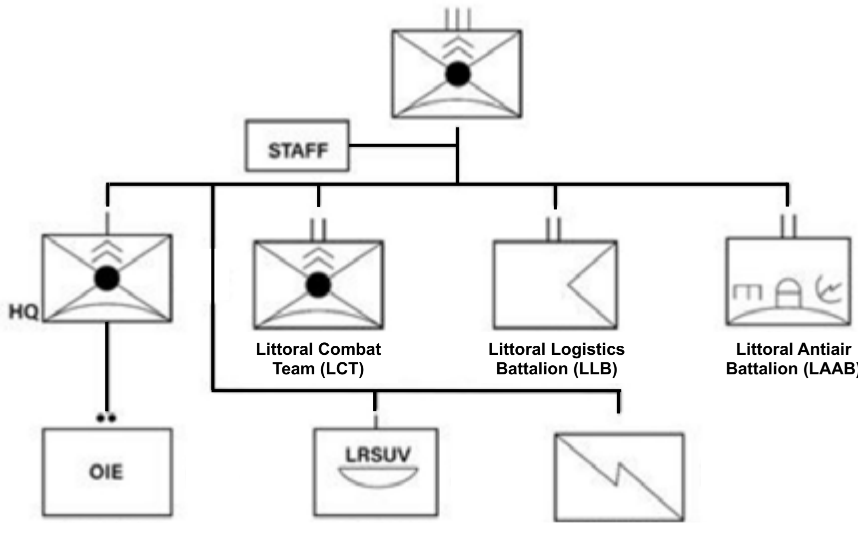
130 *Littoral Operations in a Contested Environment* (Arlington, VA: Headquarters U.S. Marine Corps, 2017), https://www.hqmc.marines.mil/Portals/160/LOCE%20full%20size%20edition.pdf?ver=2018-06-20-095003-177; *Expeditionary Advanced Base Operations (EABO) Handbook: Considerations for Force Development and Employment* (Quantico, VA: Marine Corps Warfighting Laboratory, June 1, 2018), https://mca-marines.org/wp-content/uploads/Expeditionary-Advanced-Base-Operations-EABO-handbook-1.1.pdf.

131 David H. Berger, *Commandant's Planning Guidance: 38th Commandant of the Marine Corps* (Arlington, VA: U.S. Marine Corps, 2019), p. 9, https://www.hqmc.marines.mil/Portals/142/Docs/%2038th%20Commandant%27s%20Planning%20Guidance_2019.pdf?ver=2019-07-16-200152-700.

132 See *Force Design 2030* (Arlington, VA: Headquarters U.S. Marine Corps, March 2020), https://www.hqmc.marines.mil/Portals/142/Docs/CMC38%20Force%20Design%202030%20Report%20Phase%20I%20and%20II.pdf?ver=2020-03-26-121328-460.

fight in the Western Pacific theater, inside China's weapons engagement zone (WEZ). The Marines began exercises in the Indo-Pacific with the first MLR in the spring of 2022.[133]

FIGURE 4: 2030 MARINE LITTORAL REGIMENT ORGANIZATION



An MLR is expected to be composed of the following units: A Headquarters Company with an attached Operations in the Information Environment (OIE) Section. A Littoral Combat Team (LCT), which is a battalion-sized unit composed of a headquarters and service company, an anti-ship missile battery with two firing platoons employing the Navy-Marine Expeditionary Ship Interdiction System (NMESIS), three rifle companies of three rifle platoons each, and an engineer platoon; A Littoral Logistics Battalion (LLB) composed of a headquarters and service platoon, two direct support companies, and one general support company; A Littoral Antiair Battalion (LAAB) composed of a headquarters and service company, a Marine Air Defense Integrated System (MADIS) battery with four firing platoons, a forward arming and refueling point (FARP) company with three platoons, and an air control company (as needed, a Medium Range Intercept Capability (MRIC) battery may be attached to the LAAB); A Long Range Unmanned Surface Vessel (LRUSV) Company; A Communications Company.

Source: Graphic modified from Headquarters Marine Corps, *Tentative Manual for Expeditionary Advanced Base Operations*, February 2021, Appendix A, https://mca-marines.org/wp-content/uploads/TM-EABO-First-Edition-1.pdf

The Marine Corps has also developed and begun fielding new capabilities to defend expeditionary bases and perform maritime strike, including shore-based anti-ship missiles and longer-range ground fires. One system, the Navy Marine Expeditionary Ship Interdiction System (NMESIS), carries two Naval Strike Missiles and can be lifted by a CH-53 helicopter.[134] The Marine Corps is also working with the Navy and Army to experiment with a land-based Tomahawk missile.[135]

Many of the Marine Corps' concepts and platforms rely on the enhanced connectivity provided by JADC2 to retain control and facilitate strikes by maritime forces. Accordingly, the Marines'

133 Megan Eckstein, "First-of-kind Marine Littoral Regiment Plays with Nw Concepts, Weapons," *Defense News*, May 12, 2022, https://www.defensenews.com/digital-show-dailies/modern-day-marine/2022/05/12/first-of-kind-marine-littoral-regiment-plays-with-new-concepts-weapons/.

134 Peter Ong, "Latest Details On The USMC's NMESIS and Long Range USV," *Naval News*, June 22, 2022, https://www.navalnews.com/naval-news/2022/06/latest-details-on-the-usmcs-nmesis-and-long-range-usv/.

135 Peter Ong, "USMC Discusses Land-Based Tomahawk Missile Launchers," *Naval News*, June 9, 2022, https://www.navalnews.com/naval-news/2022/06/usmc-discusses-land-based-tomahawk-missile-launchers/.

piece of Project Overmatch focuses on maritime kill chains and the integration of new sensors and weapons such as the Ground/Air Task-Oriented Radar (G/ATOR) and NMESIS.

Examining Current Service Innovation Efforts

Using the framework established in chapter two, the following section aims to provide a snapshot of the current innovation efforts of the military services. The previous section outlined how each service is developing and implementing its own concepts, organizations, and programs, many of which are developing rapidly and may be classified in nature. This section assesses the services' progress up to the fall of 2022 using publicly available information. Even with these information limitations, our application of the innovation framework allows us to form a meaningful picture of service innovation to this point in time.

It should be noted that this report does not pass judgment on whether the services' problem statements, concepts, or other innovation efforts are the *right* ones—only whether or not they are making significant and consequential changes in response to strategic and operational problems. Assessing the viability and suitability of each of the services' initiatives is outside the scope of this study, but is discussed in many other CSBA monographs.[136]

Threat Environment

There is broad recognition in each service that, since the end of the Cold War, the U.S. military has become accustomed to operating with advantages it no longer has. These advantages include those in time and space, as well as technological advantages it held over adversaries. The 2018 NDS, which called for a shift in the military's focus towards competition and potential conflict with near-peer powers, gave each of the military services adequate direction through which to think about the threat environment and identify problems to drive innovation. Broad themes—such as the challenges presented by anti-access and area denial (A2/AD) systems, the vulnerability of traditional safe havens, the need

136 See, for example, Eric Edelman, Christopher Bassler, Toshi Yoshihara, and Tyler Hacker, *Rings of Fire: A Conventional Missile Strategy for a Post-INF Treaty World* (Washington, DC: Center for Strategic and Budgetary Assessments, 2022), https://csbaonline.org/research/publications/rings-of-fire-a-conventional-missile-strategy-for-a-post-inf-treaty-world; Thomas G. Mahnken, Travis Sharp, Christopher Bassler, and Bryan W. Durkee, *Implementing Deterrence by Detection: Innovative Capabilities, Processes, and Organizations for Situational Awareness in the Indo-Pacific Region* (Washington, DC: Center for Strategic and Budgetary Assessments, 2021), https://csbaonline.org/research/publications/implementing-deterrence-by-detection-innovative-capabilities-processes-and-organizations-for-situational-awareness-in-the-indo-pacific-region; Thomas G. Mahnken, Travis Sharp, and Grace B. Kim, *Deterrence by Detection: A Key Role for Unmanned Aircraft Systems in Great Power Competition* (Washington, DC: Center for Strategic and Budgetary Assessments, 2020), https://csbaonline.org/research/publications/deterrence-by-detection-a-key-role-for-unmanned-aircraft-systems-in-great-power-competition; Thomas G. Mahnken, Travis Sharp, Billy Fabian, and Peter Kouretsos, *Tightening the Chain: Implementing a Strategy of Maritime Pressure in the Western Pacific* (Washington, DC: Center for Strategic and Budgetary Assessments, 2019), https://csbaonline.org/research/publications/implementing-a-strategy-of-maritime-pressure-in-the-western-pacific; Thomas G. Mahnken, Grace B. Kim, and Adam Lemon, *Piercing the Fog of Peace: Developing Innovative Operational Concepts for a New Era* (Washington, DC: Center for Strategic and Budgetary Assessments, 2019), https://csbaonline.org/research/publications/piercing-the-fog-of-peace-developing-innovative-operational-concepts-for-a-.

for distributed forces and unprecedented connectivity—are found in joint guidance and throughout the new concepts adopted by the services.

However, each service continues to think differently about the specific challenges of this environment and how they should be addressed. For example, the Army's MDO concept identifies the key operational problem as "layered standoff," which it characterizes as:

> Adversaries, such as Russia and China, have leveraged these trends [in the information environment and the diffusion of advanced technologies] to expand the battlefield in time (a blurred distinction between peace and war), in domains (space and cyberspace), and in geography (now extended into the Strategic Support Area, including the homeland) to create tactical, operational, and strategic stand-off.[137]

The Army has already enshrined its proposed solution within the central idea of MDO—the need to "penetrate and disintegrate enemy anti-access and area denial systems and exploit the resultant freedom of maneuver to achieve strategic objectives (win) and force a return to competition on favorable terms."[138] Like the Army, the Marine Corps has also cited "stand-off" capabilities as its key challenge, specifically China's approach to the Western Pacific and the People's Liberation Army's (PLA's) ability to keep U.S. forces at arm's length from the Chinese mainland and U.S. allies and partners. The focus of Marine experimentation appears to be operating and persisting as the Navy and the Joint Force's "inside force" within the PLA's WEZ, and the service is already beginning to implement organizational changes to tailor its forces to this problem. The clearest indicator of this alignment is General Berger's *Force Design 2030* changes, which used preliminary conclusions from wargames and experiments to recommend force structure and capability modifications such as eliminating tanks, reducing the quantity of towed artillery, and fielding new ground-based strike platforms.[139]

A RAND study on the Air Force noted, "When Air Force leadership identified, framed, and prioritized concrete operational problems to be solved, the service has proved to be remarkably innovative."[140] This observation holds true for the other services as well. In the case of the Air Force, the challenges emanate primarily from Russia and China, but communication from senior leaders has thus far only described how adversary technological and doctrinal

137 *The U.S. Army in Multi-Domain Operations 2028*, p. vi.

138 *The U.S. Army in Multi-Domain Operations 2028*, p. vii.

139 Todd South, "Goodbye, Tanks: How the Marine Corps Will Change, and What It Will Lose, by Ditching Its Armor," *Marine Corps Times*, March 22, 2021, https://www.marinecorpstimes.com/news/your-marine-corps/2021/03/22/goodbye-tanks-how-the-marine-corps-will-change-and-what-it-will-lose-by-ditching-its-armor/.

140 Adam R. Grissom, Caitlin Lee, Karl P. Mueller, *Innovation in the United States Air Force: Evidence from Six Cases* (Santa Monica, CA: RAND, 2016), p. vii, https://www.rand.org/pubs/research_reports/RR1207.html.

development threatens Air Force core missions.[141] As for the Navy, although the CNO singled out China as the top strategic threat to the United States, the Navy's public articulation of the threats and challenges it faces remains broad.[142] Moreover, there is a lack of appreciation among the general public and many elected leaders about the state of China's growing Navy and the extent to which its commercial and military shipbuilding industries are fused and mutually supportive. The services are also poorly communicating *why* these developments are a threat to the United States and its allies. Improved communication of the threats and how they challenge U.S. interests could lend the services (as well as the wider DoD) additional internal support and political capital for their innovation efforts.

Less clear among some of the services is the prioritization of Russia and China. The Navy and Marine Corps, naturally, have been most explicit about the need to focus on the Indo-Pacific, but the Army and Air Force have remained more ambiguous. Despite the Army's prominent presence on the European continent, it has tried to find and expand its role in the Indo-Pacific, claiming that the Army's concept assumes that Chinese and Russian doctrinal and force development are sufficiently similar for the Army to solve the problems presented by Russia in the near-term and adapt to the China challenge as it develops in the future.[143] Secretary of the Army Christine Wormuth has even gone as far as calling the Army the "linchpin" of the Joint Force in the Pacific because of its role in establishing staging areas, basing, C2 networks, and logistics support.[144] For now, the conflict in Ukraine is keeping the Army focused on Europe and causing it to delay the release of further MDO doctrine as it seeks to glean lessons from the ongoing war.[145]

Beyond identifying strategic and operational problems in operational concepts, wargames and exercises are other key indicators of recognition of a changing threat environment requiring innovation. Even during peacetime, these forms of experimentation can help militaries search for and refine solutions to emerging challenges. Among the military services, there has been a revival of these activities in recent years. The Navy has resurrected the practice of putting its sailors en route or returning from deployment through

141 The Air Force's five core missions include: (1) air and space superiority; (2) ISR; (3) rapid global mobility; (4) global strike; and (5) C2. See Charles Q. Brown Jr., *Accelerate Change or Lose* (Arlington, VA: U.S. Air Force, August 2020), p. 4, https://www.af.mil/Portals/1/documents/csaf/CSAF_22/CSAF_22_Strategic_Approach_Accelerate_Change_or_Lose_31_Aug_2020.pdf.

142 Diana Stancy Correll, "Chief of Naval Operations: China is 'the strategic threat' to the US," *Navy Times*, October 13, 2020, https://www.navytimes.com/news/your-navy/2020/10/13/chief-of-naval-operations-china-is-the-strategic-threat-to-the-us/.

143 For example, Haley Britzky, "The Army Thinks China Will Surpass Russia by 2028. Here is How the Service is Planning to Take Them on," *Task & Purpose*, September 20, 2019, https://taskandpurpose.com/news/army-china-mdo/.

144 Quoted in C. Todd Lopez, "For Contingencies in Indo-Pacom, Army Will Serve as 'Linchpin' for Joint Force," *DOD News*, December 1, 2021, https://www.defense.gov/News/News-Stories/Article/Article/2858596/for-contingencies-in-indo-pacom-army-will-serve-as-linchpin-for-joint-force/.

145 Andrew Eversden, "Army Delays Multi-domain Doctrine, Sends Team to Glean Info from Ukraine Fight," *Breaking Defense*, June 3, 2022, https://breakingdefense.com/2022/06/army-delays-multi-domain-doctrine-sends-team-to-glean-info-from-ukraine-fight/.

"Fleet Battle Problems" reminiscent of the Interwar Period.[146] It also appears to be moving toward fielding dedicated opposing force (OPFOR) units, which help train friendly forces by mirroring adversary doctrine and capabilities. The most prominent example so far has been the standing up of a submarine aggressor squadron under the Undersea Warfighting Development Center.[147] The Army has again begun conducting large-scale exercises in Europe and the Pacific, such as Defender and Pathways.[148] More recently, the Army has sought to update its training centers to move away from counterinsurgency simulations and reflect modern threats such as drone swarms and improved tactical ISR.[149] The Air Force has similarly conducted large exercises to work through future force structures and assess how its C2 architecture would fare in a near-peer fight.[150] The Marine Corps has used wargames to hone its future force structure and test new concepts for littoral operations in support of the Fleet.[151] Less clear overall is how the services are systematically capturing the lessons of wargames and simulations and inserting them into the capability and doctrine development process.

The services are also developing more opportunities for live, virtual, and constructive (LVC) training for a wide range of missions and capabilities, especially in the air, cyber, and electromagnetic domains. As noted by other analysts, LVC training offers solutions for many training deficiencies, including airspace and range limitations, accurate threat simulation, and protecting sensitive capabilities from collection by adversaries. Leveraging these

146 Most recently, "Fleet Battle Problem 2022-1 Underway in the Atlantic," U.S. Navy, March 16, 2022, https://www.navy.mil/Press-Office/Press-Releases/display-pressreleases/Article/2968844/fleet-battle-problem-2022-1-underway-in-the-atlantic/#:~:text=U.S.%20Fleet%20Forces%20Command%20will,and%20Naval%20Special%20Warfare%20community.

147 Megan Eckstein, "Submarine Force Changing Training, Acquisition to Focus on Warfare Against Sophisticated Adversary," *USNI News*, November 25, 2020, https://news.usni.org/2020/11/25/submarine-force-changing-training-acquisition-to-focus-on-warfare-against-sophisticated-adversary.

148 See U.S. Army Europe and Africa, "About DEFENDER-Europe 22," https://www.europeafrica.army.mil/DefenderEurope/; and Wyatt Olsen, "US Army Pacific expects to complete Pathways 2020 exercises, commander says," *Stripes*, May 28, 2020, https://www.stripes.com/theaters/asia_pacific/us-army-pacific-expects-to-complete-pathways-2020-exercises-commander-says-1.631449#:~:text=Pacific%20Pathways%20is%20a%20series,the%20second%20half%20of%202020.

149 Todd South, "New Challenges Await Army Units at the National Training Center," *Army Times*, March 29, 2022, https://www.armytimes.com/news/your-army/2022/03/29/new-challenges-await-units-at-the-national-training-center/; Lolita C. Baldor, "US Army using lessons from Ukraine war to aid own training," *AP News*, April 16, 2022, https://apnews.com/article/russia-ukraine-war-us-army-training-54e76eba46f9bf79542dd3f872456e67.

150 Valerie Insinna, "A US Air Force War Game Shows What the Service Needs to Hold Off – or Win Against – China in 2030," *Defense News*, April 12, 2021, https://www.defensenews.com/training-sim/2021/04/12/a-us-air-force-war-game-shows-what-the-service-needs-to-hold-off-or-win-against-china-in-2030/.

151 Paul McLearly, "EXCLUSIVE Marines Tested Commandant's New Vision In Largest Marine Exercise Since Cold War," *Breaking Defense*, November 12, 2019, https://breakingdefense.com/2019/11/exclusive-marines-tested-commandants-new-vision-in-largest-marine-exercise-since-cold-war/.

technologies can increase the ability of forces to train for increasingly complex operations and test new operational concepts from distributed locations.[152]

Although the services and the Defense Department overall have taken steps to improve their intellectual capital on China and Russia, the level of understanding of these potential adversaries pales in comparison with that within the Defense Department during the Cold War. For example, although parts of the Defense Department have been devoting considerable attention to studying the Chinese military over the course of many years, understanding of China as a strategic competitor is neither as widespread nor as deep as it needs to be to support the 2018 *National Defense Strategy*'s focus on great-power competition and the increasing possibility of great power war.

Senior Leader Sponsorship

The services' senior leaders appear to be leading and supporting innovation. Service leaders have certainly pushed innovation with words, and many have followed with actions. The support of senior leadership for implementing changes and making difficult choices over the long term mostly remains to be seen.

In the Army, the establishment of Army Futures Command was led by Army secretaries Ryan McCarthy and Mark Esper and Chiefs of Staff James McConville and Mark Milley, with the backing of then-chairman of the Senate Armed Services Committee, John McCain.[153] The establishment of AFC as a four-star command—on par with Forces Command, Training and Doctrine Command, and Materiel Command—speaks to the level of influence Army officials intended the organization to wield. OPNAV N7, led by a three-star admiral, demands a similar level of attention throughout the Navy. Chief of Naval Operations Michael Gilday has outlined a new naval force design and N7's prominent role in bringing it to fruition in his *Navigation Plan 2022*.[154]

The Air Force Chief of Staff, General Charles Brown Jr., has released his own innovation guidance in which he extols the importance of accelerating change and encourages leaders at all levels to "empower Airmen" to think innovatively.[155] Brown has since conducted a series of visits around the Air Force, including in the Indo-Pacific, to call for change and discuss

152 Jennifer McArdle, *Victory Over and Across Domains: Training For Tomorrow's Battlefields* (Washington, DC: Center for Strategic and Budgetary Assessments, January 25, 2019), https://csbaonline.org/research/publications/victory-over-and-across-domains-training-for-tomorrows-battlefields; Harrison Schramm, Kevin A. Chlan, and Peter Kouretsos, *COVID-19: Analysis and Policy Implications* (Washington, DC: Center for Strategic and Budgetary Assessments, April 7, 2020), p. 28, https://csbaonline.org/research/publications/covid-19-analysis-and-policy-implications.

153 Sydney J. Freedberg Jr., "How McCain & Milley Created Army Futures Command: It Almost Didn't Happen," *Breaking Defense*, August 24, 2018, https://breakingdefense.com/2018/08/how-mccain-milley-created-army-futures-command-it-almost-didnt-happen/.

154 Michael Gilday, *Chief of Naval Operations Navigation Plan 2022* (Arlington, VA: U.S. Navy, July 26, 2022), p. 11, https://media.defense.gov/2022/Jul/26/2003042389/-1/-1/1/NAVIGATION%20PLAN%202022_SIGNED.PDF.

155 Charles Q. Brown Jr., *Accelerate Change or Lose*, p. 6.

his guidance.[156] Marine Corps Commandant General David Berger has had perhaps the most success encouraging senior Marine leaders to support *Force Design 2030*, and has himself largely become the face of the effort. To further push his changes, Berger has released an annual update to the original concept.[157] Of course, innovations must also survive leaders who promote them. As influential as Commandant Berger has been in the initial stages of *Force Design 2030*'s implementation, there is no guarantee that future Commandants will continue the push.

Innovators & Networks

The new organizations created by each service and pushed by senior leaders appear to be successfully developing, experimenting, and implementing innovative ideas and technologies. Indeed, many have touted technology demonstrations and the rapid fielding of new weapons and platforms as examples of successful innovation. Still, it remains to be seen how enduring or widespread these changes will become—cracks may be forming as the services move beyond easy fixes and attempt to implement major changes. Since 2018, Army Futures Command has successfully delivered the M-SHORAD air defense system, Enhanced Night Vision Goggles, and two Iron Dome batteries to operational forces. In fiscal year (FY) 2023, the service is on track to field the Precision Strike Missile (PrSM), Extended Range Cannon Artillery (ERCA), Long-Range Hypersonic Weapon (LRHW), Mid-Range Capability (MRC) anti-ship missiles, and the Mobile Protected Firepower (MPF) light tank, among other programs.[158] Even so, the organization's future remains uncertain as policymakers shift influence back and forth between AFC and the Army's traditional acquisitions branch.[159] In a further sign of AFC's waning influence, the Army has yet to replace General Michael Murray, AFC's first commander, after his departure in December 2021, leaving AFC with an acting commander for over nine months.

The Air Force Research Laboratory (AFRL) has also successfully developed and tested new technologies as part of its four Vanguard programs. From collaborative munitions to autonomous aircraft, the Vanguard programs include successful technology demonstrations and experiments.[160] How these research and development programs transition to the operational Air Force remains to be seen. Similarly, the secrecy surrounding the Navy's Project Overmatch makes it difficult to discern true implementation from development projects and

156 For example, Hailey Haux, "CSAF visits Indo-Pacific bases, stresses importance of DoD's priority theater," Headquarters, Pacific Air Forces Public Affairs, August 28, 2022, https://www.af.mil/News/Article-Display/Article/3141473/csaf-visits-indo-pacific-bases-stresses-importance-of-dods-priority-theater/.

157 Megan Eckstein, "Marines Update Force Design 2030 After a Year of Experimentation in the Field," *USNI News*, April 26, 2021, https://news.usni.org/2021/04/26/marines-update-force-design-2030-after-a-year-of-experimentation-in-the-field.

158 Jen Judson, "Futures Command faces Identity Crisis as Army Shifts Mission," *Defense News*, September 6, 2022, https://www.defensenews.com/land/2022/09/06/futures-command-faces-identity-crisis-as-army-shifts-mission/.

159 Ibid.

160 For more information about the Air Force's Vanguard programs, see Air Force Research Laboratory, "Air Force Vanguards," https://afresearchlab.com/technology/vanguards/.

technology demonstrations. The Marine Corps' new organizations and platforms, on the other hand, offer a more visible indicator of experimentation and implementation. The Corps tested its new anti-ship missile capability, NMESIS, last year, and is currently executing a series of training exercises designed to experiment with and refine its new Marine Littoral Regiment.[161] Of course, the force structure and large personnel-centered units of the Army and Marine Corps may be better public indicators of innovation, while the sensitive nature of next-generation aircraft, ships, and high-technology programs make the Navy and Air Force more difficult to examine.

Still, many of these initiatives are not as well-funded or well-protected by senior leaders as they might initially seem. The Army has at times been forced to cut funding for some of its 31 modernization priorities in order to support others. For example, in FY2022 the Army slashed funding for its Armored Multi-Purpose Vehicle (AMPV) in order to fund longer-term modernization programs.[162] The Optionally Manned Fighting Vehicle, the service's replacement for the M2 *Bradley* infantry fighting vehicle, has been hindered by unrealistic requirements and a lack of interest from industry.[163] These struggles harken back to the infamous Future Combat Systems program, which cost the Army just under $20 billion but failed to deliver any large combat vehicles.[164] The Government Accountability Office (GAO) has also been critical of the Air Force's JADC2 contribution, ABMS, saying "the authorities of Air Force offices to plan and execute ABMS efforts are not fully defined."[165] The Navy, still reeling from difficulties with the *Zumwalt*-class destroyer, *Ford*-class aircraft carrier, and Littoral Combat Ship, has faced similar criticisms of poorly defined and articulated concepts and programs. Unlike the other services, the Navy has yet to release substantial public documentation outlining Distributed Maritime Operations.

This inability to effectively articulate new operational concepts and the linkages between these concepts and supporting technology programs (and their funding) is endemic in all military services. The Army has struggled to explain how its long-range precision fires capabilities will complement Air Force capabilities, rather than create redundancies, leading to

161 Kelly Flynn, "Marine Corps Successfully Demonstrates NMESIS During LSE 21," Marine Corps Systems Command, August 17, 2021, https://www.marcorsyscom.marines.mil/News/News-Article-Display/Article/2735502/marine-corps-successfully-demonstrates-nmesis-during-lse-21/; Megan Eckstein, "First-of-kind Marine littoral regiment plays with new concepts, weapons," *Defense News*, May 12, 2022, https://www.defensenews.com/digital-show-dailies/modern-day-marine/2022/05/12/first-of-kind-marine-littoral-regiment-plays-with-new-concepts-weapons/.

162 Ethan Sterenfeld, "Army cuts JLTV, AMPV funding," *Inside Defense*, May 28, 2021, https://insidedefense.com/daily-news/army-cuts-jltv-ampv-funding.

163 Sydney J. Freedberg, Jr., "OMFV: Army Revamps Bradely Replacement For Russian Front," *Breaking Defense*, April 10, 2020, https://breakingdefense.com/2020/04/army-revamps-omfv-bradley-replacement-for-russian-front/.

164 Sydney J. Freedberg, Jr., "Total Cost To Close Out Cancelled Army FCS Could Top $1 Billion," *Breaking Defense*, June 19, 2021, https://breakingdefense.com/2012/06/total-cost-to-close-out-cancelled-army-fcs-could-top-1-billion/#:~:text=All%20sources%20consulted%20for%20this,is%20just%20under%20%2420%20billion.

165 *Defense Acquisitions: Action Is Needed to Provide Clarity and Mitigate Risks of the Air Force's Planned Advanced Battle Management System* (Washington, DC: Government Accountability Office, April 2020), https://www.gao.gov/assets/gao-20-389.pdf.

criticism from Air Force officials and defense analysts.[166] The Air Force itself encountered difficulties explaining ABMS to Congress, which halved the program's funding in FY2021, before the service adopted a new approach to selling its contribution to JADC2.[167] The Air Force recently announced the establishment of a new office to take the lead on ABMS, with Air Force Secretary Frank Kendall saying its previous efforts "have not been adequately focused nor have they been adequately integrated."[168] Overall, the Marines are most effectively conveying their new concepts and how innovation programs enable them, but even the Corps has not fully explained how *Force Design 2030* will proceed if the other services do not fully support the Marine Corps with the necessary force structure when needed.[169]

Culture

Culture may be the most difficult element to change, and is an aspect of innovation in which senior leadership and organizational structures and incentives are vital. Despite many recent innovation successes, the armed services continue to face internal and external resistance to change. This cultural resistance is most easily seen in the heated debate surrounding *Force Design 2030* and its changes to Marine Corps force structure.[170] The Navy and Air Force have faced similar difficulties attempting to divest older platforms to invest in new capabilities. Contributing to service and community parochialisms is DoD-wide culture—which often places the needs of combatant commanders and current operations over the needs for long-term investment and modernization.[171]

Within each service, implementing concepts like JADC2 will necessitate incentivizing leaders and personnel with particular skills or specialties, such as communications or networking. These incentives, including career opportunities, long-term advancement, and institutional respect, must extend beyond the services' traditional branches and

166 See, for example, Jon Harper, "Sibling Rivalry: Military Services in High-Stakes Tussle Over Long-Range Fires," *National Defense Magazine*, June 1, 2021, https://www.nationaldefensemagazine.org/articles/2021/6/1/military-services-in-high-stakes-tussle-over-long-range-fires; Mark Gunzinger, Lukas Autenried, and Bryan Clark, "Understanding the Long-Range Strike Debate," Mitchell Institute for Aerospace Studies, April 2021, https://mitchellaerospacepower.org/wp-content/uploads/2021/05/a2dd91_584d2a721b0f44bab0bf7d25986ea40d.pdf.

167 Shelley K. Mesch, "ABMS program budget could receive even more than USAF asked for from Congress," *Inside Defense*, March 10, 2022, https://insidedefense.com/daily-news/abms-program-budget-could-receive-even-more-usaf-asked-congress.

168 Frank Kendall quoted in Valerie Insinna, "With a New Office, Air Force Revamps ABMS Acquisition… Again," *Breaking Defense*, September 19, 2022, https://breakingdefense.com/2022/09/with-a-new-office-air-force-revamps-abms-acquisition-again/.

169 *Force Design 2030* relies on Navy amphibious vessels capable of delivering Marine forces in the distributed, contested environments envisioned in the concept. By giving up main battle tanks and some other units, the Marine Corps would also rely on support from the Army and Air Force in some scenarios.

170 For a summary of the debate, see Scott Cuomo, "On-the-Ground Truth and Force Design 2030 Reconciliation: A Way Forward," *War on the Rocks*, July 12, 2022, https://warontherocks.com/2022/07/on-the-ground-truth-and-force-design-2030-reconciliation-a-way-forward/.

171 Mackenzie Eaglen, "Putting Combatant Commanders On a Demand Signal Diet," *War on the Rocks*, November 9, 2020, https://warontherocks.com/2020/11/putting-combatant-commanders-on-a-demand-signal-diet/.

communities into key career fields like communications, cyber, and space. Evidence shows, however, that the services currently struggle to recruit and retain personnel with these skills.[172] Organizational culture and incentives will also play a key role as the services field non-traditional and experimental capabilities. For example, the Army and Marine Corps are introducing anti-ship missile capabilities to their field artillery communities. These services must choose between integrating these new units with existing artillery training and operational forces despite their different mission, or creating new units with no roots in existing institutions and organizational culture. All the services will likely encounter similar choices as they field innovative platforms and weapons over the next decade.

Conclusion

All in all, the services, with some variation between them, appear to possess the foundational ingredients for successful military innovation. Each of the services has created new organizations intended to develop, refine, and implement innovative concepts and programs to overcome current operational challenges. From the Marine Corps' anti-ship missiles to the Army's long-range hypersonic weapon, the armed services are rapidly fielding and exercising new capabilities. Each service continues to make progress toward supporting DoD's JADC2 approach. Although the services, for the most part, continue to lack the mature tissue connecting platforms, organizations, and concepts, these linkages can be developed over time and through continued experimentation and wargaming.

The services would benefit from better articulating their innovation visions to key stakeholders—including each other, DoD, Congress, and the American people. Improved joint guidance, as we will explore in the next chapter, could aid this endeavor. Overall, when given a clear vision and guidance from senior leadership, the armed services appear to be moving through the stages of innovating to address the challenges posed by great power competition and conflict. Grading the efforts of the services ultimately depends on the metric of success—namely, the pace one expects them to progress through the innovation stages. Regardless of where the individual services are currently, the information available indicates that the conditions for innovation are present.

But will the individual efforts of the services be sufficient to address the challenges of great power conflict outlined in the National Defense Strategy? These separate operational concepts and approaches to JADC2 run the risk of being misaligned at best and conflicting at worst. In either case, stovepiped service innovations are unlikely to be as effective as mutually supporting and integrated concepts developed at the joint level. The next chapter

172 For example, Chaitra M. Hardison, Leslie Adrienne Payne, John A. Hamm, Angela Clague et al., *Attracting, Recruiting, and Retaining Successful Cyberspace Operations Officers: Cyber Workforce Interview Findings* (Santa Monica, CA: RAND, 2019), https://www.rand.org/pubs/research_reports/RR2618.html; David Vergun, "Recruiting Cyber Workforce Easier Than Retaining Them," U.S. Department of Defense, September 9, 2019, https://www.defense.gov/News/News-Stories/Article/Article/1955580/recruiting-cyber-workforce-easier-than-retaining-them/.

examines DoD's efforts to remedy these issues at the joint level and the challenges associated with leading centralized military innovation.

CHAPTER 5

Current Joint Innovation Efforts

With the services moving forward with new concepts and programs, the Department of Defense is attempting to guide innovation throughout the U.S. military with overarching concepts and approaches. This chapter will apply our innovation framework to two of the Department's most well-known efforts—the Joint Warfighting Concept (JWC) and Joint All-Domain Command and Control (JADC2). Our evaluation reveals the enduring challenges of fostering centralized innovation in large bureaucratic organizations.

The Joint Warfighting Concept and JADC2 as Cases of Joint Innovation

We evaluate the JWC as a measure of joint innovation in this chapter because operational concepts are a key metric of military innovation in the conceptual realm. Just as AirLand Battle guided service investments and doctrine during the Cold War and the services are currently implementing concepts like MDO, ACE, DMO, and EABO, the JWC should include general capability and capacity requirements for meeting the operational challenge it sets out to address, as well as a clear argument for how existing and prospective military forces can be employed to achieve explicit operational objectives.

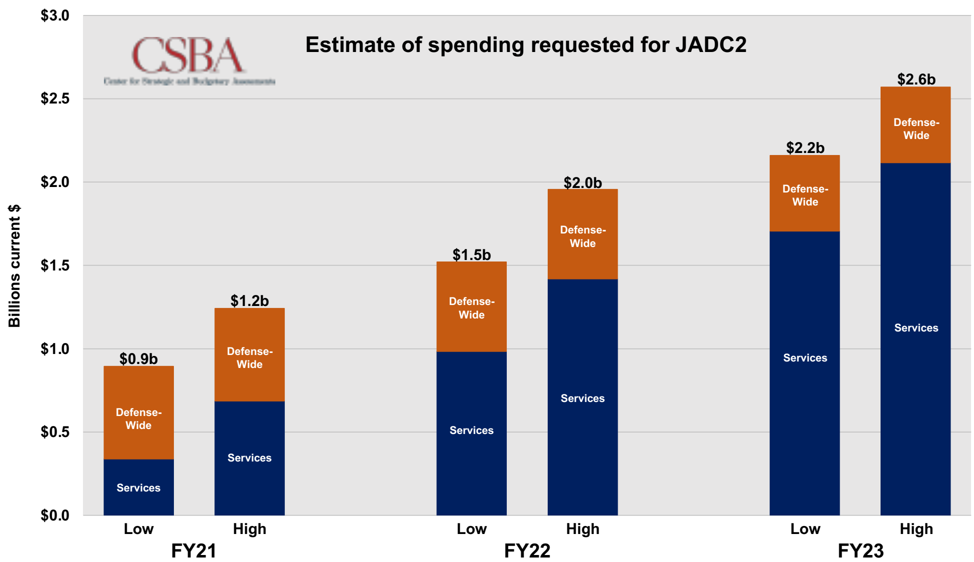
Along with JWC 1.0, we evaluate the development of the JADC2 concept as a case of joint military innovation. We use JADC2 as a case of joint innovation for several reasons. First and foremost, JADC2 seems to be the focus of the Department's work on JWC-supporting concepts. The concept is a key enabler of the other three supporting concepts: joint fires, contested logistics, and information advantage. CJCS General Mark Milley explained:

> Conceptual frameworks like the JWC and JADC2 will ensure capabilities such as Long Range and Hypersonic Fires, Logistics and Information Advantage are employed to the full extent. This combination of operational concepts and technology will enable integrated deterrence.[173]

173 Mark A. Milley, "Written Statement of General Mark. A. Milley, USA, 20th Chairman of the Joint Chiefs of Staff, FY23 Department of Defense Budget Hearing," Senate Armed Services Committee, April 7, 2022, p. 5, https://www.armed-services.senate.gov/imo/media/doc/CJCS%20PB23%20Written%20Statement.pdf.

JADC2 is the only supporting concept for which the Pentagon has an approved strategy and implementation plan. Second, although DoD has developed joint guidance for JADC2, each of the services is responsible for further developing and implementing JADC2 approaches. As such, JADC2 offers a unique opportunity to examine the linkages between joint and service innovation. Finally, a large portion of JADC2 funding is spent at the joint level. As shown in Figure 5, CSBA estimated that DoD's fiscal year (FY) 2023 budget request included between $2.2 and $2.6 billion for JADC2's core initiatives, with about 20 percent allotted to defense-wide entities such as the Defense Advanced Research Projects Agency (DARPA), the Office of the Secretary of Defense (OSD), and the Joint Staff.[174] With the previous chapter examining the services' contributions to JADC2, this chapter will assess these joint JADC2 initiatives.

FIGURE 5: SERVICE VERSUS JOINT JADC2 SPENDING FROM FY2021 TO FY2023



Source: Graphic created by CSBA based on data found in Department of Defense annual budget documents.

Assessing the success of military innovation through JWC 1.0 and JADC2 presents some challenges related to data availability and currency. Both the JWC and key documents related to JADC2 remain classified, although an unclassified summary of the JADC2

174 The cost of JADC2 efforts are split among many separate budget lines across the military services and DoD, making them difficult to track. CSBA compiled program costs for major initiatives that directly support JADC2 efforts such as Air Battle Management System, Project Overmatch, Project Convergence, and Mosaic Warfare. This estimate is conservative and likely underestimates, perhaps significantly, how much the Department is spending on JADC2 due to the difficulty of assigning dollar values to programs that indirectly support JADC2. For a deeper look at FY2023 JADC2 spending, see Travis Sharp, "JADC2 Spending is Sprawling. DoD Should Keep Watch, but Let It Go," *Breaking Defense*, October 20, 2022, https://breakingdefense.com/2022/10/jadc2-spending-is-sprawling-dod-should-keep-watch-but-let-it-go/.

strategy was released in March of 2022. Although incomplete, a sufficient picture of these joint innovation efforts can be built from this document, the statements of senior officials, and other public reporting. In addition, CSBA conducted numerous interviews with senior military officers and policymakers regarding the process that produced the JWC to further corroborate this chapter's assessment.[175]

In addition to classification issues, the following evaluation reflects the status of joint innovation at a specific point in time. The research for this monograph was completed from 2021 to August 2022, and therefore can only provide a "snapshot" of joint innovation during that timeframe. The innovation initiatives of the Department are continually being implemented and evolving. Our examination reflects the information available during this time period, not necessarily at the time of this monograph's publication. Nevertheless, a "snapshot" assessment of JWC 1.0 and the initial stages of JADC2 offer valuable insights and lessons for continued joint innovation.

Examining Current Joint Innovation Efforts

Threat Environment

The 2018 *National Defense Strategy* and the National Defense Strategy Commission report portrayed a strategic environment dominated by great power competition.[176] The *NDS Summary* called for "a clear-eyed appraisal of the threats we face, acknowledgment of the changing character of warfare, and a transformation of how the Department conducts business."[177] Working from these recommendations and the strategic approach offered in the *NDS*, the Department began developing the first version of the JWC in the fall of 2019.[178] The concept, according to then-Vice Chairman of the Joint Chiefs of Staff (VCJCS) General John Hyten, was intended to outline specific capability requirements for the Joint Force.[179] This top-down approach contrasts with the traditional bottom-up requirements development process, which relies on the individual services identifying capability requirements

175 CSBA conducted these interviews while executing a congressionally mandated review of the Joint Warfighting Concept 1.0 in 2021. CSBA interviewed over 30 military and civilian personnel within the Department of Defense in response to Section 1708 of the fiscal year 2020 National Defense Authorization Act, which directed the Office of the Secretary of Defense to commission an independent assessment of the JWC.

176 In the words of the 2018 *NDS Summary*: "the *reemergence of long-term, strategic competition* by what the National Security Strategy classifies as revisionist powers." See Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America* (Washington, DC: Department of Defense, 2018), p. 2.

177 Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America*, p. 2.

178 Mark A. Milley, "Written Statement of General Mark. A. Milley, USA, 20th Chairman of the Joint Chiefs of Staff, FY23 Department of Defense Budget Hearing," Senate Armed Services Committee, April 7, 2022, p. 5, https://www.armed-services.senate.gov/imo/media/doc/CJCS%20PB23%20Written%20Statement.pdf.

179 Kris Osborn, "Pentagon Crafts New 'Joint Warfighting' Concept," *Warrior Maven*, August 22, 2021, https://warriormaven.com/history/integrated-deterrence-space-force.

and submitting them to the Joint Requirements Oversight Council (JROC) for evaluation and endorsement.

To arrive at these future capability requirements for the Joint Force, JWC 1.0 was organized around a single scenario related to the Department's stated pacing threat—China.[180] In line with the *NDS*, any great power conflict scenario in the Indo-Pacific region is a vital contingency, one in which a failure of the U.S. military to meet its objectives would have dire consequences for the United States, its allies, and international order. Moreover, it is increasingly open to question whether the U.S. military can prevail in such a contingency with existing approaches.[181] This threat environment has been embraced by other joint organizations, such as the U.S. Indo-Pacific Command (USINDOPACOM).[182]

Unfortunately, it seems that handoff is where clarity ended, and the Department muddled further efforts to define these challenges. There were significant, albeit sometimes implicit, differences over what defense officials believe the JWC should try to achieve and what it could actually accomplish. The stated rationale was to develop a new warfighting concept to deal with the most stressing and significant contingency the Joint Force might be directed to address. Nevertheless, there was a lack of clarity (and sometimes debate) over several critical issues in terms of its content: whether the document should focus on deterring versus winning a conflict; whether it should tackle day-to-day competition or warfighting alone; and, perhaps most importantly, whether it should focus on a single scenario, rival, and region of the world, or whether it should have been more broadly applicable to multiple rivals, in different situations, across diverse locations.

This reflects a deeper divide that has been evident in recent strategy and concept development efforts: whether the Pentagon should narrowly focus much of its effort and attention on a single pacing threat and planning scenario, even at the risk of overoptimizing the Joint Force and overcommitting to prevent or prevail in a low-probability but extraordinarily high consequence conflict, or whether it requires greater flexibility to manage a full plate of functionally and geographically diverse commitments. This ambiguity surrounding the JWC's purpose raises questions about the concept's ability to effectively guide joint innovation.

The same strategic and operational challenges that animate the JWC have motivated the development of JADC2. The emergence of advanced command and control (C2) concepts has been driven by the recognition that the evolving battlespace is accelerating in terms of speed, complexity, and lethality. The demands placed on U.S. and allied military forces operating in the advanced battlespace are forcing change, not just in terms of new technologies

180 Osborn, "Pentagon Crafts New 'Joint Warfighting' Concept."

181 National Defense Strategy Commission, *Providing for the Common Defense: The Assessment and Recommendations of the National Defense Strategy Commission*, p. 10.

182 Philip S. Davidson, "Transforming the Joint Force: A Warfighting Concept for Great Power Competition," March 3, 2020, https://www.pacom.mil/Media/Speeches-Testimony/Article/2101115/transforming-the-joint-force-a-warfighting-concept-for-great-power-competition/.

and capabilities, but also in terms of a more complex and rapidly evolving battlespace with a growing torrent of data and information. The sequential battlespace of past wars must effectively evolve into the non-linear battlespace of future wars. In such a future war, command and control must be supported by ubiquitous information shared across platforms, facilitated by artificial intelligence (AI), focused on anticipation rather than response, and being proactive rather than reactive. Within this evolving battlespace, a JADC2 architecture is needed to facilitate information access across the various nodes and systems, such that kill chains and supporting data and information chains are formed as required to support a given military action, and then dissolved and reformed to support the next. The current JADC2 strategy acknowledges this threat environment and seeks to address "these challenges and opportunities by advancing an interconnected and enterprise-wide approach for … support[ing] globally integrated operations."[183]

In sum, although DoD has been made aware of strategic and operational challenges requiring military innovation, JWC 1.0 and JADC2 have struggled to focus the Department on the evolved threat environment. Disagreements persist about the JWC's purpose and how it should consider specific peacetime and wartime contingencies in the context of the broader strategic environment. In addition, the extent to which it is influencing the Defense Department's strategic choices remains unclear. The JADC2 concept appears further along on the innovation timeline, with the Department already integrating JADC2 and the need for information advantage into wargames designed to test the JWC.[184]

Senior Leader Sponsorship

Disagreements about the threat environment outlined in the JWC stemmed from insufficient and sporadic support from senior leaders in the Department. Ultimately, DoD leadership has an important role to play in focusing the Department on the imperative of innovation, however challenging intellectually, operationally, organizationally, and bureaucratically. Similarly, it is the responsibility of civilian leaders to define the parameters within which joint concepts are developed, including the strategic constraints and operational assumptions that should guide concept development. CSBA found in interviews with DoD officials that JWC 1.0's development was hindered by civilian leaders who allowed the document to develop with little input from OSD, as well as military leaders who were not fully engaged in the effort.

Beyond defining strategic and operational challenges, the involvement of senior leadership in the formulation of JWC 1.0 was often episodic. The Secretary of Defense was personally engaged in launching its development in 2019, and the VCJCS was actively engaged

183 Department of Defense, *Summary of the Joint All-Domain Command & Control (JADC2) Strategy*, p. 10.

184 Theresa Hitchens, "The Joint Warfighting Concept Failed, Until It Focused On Space And Cyber," *Breaking Defense*, July 26, 2021, https://breakingdefense.com/2021/07/the-joint-warfighting-concept-failed-until-it-focused-on-space-and-cyber/.

throughout the process.[185] The Office of the Under Secretary of Defense for Policy, or OSD(P), and the Office of Cost Assessment and Program Evaluation (CAPE) were similarly heavily involved during the early stage of JWC development. Once the concept was turned over to the Joint Staff, however, both offices assumed diminished roles in the development process. Additionally, the turnover of senior civilians and the military personnel rotation added further friction to the slowdown that typically characterizes the end of a presidential administration. Together, these issues yielded a concept development process that occurred largely absent senior policy and strategy input on a range of matters, including essential planning assumptions.

JADC2, at least in words, has clearly received more senior leader attention from across the Pentagon. As early as January 2020, DoD directed the establishment of a JADC2 cross-functional team (CFT). According to former Deputy Defense Secretary David Norquist:

> CFT will identify and address JADC2 gaps and requirements, promote rapid, streamlined, cross-process JADC2 capability development and develop plans and recommendations for both materiel and non-materiel C2 capability improvements in support of the National Defense Strategy.[186]

The JADC2 CFT is chaired by the Deputy Director of the Joint Staff J6. The team functions as a link between the Joint Requirements Oversight Council (JROC) and the military services. As such, the CFT deconflicts the various JADC2 efforts of the services and confirms that program requirements and procurement plans fall in line with the overall JADC2 approach.[187] The Joint Staff J6 also produced a JADC2 strategy which Secretary of Defense Lloyd Austin officially endorsed in May 2021.[188] Lieutenant General Dennis Crall, Director of the Joint Staff J6, called this endorsement "the clear signal to begin" implementing the JADC2 concept across the Department.[189]

185 Theresa Hitchens, "COVID Delays Joint Warfighting Concept: Hyten," *Breaking Defense*, January 22, 2021, https://breakingdefense.com/2021/01/covid-delays-joint-warfighting-concept-hyten/. For further evidence of the VCJCS's involvement, see Theresa Hitchens, "New Joint Warfighting Plan Will Help Define 'Top Prioirty' JADC2: Hyten," *Breaking Defense*, January 29, 2020, https://breakingdefense.com/2020/01/new-joint-warfighting-plan-will-help-define-top-priority-jadc2-hyten/; Theresa Hitchens, "The Joint Warfighting Concept Failed, Until It Focused On Space And Cyber."

186 David Norquist quoted in Sara Sirota, "Norquist Directs Establishment of JADC2 Cross-functional Team," *Inside Defense*, February 7, 2020, https://insidedefense.com/daily-news/norquist-directs-establishment-jadc2-cross-functional-team.

187 Andrew Eversden, "Pentagon's JADC2 Officer Could Phase Out in Coming Years," *Breaking Defense*, November 5, 2021, available at https://breakingdefense.com/2021/11/pentagons-jadc2-office-could-phase-out-in-coming-years/.

188 Tony Bertuca, "Pentagon Begins Aligning Services under JADC2 Strategy," *Inside Defense*, June 4, 2021, available at https://insidedefense.com/daily-news/pentagon-begins-aligning-services-under-jadc2-strategy.

189 Quoted in Jackson Barnett, "Secretary of Defense Austin Approves JADC2 Strategy," *FedScoop*, June 4, 2021, https://www.fedscoop.com/secretary-of-defense-austin-approves-jadc2-strategy/.

Innovators & Networks

JWC 1.0 also suffered from deficits in intellectual capital within the Defense Department. First, although parts of the DoD have been devoting considerable attention to studying the Chinese military over the course of many years, understanding of China as a strategic competitor is neither as widespread nor as deep as it needs to be to support the 2018 NDS's focus on great power competition and the increasing possibility of great power conflict. A second area where the Department falls short in intellectual capital is in understanding the character of contemporary warfare, including the relationship between strategy, operations, and tactics; deterrence and warfighting; among various domains of warfare; and the role of nuclear weapons. A lack of understanding in these areas was apparent during interviews with DoD personnel regarding JWC 1.0. Many officials had difficulty explaining the operational logic behind the concept and how it would lead to victory. Specifically, many struggled to articulate how the implementation of the concept described in the JWC would lead to the United States achieving its specified political objectives. Rather than a criticism of any individual, military or civilian, this is a concrete manifestation of the fact that the U.S. military is three decades removed from serious consideration of great power conflict; what it is fought over, how it is fought, and how it is won.

It also remains unclear whether the Department has adequate analytical resources to do the type of work necessary to assess new joint operational concepts. The NDS Commission previously found that:

> DOD [struggles] to link objectives to operational concepts to capabilities to programs and resources. This inability is simply intolerable in an organization with responsibility for tasks as complex, expensive, and important as the Department of Defense. It hampers the Secretary's ability to design, assess, and implement the NDS, and it makes it difficult for Congress to have faith that the administration's budget request supports its strategy. This deficit in analytical capability, expertise, and processes must be addressed.[190]

Many existing processes are federated, slow, and inconsistent, and it is unclear how well they portray all the dimensions of 21st-century warfare.

It must be noted that much of the JWC formulation took place during the height of the COVID-19 pandemic. Much of the development process, particularly related to testing and experimentation, was slowed or hampered by the restrictions placed upon the DoD workforce. Although the single wargame that was held in October 2020 to test the concepts embodied in the then-current draft of the JWC revealed weaknesses in the then-extant concept and limits to intellectual capital, COVID-19 restrictions prevented the concepts portrayed in subsequent versions of JWC 1.0 from being similarly tested.

190 National Defense Strategy Commission, *Providing for the Common Defense*, p. 30.

Like the JWC, JADC2 at the joint level also suffers from conceptual ambiguity that hinders integration and creates space for the services' efforts to diverge. The DoD's strategy describes JADC2 as a "coherent approach," for:

> … shaping future Joint Force C2 capabilities and is intended to produce the warfighting capability to sense, make sense, and act at all levels and phases of war, across all domains, and with partners, to deliver information at the speed of relevance. As an approach, JADC2 transcends any single capability, platform, or system; it provides an opportunity to accelerate the implementation of needed technological advancement and doctrinal change in the way the Joint Force conducts C2.[191]

CJCS Mark Milley previously explained JADC2 in Congressional testimony as "a warfighting capability."[192] VCJCS Admiral Christopher W. Grady similarly described JADC2 as "an important developing joint capability, critical to the success of the Department. JADC2 is not a joint product or program of record but rather a capability delivery framework to modernize and accelerate the fielding of material and non-material C2 capabilities."[193] The Congressional Research Service, perhaps most simply, defines JADC2 as "the Department of Defense's concept to connect sensors from all of the military services … into a single network."[194] These varied and over-complicated definitions and understandings of JADC2's intent, depth, and coordinating functions have hindered joint integration of service C2 efforts.

Culture

Much like the other elements of innovation, the development of the JWC highlighted DoD's lack of a culture that promotes innovation, analysis, and learning, let alone implementation and enforcement. Despite guidance from the Secretary of Defense that the development of JWC 1.0 adequately consider and test alternative concepts, CSBA found during its study that the document mostly focused on individual concepts rather than a series of alternative theories of victory for a future conflict. The generation of new ideas and the adjudication of those ideas through rigorous analysis based on well-established standards was truncated by several factors, including a lack of cooperation between joint offices and the services, the press of deadlines, COVID-19 restrictions, and gaps in analytic capability across the Department.

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191 Department of Defense, *Summary of the Joint All-Domain Command & Control (JADC2) Strategy*, p. 2.

192 Mark A. Milley, "Written Statement of General Mark. A. Milley, USA, 20th Chairman of the Joint Chiefs of Staff, FY23 Department of Defense Budget Hearing," Senate Armed Services Committee, April 7, 2022, p. 5, https://www.armed-services.senate.gov/imo/media/doc/CJCS%20PB23%20Written%20Statement.pdf.

193 Christopher W. Grady, "Advance Questions for Admiral Christopher W. Grady, Nominee for Appointment to be Vice Chairman of the Joint Chiefs of Staff," Senate Armed Services Committee, https://www.armed-services.senate.gov/imo/media/doc/Grady%20APQ%20responses.pdf.

194 John R. Hoehn, *Joint All-Domain Command and Control: Background and Issues for Congress* (Washington, DC: Congressional Research Service, March 18, 2021), p. 1, https://crsreports.congress.gov/product/pdf/R/R46725/2.

CJCS Mark Milley has suggested the possibility of creating a joint office to overcome cultural resistance to innovation and enforce the development and adoption of joint concepts. He described such an organization as a joint version of Army Futures Command, the organization charged with leading the Army's modernization efforts. Milley noted the importance of organizations and culture in joint innovation efforts, saying, "You're going to have to do really fundamental changes to our military in order to take advantage of this change in the character of war. In order to do that, you need organizations to drive that."[195]

JADC2 suffers from a similar culture of stovepiping and resistance to change. Although the JADC2 strategy produced by the Joint Staff J6 is intended to provide guidance for ensuring the various technological and programmatic components of the services' JADC2 efforts remain compliant with the overall concept—the results to this point remained functionally stovepiped. Senior military officials and industry leaders have openly expressed concerns that the current DoD approach to JADC2 is allowing the services to develop individual programs without any ability to integrate at the joint level.[196] Deputy Defense Secretary Kathleen Hicks recently confirmed that "Neither the secretary nor I are satisfied with the – where we are in the department on advanced command and control," and suggested the potential to create a joint office, similar to the Joint Counter-small Unmanned Aircraft Systems Office (JCO), to organize JADC2 requirements.[197]

Former VCJCS John Hyten noted the bureaucratic cultures of the services have caused resistance to complying with joint guidance and concepts.[198] In an effort to address issues with JADC2 at the joint level, Deputy Secretary of Defense Kathleen Hicks has since approved a JADC2 implementation plan which remains classified.[199]

The Challenges of Joint Innovation

Examining the criteria for innovation in the development of JWC 1.0 and JADC2 creates a concerning snapshot of contemporary joint innovation efforts. Overall, conceptual and

195 Joe Gould, "US Military May Need Innovation Overhaul to Fight Future Wars, Milley Says," *Defense News*, June 1, 2022, https://www.defensenews.com/congress/2022/06/01/us-military-may-need-innovation-overhaul-to-fight-future-wars-milley-says/.

196 See for example Mark Pomerleau, "Military Services 'not Aligned' on JADC2 Efforts, Air Force Official Warns," *FedScoop*, July 26, 2022, https://www.fedscoop.com/military-services-not-aligned-on-jadc2-efforts-air-force-official-warns/; Mikalya Easley, "Skeptics of Services' JADC2 Plans Emerge," *National Defense Magazine*, August 25, 2022, https://www.nationaldefensemagazine.org/articles/2022/8/25/skeptics-of-services-jadc2-plans-emerge; and Dan Goure, "Are The Wheels Coming Off the JADC2 Bus?," *Real Clear Defense*, September 6, 2022, https://www.realcleardefense.com/articles/2022/09/06/are_the_wheels_coming_off_the_jadc2_bus_851924.html?mc_cid=53cb2445fe&mc_eid=7cbf43077b.

197 Brandi Vincent, "Hicks Wants More High-level Oversight of Pentagon's JADC2 Efforts," *FedScoop*, August 23, 2022, https://www.fedscoop.com/hicks-wants-more-high-level-oversight-of-pentagons-jadc2-efforts/.

198 Theresa Hitchens, "The Joint Warfighting Concept Failed, Until It Focused On Space And Cyber."

199 Mikalya Easley, "Skeptics of Services' JADC2 Plans Emerge," *National Defense Magazine*, August 25, 2022, https://www.nationaldefensemagazine.org/articles/2022/8/25/skeptics-of-services-jadc2-plans-emerge.

organizational innovation at the joint level is struggling from ill-defined concepts and poorly supported approaches which hinder senior leader buy-in, experimentation, and the development of the intellectual capital needed for transformative innovation. Like prior efforts to develop AirLand Battle from Active Defense, the development of innovative concepts by large bureaucracies presents many challenges. This section has attempted to illustrate a sample of the barriers to innovation that exist presently at the joint level.

Former VCJCS Hyten has already described the JWC as an "aspirational" document to be expanded and refined.[200] With bureaucracies often exhibiting catlike attention spans, the successful development and implementation of the JWC and JADC2 will require the focused and sustained attention of Department of Defense leadership. Organizations have a tendency to adopt pain-avoidance strategies to eschew dealing with difficult challenges, either wishing them away politically, relying too much on non-existent or unproven technologies, or, alternatively, despairing that defeat is inevitable and all hope is lost. Defense leaders have an important role to play in focusing the Department on the imperative of innovation, however challenging intellectually, operationally, organizationally, and bureaucratically. Specifically, it is the professional obligation of U.S. military leaders to ensure that the U.S. armed forces are prepared to fight and win the nation's wars, including the development of joint operational concepts to do so in the face of looming strategic and operational challenges. It is the role of civilian leaders to hold the U.S. military accountable for developing operational concepts to meet the challenges that our nation faces, not wishing them away. Similarly, it is the responsibility of civilian leaders to define the parameters within which joint concepts are developed, including the strategic constraints and operational assumptions that should guide concept development.

In addition to clarifying the threat environment, the JWC will benefit from further development of its supporting concepts, such as JADC2. Development should be an interactive and interdependent process, where the JWC itself and the supporting concepts are refined and reconnected, both across each other and with the JWC. Each supporting concept focuses on an important area that has received insufficient attention, or integrates multiple competing service approaches. Although JADC2 appears further along the innovation timeline than the JWC, important work remains to take it and the other supporting concepts forward in the context of the JWC.

Finally, the classification of the JWC and documents related to JADC2 deserve careful consideration. There are several reasons for these documents to remain classified. The development of joint operational concepts requires a precise definition of the threat as well as a frank discussion of friendly and adversary strengths and weaknesses. It also benefits from a full discussion of capabilities and concepts, including those that may be sensitive. At the same time, it must be acknowledged that the existence of the JWC as a classified document has negative consequences as well. It necessarily limits the ability to share the concept

200 Theresa Hitchens, "The Joint Warfighting Concept Failed, Until It Focused On Space And Cyber."

broadly to stimulate discussion and debate, to promote good ideas, and expose flawed logic. It also prevents large swaths of the Department and broader defense community from understanding the JWC clearly and harnessing approaches, solutions, and innovations in support of it.

Our examination to this point is both a good news and bad news story. Progress within the services creates a new set of challenges based on DoD's slower move forward. Current conditions create the possibility that service efforts succeed independently, without the ability to fight jointly with their sister services. The armed services reluctantly admit that their current operational concepts are somewhat mutually dependent, but the inadequacy of the JWC and other joint guidance may leave the services without the joint support they require. Lacking sufficient joint concepts and guidance, the services are left to coordinate and synchronize their innovation efforts in an independent and ad hoc manner that could lead to significant risks for the entire U.S. military. The next chapter will further examine this relationship and explore ways the military can reduce the risks of mismatched innovation.

CHAPTER 6

Assessing the Dynamic between Joint and Service Innovation

Our application of the innovation framework has shown that the military services possess the necessary elements for conceptual, organizational, and technological innovation, while joint efforts remain ill-defined and poorly supported. This dynamic leads to questions about the interaction between joint and service-level innovation in today's Department of Defense. Specifically:

- *How does the success or failure of innovation at the joint or service level impact the success or failure of the other level?*
- *How dependent are joint and service-level efforts on each other for successful military innovation?*
- *How can the Department better create the conditions for innovation at the joint level?*
- *How can the services effectively fight together, lacking joint concepts to confront today's strategic and operational challenges?*

This concluding chapter seeks to explore these questions and provide some initial conclusions and recommendations based on our examination of military innovation for great power competition.

Potential Innovation Outcomes

The structure of the Department of Defense and the bifurcation of innovation efforts between the Pentagon and the military services creates several potential outcomes for current innovation efforts. For the purposes of this study, we simplify the options by creating broad binary outcomes—success or failure—for both joint and service innovations. Acknowledging that complete innovation "success" or "failure" is unrealistic and that both DoD and the services are likely to have a wide variety of individual successes and failures, this categorization allows us to make meaningful comparisons when one organization innovates more effectively or at a faster pace than the other. Table 2 displays a matrix of possible innovation outcomes for today's Joint Force.

TABLE 4: JOINT AND SERVICE INNOVATION OUTCOMES

	Joint Innovation Success	**Joint Innovation Failure**
Service Innovation Success	*Best case: Effective joint concepts that integrate and are supported by the concepts and programs of the services.*	*Military services develop successful concepts and technologies for great power competition, but without a joint concept to integrate them with each other.*
Service Innovation Failure	*Joint concepts are only supported by legacy service programs and concepts.*	*Complete failure to innovate: Military trapped in legacy programs and concepts from top to bottom.*

Each of these outcomes entails different risks and benefits for the U.S. military. Successful joint and service innovation—the top left box—is the best-case outcome for DoD and the United States. In this case, joint institutions provide concepts and drive technological requirements for each of the armed services. Because they are effectively overseen at the joint level, the services develop capabilities, doctrine, and force structures that are mutually supporting and enabling. This results in the capability of the Joint Force exceeding the capabilities of each of the services—the whole becoming greater than the sum of its parts.

The second case involves the services implementing military innovations more effectively or at a faster pace than the Pentagon. This case stands as the second-best outcome. Innovation occurs within the services, which develop solutions to their own operational challenges as they see them. Of course, the services are at risk of working toward innovations that are disjointed, uncoordinated, or duplicative of each other. The greatest danger in this outcome is the services developing concepts and programs that are reliant on joint capabilities that never materialize due to a lack of synchronization. Still, many issues between the services, in this case, could be of a less serious nature and could be resolved through ad hoc and bilateral coordination. This outcome will be further explored below.

Should joint efforts succeed and service efforts fail, the degree of innovation within the U.S. military as a whole may be limited by the failures of the services. Although DoD plays an essential guidance and oversight role, it is mostly dependent on the military services to actually develop and field new capabilities. As a result, the success of the joint enterprise is bound by the outcomes of the services' efforts. Even with a clear, prescient JWC and supporting concepts, one or more of the armed services could leave the Department in the lurch. This could result in overall innovation failure, because legacy forces may not have the capabilities required to implement forward-looking joint concepts that are tailored to the challenges of great power competition.

Lastly, failure at both levels constitutes the worst-case outcome. In this scenario, strategic and operational challenges remain as barriers that limit the United States' chances for success in great power competition. From top to bottom, the U.S. military would be left with legacy concepts and weapons to confront adversaries that have adapted specifically to defeat these methods of warfighting.

Today's Most Likely Innovation Outcome

This study currently places the U.S. military in the top right box of Table 2: successful service concepts and programs may, at least in the near future, be implemented without a fully developed joint concept to integrate them. Despite DoD's lagging progress on devising a JWC and supporting concepts, the armed services are pushing ahead with new operational concepts, force structures, and platforms. Although progress varies among the services, the next several years will see the implementation of new units and weapons such as the Multi-Domain Task Force, Marine Littoral Regiment, unmanned surface and undersea vessels, and next-generation unmanned aircraft. These organizations and platforms are intended to overcome the operational problems presented by great power conflict.

Without clear joint concepts and guidance, however, these efforts risk being needlessly duplicative or even clashing with each other. Duplicative or redundant programs represent a waste of valuable resources in an already resource-constrained environment. With each service confronting a formidable modernization bow wave, the services cannot afford to waste time and money duplicating the efforts of one another.[201] A lack of joint coordination could lead to two or more services making similar technological or programmatic advancements separately instead of sharing and, ideally, leapfrogging each other's progress. Additionally, if the armed services develop redundant capabilities, then the Joint Force may end up with a less diverse set of capabilities overall. This outcome is particularly dangerous given the complex challenges and uncertainties inherent to future great power competition.

More problematic, however, is the possibility that the military services develop concepts, doctrine, and platforms that are completely misaligned with those of the other services. At best, this eventuality could leave the Joint Force only as capable as each of the individual services fighting alone, without the "force multiplier" of complementary joint operations. At worst, conflicting efforts could lead to faulty assumptions that leave the services without the

201 For an exploration of the depth of the bow wave of each service, see Mackenzie Eaglen with Hallie Coyne, *The 2020s Tri-Service Modernization Crunch* (Washington, DC: American Enterprise Institute, March 2021), https://www.aei.org/wp-content/uploads/2021/03/The-2020s-Tri-Service-Modernization-Crunch-1.pdf?x91208.

support they rely on from the Joint Force. For example, the Marine Corps' EABO concept is dependent on Navy amphibious forces capable of delivering small groups of Marines in contested environments. Should the Navy fail to shift its amphibious force structure to meet this requirement, EABO and *Force Design 2030* may be left missing crucial capabilities.[202] Likewise, many of the Army's Long-Range Precision Fires assets will benefit from (or even necessitate) targeting data from Air Force airborne and spaceborne sensors. Without more robust joint guidance and coordination, the services may struggle to construct and practice these kill chains independently. The Air Force is similarly dependent on the Army for air and missile defense of its bases and logistics nodes. Beyond platforms and capabilities, warfighting doctrines that fail to account for the operations of the other services could lead to unforeseen conflicts with logistics support and battlefield coordination.

Improving Joint Innovation

Given the risks of service innovation outpacing joint innovation, how can the Department of Defense improve its current conceptual, organizational, and technological innovation efforts? What lessons can today's Pentagon draw from the innovation framework and the events of the Cold War?

Further iterations of the Joint Warfighting Concept represent opportunities for improved guidance and coordination from the Department. Accordingly, follow-on efforts must fully involve the Office of the Undersecretary of Defense for Policy and other senior civilian DoD leadership from its conception to its implementation. Although the pen may be passed between OSD, the Joint Staff, and other essential offices, DoD leadership must strictly enforce the concept's vision and key points—lest the JWC suffer from the "death by committee" typical of high-level government documents.

After its initial development, the concept will require experimentation at all levels with a variety of stakeholders. The DoD must avoid the mistakes of the 1950s Pentomic Division and thoroughly test and refine any joint concept before attempting to implement it across the Department. Innovation efforts would benefit from a genuine discussion and debate over the effectiveness of alternative concepts as well as an extensive program of gaming and experimentation. Service efforts need to be augmented by a joint experimentation effort.

Finally, further iterations of the JWC would benefit from a clear unclassified summary to inform the majority of servicemembers, the defense analysis community, Congress, and the American public. With current joint and service concepts frustrated by a lack of clarity, an unclassified summary would help clear up confusion, provide direction, and build the

202 Already, the Navy and Marine Corps are struggling to maintain an agreeable mix of amphibious vessels. See Megan Eckstein, "US Marines Warn against Navy's FY24 Decommission Scheme," *Defense News*, October 4, 2022, https://www.defensenews.com/naval/2022/10/04/us-marines-warn-against-navys-fy24-decommission-scheme/?utm_campaign=dfn-ebb&utm_medium=email&utm_source=sailthru&SToverlay=2002c2d9-c344-4bbb-8610-e5794efcfa7d.

necessary political capital for further innovation efforts. The summary should display clear linkages between programs, concepts, operational challenges, and ultimately how the challenges affect the national security interests of the United States.

Like the JWC, an effort as large and integral to joint operations as JADC2 would also benefit from increased joint direction in order to shape service efforts to the degree necessary to enable widespread joint connectivity. First, DoD should consider that the ultimate goal of "linking everything together" within the U.S. military is an overwhelming and potentially unachievable goal in the near term. DoD must heed the lessons of the Pentomic Division and avoid basing the entire success of future warfighting concepts on technological progress that may or may not be achieved on the desired timeline. Even when successful concepts like AirLand Battle drove technological and programmatic innovation, these advances sometimes took years longer than expected.

Moreover, for JADC2 to be successful, DoD will likely need a more robust lead organization than the current cross-functional team. Instead of a CFT, the Department would benefit from a single entity to set requirements and establish key JADC2 nodes in each service. The services could then work to connect these key nodes, while ensuring their lower-level C2 systems are compatible with these nodes as well. The services' current JADC2 efforts are reminiscent of the Tomahawk missile's development, with the Navy and Air Force pursuing competing cruise missile programs. Like the sharing of Tomahawk components in the 1980s, DoD intervention is required to effectively align the JADC2 efforts of the services. The Department has a plethora of proven options for leading and overseeing joint endeavors like JADC2, including a joint program office, lead military service, or independent agency.[203] At present, DoD officials appear to be moving toward the creation of a joint office to oversee JADC2.[204]

Preparing for All Outcomes

Given the likelihood that the services outpace innovation at the joint level, how should they best prepare themselves for this contingency? How can they ensure their individual efforts still result in successful innovation and victory on tomorrow's battlefield? To be clear, we are not advocating that the services abandon or ignore joint efforts, but rather that they must be prepared to fight in any scenario regardless of the status of joint concepts or programs. In this case, each service must prepare to operate with its new concepts and technologies

203 For more information on potential DoD options and their benefits, see Todd Harrison, *Battle Networks and the Future Force Part 2: Operational Challenges and Acquisition Opportunities* (Washington, DC: Center for Strategic and International Studies, November 2021), pp. 7-9, https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/211103_Harrison_Battle_Networks_Part2_0.pdf?vsuBpGNyDDOwNE_hMzckmGEfb8fq13dx.

204 Brandi Vincent, "Hicks Wants More High-Level Oversight of Pentagon's JADC2 Efforts," *FedScoop*, August 23, 2022, https://www.fedscoop.com/hicks-wants-more-high-level-oversight-of-pentagons-jadc2-efforts/; Jaspreet Gill, "Army Acquisition Exec Pushes for Joint JADC2 Office, Large-Scale Exercise," *Breaking Defense*, July 11, 2022, https://breakingdefense.com/2022/07/army-acquisition-exec-pushes-for-joint-jadc2-office-large-scale-exercise/.

absent a solid joint framework or all-encompassing joint connectivity. Several options exist for operating in this manner, some of which can be found in past or current doctrine. This section will highlight three potential ways the armed services might coordinate at the operational level to "fight together, but apart" in a dynamic manner. Each method builds on frameworks within existing doctrine for deconflicting joint operations.

First, the services could pursue a *functional separation* of efforts. This method would divide the roles and missions of each service based on functional areas or domains. For example, the Marine Corps could take responsibility for all ground-based maritime strike missions, while the Army prosecutes land-attack missions. The Air Force could divide its theater mission set with the Navy by focusing on land-attack strikes, while the Navy conducts the majority of maritime strike missions. In these examples, the division of responsibilities plays to organizational strengths, weaknesses, and traditional identities. Some services may have more operational experience or training focused on a particular function, or could have the most effective platform for executing a particular mission. Ad hoc arrangements at the operational and tactical level could complement and clarify existing lines between service roles and missions. Functional separation would ensure that units and weapons are arrayed against the missions they are best prepared for and most effective at executing.

Second, the military services could divide the area of operations into *geographic sectors* of responsibility. Within these sectors, each of the services, or a combination of services, could lead operations. In the Indo-Pacific, for example, sectors could be divided between island chains, seas, or allied nations. Within these areas of responsibility, joint operations at the tactical level would be conducted on a more ad hoc basis—such as temporary joint task forces—than in the joint and connected manner envisioned by current joint warfighting concepts. In some ways, this arrangement reflects previous operations in Afghanistan and Iraq. Geographical divides allow the services to more easily coordinate efforts using relatively simple battlefield coordination measures.

Finally, the services could use *temporal separation* and deconflict their efforts in phases. The Air Force could conduct an initial wave of long-range strikes to degrade enemy defenses and open a theater, with the Navy then using maritime strike forces to attack a second wave of targets. On the ground, the Marine Corps could secure initial footholds on Indo-Pacific islands before the Army follows with combat reinforcements, logistical support, and long-range air and missile defenses. Planners would match each service's forces with the operational phase that best suits their range of capabilities.

Of course, much like previous campaigns, all of these arrangements could be mixed and matched by the services to conduct effective joint operations from the theater level down to the tactical level. Although none of these options would be as effective as an integrated force optimized to execute a joint warfighting concept, the services must be prepared to operate without fully developed joint concepts and connectivity. Even with successful joint innovation and the realization of JADC2, these deconfliction typologies remain useful in contested environments with severely degraded communications. Adversary countermeasures may force even the most connected forces to be "network-enabled, but not network-dependent."

Final Thoughts

In closing, the innovation efforts of the Department of Defense are ongoing and contain cause for both optimism and concern. Recent events in Ukraine, the Taiwan Strait, and the Sea of Japan add to the urgent need to address the strategic and operational challenges presented by contemporary great power competition. Although uncertainty remains about the exact nature and timeframe of the Chinese and Russian threats, the need for military innovation has been clearly identified by the armed services, the Department of Defense, the U.S. Congress, and increasingly by the American people.[205]

This study has shown that the seeds of innovation are present, albeit unevenly, within the U.S. military. The ongoing conflict in Ukraine has demonstrated the exceedingly high costs and attrition rates of modern warfare. At the same time, advanced weapons and equipment are increasingly complex to produce and replace. In today's great power arena, these factors combine to make innovating to overcome challenges and avoid these losses—particularly in the initial acts of a conflict—more essential than ever.

The examinations in this monograph present a momentary "snapshot" of current joint and service-level innovation. As these efforts progress through the stages of speculation, experimentation, and implementation, further research and reassessments will be required. Many of the Department's current initiatives are significant in scale and may take years to fully implement.

Still, our assessment has revealed reasons for optimism. Several paths forward for the Joint Warfighting Concept and JADC2 are possible, and the armed services appear to be well on their way to confronting today's challenges. Innovation is never a simple or fast process, but every step of progress made in the present will save American lives in the opening moves of tomorrow's war.

205 2021 survey data shows an increase the percentage of Americans concerned by China's growing military and technological power. See Laura Silver, Kat Devlin, and Christine Huang, "Most Americans Support Tough Stance Toward China on Human Rights, Economic Issues," *Pew Research Center*, March 4, 2021, https://www.pewresearch.org/global/2021/03/04/most-americans-support-tough-stance-toward-china-on-human-rights-economic-issues/.

LIST OF ACRONYMS

A2/AD	Anti-access/area denial
ABMS	Advanced Battle Management System
ACE	Agile Combat Employment
AFC	Army Futures Command
AFRL	Air Force Research Laboratory
AI	Artificial intelligence
ALCM	Air-launched cruise missile
AMPV	Armored Multi-Purpose Vehicle
APC	Armored personnel carrier
ASCM	Anti-ship cruise missile
AT3	Advanced Tactical Targeting Technology
ATGM	Anti-tank guided missile
AWACS	Airborne Warning and Control System
BCT	Brigade Combat Team
C2	Command and control
CAPE	Office of Cost Assessment and Program Evaluation
CCDC	Combat Capabilities Development Center
CEC	Cooperative Engagement Environment
CFT	Cross-functional team
CJCS	Chairman of the Joint Chiefs of Staff
COTS	Commercial off-the-shelf
CPOF	Command Post of the Future
CSBA	Center for Strategic and Budgetary Assessments
CVBG	Carrier battle group
DARPA	Defense Advanced Research Projects Agency
DCNO	Deputy Chief of Naval Operations
DMO	Distributed Maritime Operations
DoD	U.S. Department of Defense
EABO	Expeditionary Advanced Base Operations
ELINT	Electronic intelligence
ERCA	Extended Range Cannon Artillery
FBCB2	Force XXI Battle Command Brigade and Below
FM	Field manual
FOFA	Follow-on Forces Attack
FY	Fiscal year

GAO	Government Accountability Office
G/ATOR	Ground/Air Task-Oriented Radar
GIG	Global Information Grid
HAF	Headquarters Air Force
HULTEC	Hull-to-emitter correlation
INS	Inertial navigation system
ISR	Intelligence, surveillance, and reconnaissance
JADC2	Joint All-Domain Command and Control
JCO	Joint Counter-small Unmanned Aircraft Systems Office
JOTS	Joint Operational Tactical System
JROC	Joint Requirements Oversight Council
JSTARS	Joint Surveillance Target Attack Radar System
JWC	Joint Warfighting Concept
LCS	Littoral Combat Ship
LOCE	Littoral Operations in Contested Environments
LRHW	Long-Range Hypersonic Weapon
LVC	Live, virtual, and constructive
MAJCOM	Major command
MDO	Multi-Domain Operations
MDTF	Multi-Domain Task Force
MLR	Marine Littoral Regiment
MOC	Marine Corps Operating Concept
MPF	Mobile Protected Firepower
MRC	Mid-Range Capability
NATO	North Atlantic Treaty Organization
NAVWAR	Naval Information Warfare Systems Command
NDS	National Defense Strategy
NIFC	Naval Integrated Fire Control
NMESIS	Navy Marine Expeditionary Ship Interdiction System
NTCS-A	Naval Tactical Command System—Afloat Element
NTDS	Navy Tactical Data System
NWDC	Naval Warfare Development Command
OPFOR	Opposing force
OSD	Office of the Secretary of Defense
OSD(P)	Office of the Under Secretary of Defense for Policy
OSIS	Ocean Surveillance Information Center

PACAF	U.S. Pacific Air Forces
PGM	Precision-guided munition
PLA	People's Liberation Army
PNT	Positioning, navigation, and timing
PRC	People's Republic of China
PrSM	Precision Strike Missile
SAM	Surface-to-air missile
SLCM	Submarine-launched cruise missile
SPAWAR	Space and Naval Warfare Systems Command
SURFDEVRON	Surface Development Squadron
TASM	Tomahawk Anti-Ship Missile
T-BONE	Theater Battle Operations Network Environment
TERCOM	Terrain contour matching
TFCC	Tactical Flag Communication Center
TRADOC	Training and Doctrine Command
UAS	Unmanned air system
USAF	U.S. Air Force
USINDOPACOM	U.S. Indo-Pacific Command
USN	U.S. Navy
USV	Unmanned surface vessel
VCJCS	Vice Chairman of the Joint Chiefs of Staff
VLS	Vertical Launching System
WEZ	Weapons engagement zone
WIN-T	Warfighter Information Network

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