Support for Division-Level Innovation Cells During Continuous Transformation

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> *We are an Army in transition that must win in the current environment and build for the future. All of us, regardless of rank, are empowered to solve problems and identify opportunities to improve how we fight and how we take care of our Soldiers, Civilians, and Families. We will foster and sustain the right culture and processes while capturing our initiative in programs of record that will outlast each of us.*[1]

I. Introduction

For the past three years, Ukraine has defended against a conventionally superior adversary when "virtually all" expected Russian success.[2] When The Russian Federation (Russia) invaded Ukraine in February of 2022, Russia boasted the "preponderance of power" with a defense budget that was ten times larger, an economy nearly eight times larger, nearly five times as many military personnel, and significantly superior military capabilities compared to its opponent.[3] Despite

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1. XVIII Airborne Corps, XVIII Airborne Corps Innovation Process: Guide for Innovation Projects 1 (Dec. 2022) [hereinafter XVIII Airborne Corps Innovation Guide] (quoting then-Lieutenant General Christopher T. Donahue, who had been serving as the Commanding General of XVIII Airborne Corps and Fort Liberty at the time of the statement).

2. Steven Pifer, *Russia-Ukraine after three years of large-scale war*, Stanford Center for Int'l Sec. and Coop. (Feb. 19, 2025), https://perma.cc/XH29-XV9U.

3. Seth G. Jones et al., *Ukrainian Innovation in a War of Attrition*, Center for Strategic and Int'l Stud. (Feb. 27, 2023), https://perma.cc/HNV4-83RG.

these enormous quantitative and qualitative advantages, Russia failed to achieve its goal of seizing the Ukrainian capital of Kyiv, which the Kremlin assumed it would control within days of invading.[4] Even after expending staggering amounts of personnel and equipment on this unexpectedly protracted war, Russia continues to fall short of its goal of occupying the Eastern one-half to two-thirds of Ukraine.[5] While many factors have contributed to Ukraine's astonishing ability to overcome the odds, its use of bottom-up military innovation is undoubtedly a critical factor.[6]

The importance of innovation for national security has not gone unnoticed by the rest of the world. While the United States was bogged down by counterinsurgency conflicts with non-peer forces, its Great Power competitors focused their efforts on quickly approaching technological parity with the United States.[7] The People's Republic of China (China), the United States' "pacing threat", has focused heavily on modernization, going so far as to reorganize the country's science and technology sectors to ensure that potentially disruptive technologies advance Chinese military capabilities.[8] The United States has taken notice and responded with strategic-level changes in the hopes of accelerating innovation.[9]

However, not all innovation is created equal. While China's authoritarian government has enabled it to effectively translate technological innovations into military capabilities, this top-down structure has failed to produce its own disruptive innovations.[10] In contrast to China, Ukraine has effectively leveraged disruptive technologies, tactics, techniques, and procedures as generated from end-user innovators rather than the traditional military-industrial complexes.[11] While not sufficient in itself, embracing bottom-up innovation has become increasingly necessary to winning contemporary wars. The democratization of technology means that conventional military advantages will no longer be the sole determinant of victory.[12]

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4. *See generally* Soph Warnes and Lou Robinson, *Visualizing how Ukraine has changed in the 3 years since Russia's full-scale invasion*, CNN (Mar. 3, 2025), https://perma.cc/8YNF-SASQ.

5. *See* Pifer, *supra* note 2; *see generally* Grace Mappes, *Russia Has Failed to Break Ukraine*, INSTITUTE FOR THE STUDY OF WAR (Feb. 24, 2025), https://perma.cc/E649-RPWZ.

6. *See* Jones et al., *supra* note *3*.

7. *See* Colonel George M. Dougherty, *Accelerating Military Innovation: Lessons from China and Israel*, JOINT FORCE Q. 98 (Sep. 10, 2020), https://perma.cc/KQT5-UREV.

8. *See* Nicholas R. Licata, *China's Military-Civil Fusion Strategy: A Blueprint for Technological Superiority*, FOREIGN POL'Y RSCH. INST. (Dec. 19, 2023), https://perma.cc/7WAW-7YA7. China's designation as a "pacing threat" means that "China is the only country that can pose a systemic challenge to the United States in the sense of challenging us, economically, technologically, politically and militarily." Jim Garamone, *Official Talks DOD Policy Role in Chinese Pacing Threat, Integrated Deterrence,* DEP'TM DEF. NEWS (Jun. 2, 2021), https://perma.cc/RC54-YDHE (quoting then-Undersecretary of Defense for Policy Colin Kahl).

9. *See* Doughtery, *supra* note 7 (explaining that one such change was the creation of U.S. Army Futures Command (AFC)).

10. *See* Doughtery, *supra* note 7.

11. *See generally VIDEO: Robot War: Inside Ukraine's Battlefront of Steel and Circuits,* SMALL WARS J. (Mar. 6, 2025), https://perma.cc/8Z36-B65H.

12. *See generally* Frederick W. Kagan and Kimberly Kagan with Mason Clark et al, UKRAINE AND THE PROBLEM OF RESTORING MANEUVER IN CONTEMPORARY WAR 16 (Aug. 2024).

While the U.S. Army has taken steps to encourage Soldier-led innovation, current fiscal policies and a lack of dedicated organizational support are dampening these efforts. This paper examines the current state of bottom-up innovation in the Army and argues that its optimization requires that Division Commanders are provided flexible funding and the support of a Soldier Innovation Cross Functional Team, as organized under the U.S. Army Futures Command (AFC). To most effectively deliver innovation with speed at scale, the Department of Defense (DoD) must look inside the force as much as outside of it. This has been demonstrated throughout history, such as during the U.S. wars in Vietnam and in Iraq.

A. Gun Trucks, Two Ways

In 1966, the 54th Transportation Battalion of the 8th Transportation Group went into Vietnam with a plan that, like all good plans, did not survive first contact.[13] Having saved their firepower for combat units, the U.S. Army sent logistical units, such as the 54th, to run supply lines without many organic combat capabilities.[14] Relying on the insufficient availability of military police or air support for defense, the convoys were ripe for ambush.[15] The North Vietnamese quickly took advantage of the capability gap by interdicting supply lines in an effort to deny combat units logistical support.[16] With no immediate solution from higher in the chain of command, the unit took to its own ingenuity to solve the problem.[17] Using local resources and the skills of individual soldiers, Soldiers "hardened" their convoys by welding armor and weapons to selected trucks that were then designated for offensive duty.[18] "Every crew was proud of their truck," recalls one member of the 8th.[19] The Vietnam-era "gun truck" made it across the theater with no formal direction or promotion, and by 1969, it was a fixture for convoys across the country.[20] However, without a centralized process to capture this knowledge, each unit spent their own time and resources developing internal

13. *See* Nina A. Kollars, *War's Horizon: Soldier-Led Adaptation in Iraq and Vietnam*, J. OF STRATEGIC STUD. 529-553, 540 (Jan. 3, 2015) [hereinafter Kollars, *War's Horizon*], https://perma.cc/SPD4-5DG8.

14. *Id.*

15. *See* Kollars, *War's Horizon*, *supra* note 13, at 540.

16. *Id.*

17. *Id.*

18. *Id.* at 541. Early gun truck modifications varied based on local supply and individual solider capabilities (e.g. welding). Some used sheet metal, lumber, or sandbags to fortify their vehicles. Others pulled hulls from deadlined armored personnel carriers (APCs), welding them to their deuce-and-a-half for protection. *Id.* Almost all borrowed firepower was sourced externally, beyond their Table of Organization and Equipment (TOE). They acquired their M134 Mini-guns—high-powered machine guns capable of firing 10,000 rounds of 7.62 mm ammunition—from aviation or M2s (.50 caliber machine guns) from field artillery. *Id.* at 542.

19. Matt Fratus, *The Gun Trucks of Vietnam: How US Soldiers Transformed Cargo Vehicles into Fighting Machines*, COFFEE OR DIE (Oct. 8, 2020), https://perma.cc/7VSV-B85C.

20. *Id.*

tactics and adaptations, all of which were lost when the problem of vulnerable convoys reemerged in 2003 during Operation Iraqi Freedom (OIF).[21]

Much like in Vietnam, units in Iraq were forced to rely on their own resourcefulness as requests for support went largely unfulfilled.[22] Once more, Soldiers pilfered salvage yards and informally networked to protect themselves from enemy ambush, and by late 2004, the majority of units relied on resources outside of their Modified Table of Organization and Equipment (MTOE).[23] These Soldier-modified gun trucks resembled their Vietnam predecessors with additional plate armor and machine gun attachments. Unlike Vietnam, senior commanders encouraged junior officers to centralize their innovation efforts at two locations: one for technological solutions and one for tactical solutions.[24] Seeing a need for experienced welders, Lieutenant Mitchell Bierl of the 181st Transportation Battalion improvised a machine shop at Logistics Support Area (LSA) Anaconda that later took on the name Skunk Werks.[25] Eventually, Skunk Werks hired local Iraqi metalworkers and attracted U.S. Soldiers who welded specialized armor for any unit that brought their vehicles.[26] Outside of LSA Anaconda, Captain Andrew Bristow, another junior officer from the 181st, set up Udairi firing range, which quickly turned into a collection point for tactical adaptations as units rotated through for training.[27] Because Skunk Werks and Udairi firing range were able to receive and improve upon field adaptations, their lessons learned were directly responsible for the production of two gun truck kits, as well as two formally-produced convoy guides.[28]

B. Modern Military Innovation

As demonstrated by the examples above, innovation is a historically important part of war that continues to maintain relevance today. In 2014, Secretary of Defense Chuck Hagel announced that the DoD was entering the era of the Third Offset strategy in which it would be addressing its adversaries' countermeasures through innovation.[29] Shortly after, innovation became a part of key documents,

21. *Id*. at 543. Decades after the transportation units left Vietnam in 1972, a handful of historians recovered the story of the gun truck and its wide usage during the war. *Id*. While the tactics, techniques, and procedures (TTPs) were never codified, some of their ideas made it into the 1997 edition of Field Manual (FM) 55-30, Convoy Operations, which was in use during OIF. *Id*. at 547. Appendix O features suggestions for hardening a truck and includes an image of a Vietnam era gun truck as an example. *Id*. For a depiction of a gun truck, see *infra* Appendix A-1.

22. Kollars, *War's Horizon, supra* note 13, at 543.

23. *Id*. at 545.

24. *See generally id*.

25. *Id*. at 545.

26. *Id*. at 545-546.

27. *Id*. at 546-547.

28. *Id*. at 546, 548. The knowledge from Skunk Werks was directly fed into the development of the Armor Survivability Kit (ASK) and the Lawrence Livermore National Laboratory Armor Kit (LLNL). *Id*. at 546. The knowledge from Udairi training-range was also captured in a Center for Army Lessons Learned (CALL) publication entitled *Convoy Leader Training*. *Id*. at 547.

29. *See* Chuck Hagel, Sec'y of Def., U.S. Dep't of Def., "Defense Innovation Days" Opening Keynote (Southeastern New England Defense Industry Alliance) (Sep. 3, 2014), https://perma.cc/AL6H-4VB6.

including the National Defense Strategy and the Army Operating Concept.[30] As the buzzword of innovation soared across the entirety of the DoD, commanders stood up division-level innovation cells in response.[31] These division innovation cells quickly allowed great ideas to float to the top.[32] The problem, however, is that these innovation cells evolved outside of the defense acquisition system (DAS).[33] Their genesis was driven by operational-level commanders, whose organic funding is limited to operations and maintenance (O&M) funds, which cannot be spent on prototyping efforts.[34] Additionally, commanders and staff at this level are focused on operations, not strategy, and thus do not have the resources to effectively navigate the byzantine labyrinth that is the defense procurement system.[35] While large scale innovation organization such as the Defense Advanced Research Projects Agency (DARPA) and Defense Innovation Unit (DIU) do solicit Soldier input, this is to support commercial, business led innovation which is still subject to the complex acquisition process, and not driven by end-users.[36] Due to these limitations, the Army is failing to capitalize on the ingenuity of its workforce at a time when it is most critical to do so.

While updating material capabilities is crucial to advancing combat overmatch, integrating novel capabilities into the fighting force is equally important yet more difficult.[37] In armed conflict, technology often determines which side enjoys combat overmatch. Combat overmatch was plainly defined by Lieutenant Colonel Matthew A. Horning of Army Futures Command as "...the concept where my (insert lethality system here) can willfully and without prejudice or luck defeat your (insert your protective system here)".[38] Technology has

30. *See* U.S. DEP'T OF DEF., SUMMARY OF THE 2018 NATIONAL DEFENSE STRATEGY 2 (2018) [hereinafter 2018 NDS]; U.S. DEP'T OF DEF., 2022 NATIONAL DEFENSE STRATEGY 1 (2022).

31. Sam Skove, *How innovation cells in Army combat units are harnessing soldiers' ideas*, DEF. ONE (Aug. 17, 2023), https://perma.cc/G4XX-BXJX.

32. *See* discussion *infra* Section II.C.2. ("Soldier Innovations"). For depictions of innovations developed by Soldiers at division innovation cells, see Appendix B.

33. The Defense Acquisition System (DAS), otherwise known as "Little A" acquisitions, can be separated into two general categories for the purposes of this paper: (1) programs, which are management tools for acquisitions with higher price tags in the range of the tens of billions of dollars, and (2) contracts and contract-like instruments, which are the methods and authorities used to obtain acquisitions. Major Clayton J. Cox & Major Annemarie P. E. Vazquez, *Modernizing through Innovative Acquisition*, ARMY LAW. 82-91, 84 (2020).

34. *See* Lieutenant Colonel Brett Roederer, *Innovating at the Division Level – Effective Processes and TTPs*, No. 24-837 CTR. FOR ARMY LESSONS LEARNED (Jan. 2024).

35. Former President Bill Clinton remarked that the federal procurement system "would have broken Einstein's brain." Cox & Vazquez, *supra* note 33, at 83.

36. *See generally* Indy Toliver, *Innovations: How the DIU Delivers Commercial Capabilities at Speed*, NATIONAL CONTRACT MANAGEMENT ASSOCIATION, https://perma.cc/E49E-VL2V. *See generally* Congressional Research Service, *DARPA's Role in DOD and Selection of R&D Programs* in DEFENSE ADVANCED RESEARCH AGENCY, OVERVIEW AND ISSUES FOR CONGRESS (Aug. 2021). While both DIU and DARPA use Soldier input, it is only as feedback to products developed by commercial entities.

37. *See generally* Nina Kollars, *Genius and Mastery in Military Innovation*, SURVIVAL 125 (Apr. – May 2017) [hereinafter Kollars, *Genius and Mastery*].

38. *See* Matthew A. Horning, *Information Overmatch: How Information Dominance Will Win Our Nation's Wars,* UNITED STATES ARMY ACQUISITION SUPPORT CENTER (Mar. 25, 2019).

advanced at a rapid pace, and individual Soldiers are now carrying equipment and performing tasks at the squad level that were formerly the responsibilities of brigades or battalions just twenty years ago.[39] As the use of major technology is scaled down to the lowest levels, the ability for Soldiers to troubleshoot and scale-up their solutions is more critical than ever. As Lieutenant General (Lt. Gen.) Christopher Donahue noted, the Army needs dynamic, empowered Soldiers on the front lines where the operating environment is ever-changing.[40] Division innovation cells have the potential to provide the crucial understanding of the on-ground realities that our Soldiers face. However, the current fiscal and acquisition framework that we operate within prevents the rapid solution deployment that would benefit the entire force.

This paper develops a hypothesis that identifies the need for fiscal flexibility and organizational support to harness Soldier innovation at the division level. Part I of this paper provided an overview of the problem set and a preview of the proposed solution. Part II of this paper provides the background knowledge necessary to understand the problem set; importantly, this section defines innovation, explains why it is necessary to win future wars and describes the current state of bottom-up innovation in the Army. Part III describes the challenges in promoting innovation. Part IV lays out a solution to address these two issues: an addition to the Expense/Investment (E/I) threshold that would enable U.S. Army Forces Command (FORSCOM) units to spend on Research, Development, Test, and Evaluation (RDT&E) efforts, and an organizational infrastructure to prioritize and champion grassroots innovations. Ultimately, the paper concludes that the effective implementation of division innovation cells requires an RDT&E addition to the (E/I) threshold as well as a Soldier-Innovation CFT under Army Forces Command (AFC.)

II. BACKGROUND: DEFENSE INNOVATION

The importance of innovation within the DoD precedes its recent emphasis in military doctrine. According to Arthur Trevethan, the former Entrepreneur in Residence at the Army Applications Laboratory, the role of innovation within the military has shifted considerably in recent history.[41] During the Cold War, the superpowers' arms race led the DoD to focus on "large-scale, capital-intensive projects, with an extensive time horizon."[42] The role of workers was rigidly defined within hierarchical and bureaucratic structures, leaving little room for the individual creativity and spontaneity that could lead to innovation.[43] With the fall

39. *See* Todd South, *Close Combat Lethality Task Force is changing how the Army builds lethal soldiers and squads*, ARMY TIMES (Oct. 18, 2019), https://perma.cc/B3EM-BDMR (quoting Retired Army Major General Robert Scales).

40. *See* XVIII AIRBORNE CORPS INNOVATION GUIDE, *supra* note 1.

41. Arthur Trevethan, *The People Element in DoD Innovation*, DEF. ACQUISITION 44-47, 45 (Jul. – Aug. 2023) https://perma.cc/9C7A-4D66.

42. *Id.*

43. *Id.* Notably, this is also when the waterfall appropriations structure was created to support the streamlined Cold War acquisitions process. *See* Colonel Jose A. Cora, *Moving Towards an Agile Appropriations Framework for Software Funding* 4 (AY 2019-2020) (unpublished paper) (on file with

of the Soviet Union, nonstate actors emerged as a primary threat and the Department realized that a more flexible and agile approach was needed to address the changing threat environment.[44] Over time, the DoD discovered that responding to new security threats required more than technology; it necessitated the innovative implementation of this technology.[45] As a result, the focus shifted from technology to people and their adaptability.[46]

A prime example of how the DoD dealt with non-state threats was the creation of Joint Improvised Explosive Device Defeat Organization (JIEDDO). In 2006, casualties from improvised explosive devices (IEDs) mounted in Iraq and Afghanistan.[47] The Pentagon responded by creating JIEDDO- a "Manhattan Project" to defeat IEDs. JIEDDO was given its own budget of $3.6 billion and special authorities to rapidly field counter-IED technologies.[48] Even though JIEDDO fielded over 200 counter-IED products, the new organization was still too bureaucratic and slow to keep up with the ever-evolving IED threat.[49] For example, in 2007, JIEDDO spent $113 million on vehicle-mounted mine-rollers. Insurgents responded by simply offsetting the IED trigger with the main charge.[50] Thus, when a mine-roller activated a pressure plate, the main charge would detonate under the personnel cab.[51] The Center of Public Integrity noted that JIEDDO failed because of a lack of accountability and coordination with the Services.[52] JIEDDO looked to industry to solve the IED problem more than it looked to the troops. Ultimately, the IED threat was never permanently solved, and servicemembers saw the most success by relying on indigenous partner forces to spot out-of-place indicators of IEDs.[53] Although JIEDDO was a step in the right direction of faster acquisitions, more work is desperately needed to capture the end-user solutions that are quicker to respond to ever-developing challenges.

While innovation has remained relevant throughout the history of American warfare, its importance has risen now that near-peer adversaries can effectively counter traditional U.S. military strength.[54] Technology is now a necessary, but insufficient condition for military prowess. Since the Gulf War, Russia and China have observed American military operations and developed capabilities and doctrine that directly counter the U.S.'s traditional overmatch.[55] While the United

author). For a more in-depth discussion of the waterfall acquisition and appropriations process, see *infra* Part III.

44. *See* Trevethan, *supra* note 41, at 45.

45. *Id.*

46. *Id.*

47. *See* Peter Cary and Nancy Youssef, *JIEDDO: The Manhattan Project That Bombed,* THE CENTER FOR PUBLIC INTEGRITY (Mar. 2011), https://perma.cc/4VDA-HVD7.

48. *Id.*

49. *Id.*

50. *Id.*

51. *Id.*

52. *Id.*

53. *See* Jason Shell, *How the IED Won: Dispelling the Myth of Tactical Success and Innovation,* WAR ON THE ROCKS (May 2017), https://perma.cc/MJQ7-WX38.

54. *See generally infra* Section II.B.

55. *See* Jim Garamone, *Dunford: U.S. Military Advantage Over Russia, China Eroding*, U.S. DEP'T OF DEF. (Nov. 16, 2017), https://perma.cc/CDG7-728H.

States still maintains its conventional competitive advantage, this advantage has eroded over the last decade and a half.[56] Today, the "volume, velocity, and complexity of change in this era of great power competition" make innovation a national security imperative.[57] However, the DoD remains unable to "leverage its innovation capabilities with speed at scale."[58]

Daniel M. Gerstein, a RAND Senior Policy Researcher, argues that history provides important lessons for the military in its vigorous pursuit of innovation.[59] One of these lessons is that innovation is more than simply the procurement of new military "hardware or software" because at its core, innovation is the result of novel ideas that benefit operational missions.[60] Innovation is about ideas, not just technology, and it can come from "any part of the organization."[61] Further, he identifies the need for innovation to remain connected to the operational problem, which he recognizes is challenging when innovation centers are geographically separated from the operators.[62]

Attempting to fill the gap between top-down innovations and bottom-up execution, the Continuous Transformation Execution Order (EXORD) was published in February 2024.[63] The EXORD calls for commanders to innovate in their formations and to take prudent risk within the confines of their available resources (i.e. structure and budget).[64] The order calls for experimentation with organizational change and the integration of emerging technology.[65] While, throughout the order, there is a clarion call for "innovation," the word is not defined at any point.[66] The below section will define "innovation" for the purposes of this paper.

A. What Is Innovation?

The phrase "defense innovation" encompasses a wide variety of topics, from the DoD's history of creating breakthrough technologies that are now ubiquitous in society (such as the Global Positioning System and the Internet) to its recent history of courting Silicon Valley in an attempt to rebuild the defense innovation base.[67] Despite rhetoric to the contrary, innovation spans more than technological

56. *Id.*

57. *See* Marina Theodotou, *Innovate to Win—Overcoming DoD's Innovation Scaling Problem*, DEF. ACQUISITION (Jul. – Aug. 2023), https://perma.cc/L328-3WVE.

58. *Id.*

59. *See generally* Daniel M. Gerstein, *The Military's Search for Innovation*, RAND (Aug. 13, 2018), https://perma.cc/L84V-NMB7.

60. *Id.*

61. *Id.*

62. *Id.*

63. *See* HEADQUARTERS, DEP'T OF THE ARMY, EXECUTION ORDER 138-24, CONTINUOUS TRANSFORMATION – TRANSFORM IN CONTACT (Feb. 15, 2024) [hereinafter EXORD 138-24]. The EXORD is restricted to military personnel. For a summary of EXORD see Gen. James E. Rainey, *Continuous Transformation*, ARMY UNIVERSITY PRESS (Aug. 2024).

64. *Id.*

65. *Id.*

66. *Id.*

67. *See* Kollars, *Genius and Mastery*, *supra* note 37.

developments or even private sector efforts.[68] In fact, some of the most effective innovations have come from the troops.[69] This has been demonstrated in both scholarly and historical works.

Dr. Adam Grissom, a Senior Political Scientist at the RAND corporation, identified that recent empirical cases hint at the importance of bottom-up innovation in the military.[70] As Grissom notes, history provides many anecdotes describing how members of the military have risen to the occasion in times of combat, using their limited resources to create solutions in support of their mission.[71] Notable innovations that were bottom-up driven by junior officers include the tank, microwave radar, and strategic targeting.[72]

1. Historical Examples

Empirical cases of bottom-up innovation are well known in the academic realm.[73] Famous examples of warfighter innovation during the World Wars abound: the German 88 mm Flak anti-aircraft cannon (which arguably had its greatest impact as an anti-tank system during World War II), the development of the U.S. Close Air Support (CAS) in the European theater of World War II, and the creation of Germany stormtroop tactics by a captain on the Western Front of World War I.[74] One of the most well-known examples of bottom-up innovation came from the French countryside, immediately after Operation Overlord: the case of Sergeant Culin and the bocage.

The Battle of the Bocage illustrates the importance of having a system capable of rapidly absorbing Soldier-led innovations.[75] As then-Captain Boucler described in

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68. *See* James Hasik, *Beyond the Third Offset: Matching Plans for Innovation to a Theory of Victory*, 91 JOINT FORCE Q. 14-21 (Oct. 30, 2018), https://perma.cc/3L73-D4R4; *Breakthrough Technologies for National Security*, DEF. ADVANCED RSCH. PROJECTS AGENCY 1 (Mar. 2015), https://perma.cc/9FKT-MW2V (claiming such icons of modern society as "the Internet, automated voice recognition and language translation, and Global Positioning System receivers small enough to embed in myriad consumer devices" as products of the DoD).

69. *See* James Hasik, *Defense Entrepreneurship: How to Build Institutions for Innovation Inside the Military*, 81 JOINT FORCE Q. 112-17 (Mar. 29, 2016), https://perma.cc/8GY5-AAKS.

70. Adam Grissom, *The Future of Military Innovation Studies*, 29 J. OF STRATEGIC STUD. 905-34 (October 2006).

71. *See* Kollars, *War's Horizon*, *supra* note 13, at 549., *Id.*

72. *See* Jones et al., *supra* note 3.

73. Grissom, *supra* note 70, at 920.

74. *Id.*, at 922-924. *See also* Kollars, *War's Horizon*, *supra* note 13, at 549.

Many instances of 'GI ingenuity' have been documented in war narratives. Consider that two tin cans, a portion of water, and a piece of string tied to a mounted rifle helped the ANZAC forces escape from the trenches of Gallipoli. That was the delayed fire drip gun. Then there was the Rome plow, fashioned from welded steel beams attached to the front of a Sherman tank, helped bust the hedgerows of Normandy in World War II. Perhaps slightly more grisly was an improvised air bombing device constructed from a glass mason jar and a grenade. The glass jar was just narrow enough to hold the safety lever in place after the pin was pulled. When dropped from the sky it delayed the detonation of the grenade until after the jar broke upon impact with the ground. In each of these cases, soldiers in the line of fire made use of the available resources, skills, and ideas in order to solve the immediate problem at hand, and then shared those solutions across the battlefield. *Id.*

75. *See generally* Captain Michael D. Doubler, *Busting the Bocage: American Combined Arms Operations in France, 6 June-31 July 1944*, COMBAT STUD. INST. (Oct. 1, 1988).

his analysis of the battle, while the planners had been aware of the nature of the Bocage and its thick vegetation, "American commanders had done little to prepare their units for fighting among the hedgerows."[76] This is because American commanders had been so preoccupied with D-Day that they "failed to see the battlefield in depth and paid little attention to potential problems of hedgerow combat."[77] The normal control measures and tactics for the use of infantry and armor units were ineffective in the thick and compartmentalizing vegetation of the Bocage.[78] The technological wonder that is a tank was rendered useless because every time it would try to cross a hedgerow, it would go "belly up" and become easy targets for enemy fire.[79] Soldiers on the ground took to their ingenuity and resources to come up with a solution: a hedgerow cutting device welded to the front of a tank.

While the leadership had failed to address the problem in advance, they quickly enabled the adoption of this wartime invention, which ultimately allowed the Allied Forces to push through the Bocage and on to the rest of Western Europe.[80] Without this bottom-up invention, D-Day would have been in vain as the Allied troops remained stuck in the French countryside, rendered immobile by the Bocage hedgerows.[81]

While examples are plentiful in times of conflict, Soldier innovation is not limited to wartime. In fact, one of the most significant cases of innovation was the interwar development of the U.S. Marine Corps' (USMC) amphibious doctrine.[82] After World War I, the USMC shifted from a naval infantry organization to the premier provider of amphibious assault operations. This change occurred in a surprisingly informal manner, being driven from the bottom-up. Having received the mission from their senior leaders, a small group of middle-tier and junior officers was responsible for developing the small wars doctrine through informal discourse methods.[83] Ultimately, this resulted in the USMC's highly successful operational concept for amphibious landings as codified in the *Tentative Training Manual for Landing Operations*, as issued in 1934.[84]

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76. *Id*. at 21.

77. *Id*. The assistant division commander of the 82d Airborne Division best summarized the sentiment when he said, "Although there had been some talk in the U.K. before D-Day about the hedgerows, none of us had really appreciated how difficult that would turn out to be." *Id*. (first quoting Nevin Papers, *Operations to Secure a Lodgment Area*; then quoting Lieutenant Colonel Chester B. Hansen, *U.S. Army, Diaries*; then quoting James Maurice Gavin, *On to Berlin: Battles of an Airborne Commander*, *1943-1946*).

78. *See id*. at 25-28.

79. Dwight D. Eisenhower, Former President, United States, *Remarks Upon Receiving the Hoover Medal Award*, https://perma.cc/4AVN-RJRS.

80. *See id*; *see also* Doubler, *supra* note 75, at 25.28.

81. *See* Doubler, *supra* note 75, at 25-28.

82. Grissom, *supra* note 70, at 922.

83. *Id*.

84. Milan Vego, *On Military Creativity*, 70 JOINT FORCES Q. 83-90, 87 (2013), https://perma.cc/43VW-GK2R.

2. Definitions

Arguably, the overuse of the word "innovation" has rendered the word meaningless.[85] While defining innovation is an undeniably difficult task, the word has received meaningful, if not varied, definitions across both doctrinal and scholarly sources.[86] At the outset, it must be said that innovation transcends more than mere technology.[87] A common misconception about military innovation is that it is limited to the weapons and weapons systems that form the "hardware" of innovation.[88] However, organizational, conceptual, and doctrinal changes form the "software" dimension that is essential to the success of any innovative hardware.[89]

The most important doctrinal definition of innovation comes from the U.S. Army Operating Concept (AOC), as created by the U.S. Army Training and Doctrine Command (TRADOC) in 2014.[90] In his foreword to the AOC, then-Chief of Staff General Raymond Odierno emphasized the importance of innovation, reminding readers that innovation was critical "both for the operational and institutional Army."[91] This emphasis continued in the preface, where then-Commanding General of TRADOC, General David Perkins, remarked that innovation enabled the Army to anticipate changing conditions, thus ensuring that the Army was prepared to "overmatch enemies" and "seize, retain, and exploit the initiative."[92] The document goes on to identify innovation as a key aspect of all future operations: "[w]hat all Army operations will have in common is a need for

85. *See* Brigadier General Shane R. Reeves & Major Adam T. Barsuhn, *The Human Element: The Army's Competitive Advantage in The Age of Innovation*, WAR ON THE ROCKS (Apr. 24, 2023), https://perma.cc/M6ZU-QR2M (calling innovate "a buzzword almost to the point of cliché"); *see also* Captain Joshua Waddell, *Innovation and Other Words That Brief Well*, MARINE CORPS GAZETTE 16-20, 17 (Feb. 2017), https://perma.cc/QZ28-KR3Y (proposing a moratorium on DoD senior leaders using the word "innovation").

86. *See* Major Jonathan S. Smith, *Innovation in the US Military: How Commanders Can Foster An Innovative Culture* (Master's dissertation, U.S. Marine Corps Command and Staff College) (April 5, 2021), https://perma.cc/46FT-5DQL (noting that many scholars and experts forgo defining innovation, instead diverting the reader to historical examples to avoid proposing a definition); *see also* Liam Collins, *Military Innovation in War: The Criticality of the Senior Military Leader* (Ph.D dissertation, Princeton University) (June 2014), https://perma.cc/XU9E-PUUR (asserting the same).

87. *See* Kollars, *Genius and Mastery*, *supra* note 37.

88. *See* Thomas G. Mahnken et al., CTR. FOR STRAT. AND BUDGETARY ASSESSMENTS, INNOVATING FOR GREAT POWER COMPETITION: AN EXAMINATION OF SERVICE AND JOINT INNOVATION EFFORTS 1, 9 (2023), https://perma.cc/896J-8SVX.

89. *See* Kollars, *Genius and Mastery*, *supra* note 37.

90. *See generally* U.S. Army, TRADOC PAMPHLET 525-3-1, THE U.S. ARMY OPERATING COMPLEX: WIN IN A COMPLEX WORLD (Oct. 7, 2014) [hereinafter 2014 AOC], https://perma.cc/MXJ7-ACFZ. Innovation was first introduced as a tenet in the 2014 AOC. *Id.* at 20. While the current AOC does no longer list innovation as a tenet, it acknowledges the criticality of both innovation and a culture of performance in generating "decisive and sustained U.S. advantages." U.S. Army, TRADOC PAMPHLET 525-3-1, THE U.S. ARMY IN MULTI-DOMAIN OPERATIONS 25 (Dec. 6, 2018), https://perma.cc/LY5S-YH8G (quoting Jim Mattis, U.S. DEP'T OF DEF., SUMMARY OF THE 2018 NATIONAL DEFENSE STRATEGY 1, 4).

91. 2014 AOC, *supra* note 90, at i. The full quote reads, "[I]nnovation is critical, both for the operational and the institutional Army . . . to ensure that our Soldiers, leaders, and teams are prepared to win in a complex world." *Id.*

92. *Id.* at v (emphasis in original).

innovative and adaptive leaders and cohesive teams that thrive in conditions of complexity and uncertainty."[93] Innovation is defined as "the result of critical and creative thinking and the conversion of new ideas into valued outcomes" and further described as "the development of new tools or methods that permit Army forces to anticipate future demands, stay ahead of determined enemies, and accomplish the mission."[94]

The rhetoric among scholarly sources varies by author. In 2015, Nina Kollars argued that there are two types of bottom-up change in the military—innovation (which is merely an adjustment to military means or methods) and adaptation (which is the creation of new technologies, tactics, or strategies.)[95] In 2023, Michael Horowitz and Shira Pindyck surveyed dozens of studies and articles to find commonalities and differences amongst definitions of military innovation.[96] The definition they developed was military innovation as "changes in the conduct of warfare designed to increase the ability of a military community to generate power."[97] In a 2023 study on *Innovating for Great Power Competition*, authors from the Center for Strategic and Budgetary Assessments (CSBA) adopt Adam Grissom's definition of "change that affects military effectiveness and how a force operates in the field rather than purely administrative or bureaucratic changes."[98] The CSBA study's authors elaborate on the definition, stating that military innovation includes "evolutionary and potentially revolutionary warfighting innovation, undertaken during peacetime or wartime."[99]

For the purposes of this paper, Grissom's definition is too narrow. While the importance of innovation affecting field-readiness cannot be overstated, the impact of Soldier-led innovations cannot be confined to effects in the field. As Gerstein points out, innovation could equally result from non-hardware items, such as changes to operational concepts, business process reforms, changes to policy or organizations, or new training methods.[100] Gerstein wrote that innovation is simply the result of novel ideas that benefit operational missions.[101] Efficiencies gained in both the administrative and bureaucratic realm can result in substantial benefits to operational missions. Because division innovation cells seek to capture all potential efficiencies gained by harnessing the resourcefulness of the warfighter, this paper adopts the AOC definition of innovation: "the result of critical and creative thinking and the conversion of new ideas into valued outcomes."[102] Of note, the AOC identifies

93. *Id*. at 14.
94. 2014 AOC, *supra* note 90, at 20.
95. *See* Kollars, *War's Horizon*, *supra* note 13, at 533.
96. *See* Michael C. Horowitz & Shira Pindyck, *What is a military innovation and why it matters*, 46 J. OF STRATEGIC STUD. 85-114 (Mar. 22, 2022), https://perma.cc/8ZAH-LXKV.
97. *Id*. at 99.
98. Mahnken et al., *supra* note 88, at 8.
99. Mahnken et al., *supra* note 88, at 8.
100. Gerstein, *supra* note 59.
101. *Id*.
102. *See* 2014 AOC, *supra* note 90, at 20. *See also* U.S. DEP'T OF THE ARMY, ARMY INNOVATION STRATEGY 1 (2017) (adopting the 2014 AOC definition of innovation).

innovation as "particularly important in organizations that develop capabilities *as well as those that train, equip, and sustain forces*."[103]

3. Bottom-Up Versus Top-Down

A crucial distinction for this paper is the difference between bottom-up and top-down innovation. The program-based method of defense acquisition represents the top-down model. Programs, which are a tool for managing the lifecycle of high dollar acquisitions, are part of the DAS, otherwise known as "Little a" acquisitions.[104] Experts at the top of the organization project what technology will be needed for the future fight and create a program of record (POR) to "solve" the capability gap.[105] The problem with this is that the Army is terrible at predicting its future needs.[106]

Then-Captain (Capt.) Joshua Waddell, USMC, argued that DoD programs of record have not generated a return of effectiveness equal to their cost to the government.[107] Two pertinent examples Waddell points to are the "multi-billion dollar aircraft carrier" defeated by "a few million dollars in the form of a swarming missile barrage or a small unmanned aircraft system (UAS) capable of rendering its flights deck unusable" and the "M1A1 tank, which is defeated by $20 worth of household items and scrap metal" when transformed into an Improvised Explosive Device (IED).[108] Waddell laments that the Joint Improvised-Threat Defeat Organization possesses "a library full" of these examples.[109]

The accumulation of these acquisition failures can be attributed to a single truth—peacetime assumptions rarely match wartime realities. Consequently, senior defense leadership has identified the importance of innovating not only from the top-down, but also the bottom-up to keep the U.S. military's strategic edge.[110]

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103. 2014 AOC, *supra* note 90, at 20 (emphasis added).

104. For a description of how DAS fits into "Big A" acquisitions, the three interconnected systems of the DAS, the Joint Capabilities Integration and Development System (JCIDS) and the Planning, Programming, Budgeting and Execution (PPBE) process, see Cox & Vazquez, *supra* note 33, at 84. See Appendix C-1, for a diagram depicting DAS as the "acquisitions" system, PPBE as the "budgetary" system and JCIDS as the "requirements" system, all interconnecting to create the defense procurement system.

105. Lieutenant Colonel Bull Holland, *How the Army Ought to Write Requirements*, MIL. REV. 100 (Nov. – Dec. 2017).

106. For a thorough discussion on how the defense system fails to capture relevant requirements, see *id*. The author excoriates the current acquisition framework, stating that recent Army history is "replete with spectacular acquisition program failures." *Id*. at 101. He continues to cite recent failures, such as the Future Combat Systems (which had a planned cost of $200 billion) and the Crusader self-propelled artillery and Comanche helicopter programs, which cost the Army $9 billion. *Id*.

107. Waddell, *supra* note 85, at 16.

108. *Id*.

109. *Id*. at 17. The Joint Improvised-Threat Defeat Organization (JIDO) is an organization under the Defense Threat Reduction Agency (DTRA) that works to counter improvised threats, such as IEDs and UASs. *See* Jessica Lewis, *Joint Improvised-Threat Defeat Agency Joins DTRA/SCC-WMD as the Joint Improvised-Threat Defeat Organization*, DEFENSE VISUAL INFORMATION DISTRIBUTION SERVICE (DVIDS) (Oct. 3, 2016), https://perma.cc/U3HY-P9E9.

110. *See generally* Larry Lewis et al., CTR. FOR NAVAL ANALYSES, PUTTING INNOVATION INTO PRACTICE (Sep. 2020).

This idea was recently echoed by Army leadership in a tri-signed Message to the Team:

> We will integrate technology faster, pushing new, cost-effective technologies into our operational units as soon as they are useful. *We want our tactical units to innovate, test ideas, fail fast, and adapt. The best ideas often come from the bottom up*.[111]

B. Why Does the DoD Need Bottom-Up Innovation?

When Russia invaded Ukraine in February 2022, it assumed the war would be over shortly.[112] The odds were stacked in Russia's favor: it had almost five times the military personnel, eleven times the defense budget, and nearly eight times the economic power of Ukraine.[113] Not to mention, Russia had significantly more advanced military technology, such as advanced fighter aircraft, tanks, nuclear weapons, and universally feared offensive cyber capabilities.[114] Yet Russian forces have been fighting this war of attrition for over three years now, and have suffered more casualties in Ukraine than all of its previous Post-WWII conflicts combined.[115] How did this "preponderance of power" fail to provide a quick and decisive victory?[116]

While clearly not the only factor, innovation has been indispensable to Ukraine's extraordinary performance against Russia (as exemplified by its use of unmanned aircraft systems (UASs) in combined arms operations) and is likely to become an even more important factor as the war continues.[117] Having created a military culture that enables junior officer ingenuity, many innovations have flowed from the bottom of Ukraine's formation.[118] The Ukrainian Government has encouraged bottom-up innovation from its frontline troops by streamlining direct collaboration between troops and the commercial tech industry. For example, the BRAVE1 initiative is a government-led defense cluster that responds to real-time developments on the battlefield.[119] Additionally, Ukraine has reduced its military product life cycle timeline from over 120 days to less than twenty days by emphasizing almost immediate adoption into service.[120] Through this rapid fielding process, Ukraine has outcycled Russian innovations on the battlefield.

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111. Michael R. Weimer, Sergeant Major of the Army et al., *Message to the Team* (Oct. 26, 2023) (emphasis added).

112. *See generally* Jones et al., *supra* note 3.

113. *Id.*

114. *Id.*

115. *See generally* Jones et al., *supra* note 3.

116. *Id.*

117. Ukraine has utilized a variety of UASs, both military and commercial, to conduct target identification, strikes, surveillance and information operations. *Id.*

118. *Id.*

119. Kateryna Bondar, *How Ukraine Rebuilt Its Military Acquisition System Around Commercial Technology,* CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES (Jan. 2025), https://perma.cc/VC2D-JH8Z.

120. *Id.*

Although military outcomes are not easy to predict, analysts have noted that conventional warfare does not favor the side with the material or technological advantage, especially when the weaker side develops more innovative ways to fight than their adversaries.[121] Innovation provides the advantage of increasing the efficiency of forces, which is important for protracted wars of attrition.[122] As China and Russia close in on the American technological advantage, innovation may very well decide the future fight.

1. The Federal Mandate to Organize for Innovation

Clearly, innovation has been a force multiplier across both time and geography. So why are senior leaders just recently demanding innovation at every level and asserting that innovation is the key to U.S. military dominance? The answer is the nation's return to Great Power Competition (GPC).[123] While the United States was distracted by two decades of counterinsurgency (COIN) and nation-building operations, its near-peer adversaries, Russia and China, rapidly closed in on the technology gap that had made the American military dominant during the Post-Cold War era.[124] In 2016, the House Armed Services Committee emphasized the need for defense reform, stating that "security challenges have become more transregional, multi-domain, and multi-functional" and that the DoD lacked "the agility and adaptability" needed for timely decision-making and "rapid fielding" of emergent capabilities.[125]

In addition to the erosion of the U.S. military's dominance, the character of warfare is rapidly changing due to advancements in cutting-edge technologies.[126] General (Gen.) Mark Milley, then-Chairman of the Joint Chiefs of Staff, pointed to the ubiquity of precision munitions and the information explosion that has enabled militaries the ability to both see and hit at a range "that has never existed before," and stated that this alone indicates a "fundamental change in the character of war."[127] Gen. Milley further identified developments in artificial intelligence, robotics, and hypersonic weapons as examples of the emerging technologies that are changing the conduct of military operations.[128] To make matters worse, the DoD is

121. Jones et al., *supra* note 3.

122. *Id.*

123. For an in-depth overview of the U.S. shift from the Post-Cold War Era to GPC, see Ronald O'Rourke, CONG. RES. SERV. R43838, GREAT POWER COMPETITION: IMPLICATIONS FOR DEFENSE—ISSUES FOR CONGRESS 40 (Feb. 28, 2024), https://perma.cc/VX66-X7LK.

124. NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE, U.S. ARMY FUTURES COMMAND RESEARCH PROGRAM REALIGNMENT (Nat'l Acad. Press vii, 2022) [hereinafter *AFC Research Program Realignment*], https://perma.cc/K6NE-9A3G.

125. Kathleen J. Mcinnis, CONG. RSCH. SERV., R44508, FACT SHEET: FY2017 NATIONAL DEFENSE AUTHORIZATION ACT (NDAA) DOD REFORM PROPOSALS, 1 (May 18, 2017) (citing H.R REP. NO. 114-537 (2017)), https://perma.cc/X5R3-PQYB.

126. *See* 2018 NDS, *supra* note 30.

127. Jim Garamone, *Milley Makes Case for U.S. Military Keeping Up with Global, Technology Changes*, U.S. DEP'T OF DEF. NEWS (Dec. 2, 2022), https://perma.cc/T33V-P2QG.

128. *Id.*

no longer the biggest driver of research and development.[129] As the private sector leads the way, the DoD has become increasingly reliant on the militarization of civilian technologies.[130] In that way, the United States and China are both making the same mistake of looking primarily to the private sector to lead military innovation, instead of harnessing the human potential that is readily available.[131]

In response to these unprecedented challenges, then-Secretary of Defense Jim Mattis directed the DoD to "organize for innovation."[132] Declaring the current bureaucratic approach to defense as problematically risk-averse and unresponsive to the changing operating environment, Secretary Mattis charged service secretaries with restructuring their organizations to empower the warfighter.[133] However, empowerment of the warfighter requires more than just structural change, cultural change must occur as well.

2. A Culture of Innovation Will Decide the Future Fight

A culture of innovation is crucial to our ability to defend ourselves in a protracted war with our adversaries. While the creation of top-down organizations, such as the Defense Innovation Unit (DIU) and Army Futures Command (AFC), are a step in the right direction, these organizations alone will not ensure the innovation necessary to address the U.S. military's eroding advantage.[134] According to Milan Vego, longtime professor of Joint Military Operations at the Naval War College, experience has repeatedly shown that novel technologies alone are insufficient to win wars.[135] Defense innovation expert Nina Kollars furthers this argument, positing that innovation itself cannot occur without the expertise of Soldiers as innovation requires more than just new ideas or technologies, it requires the integration

129. Benjamin Jensen, *Thinking Bigger: The Third Offset and Extending the Battlefield*, WAR ON THE ROCKS (Dec. 12, 2016), https://perma.cc/9CFA-2MZA (asserting that "[u]nlike the Cold War, government research labs and defense contractors are not in the lead in key areas such as robotics and artificial intelligence.").

130. *See* Richard B. Clifford, Jr, Deputy General Counsel for Acquisition, Technology and Logistics, HEADQUARTERS U.S. DEP'T OF THE AIR FORCE, SPACE ACQUISITION (Apr. 19, 2024) (unpublished PowerPoint presentation) (on file with author). For example, the first space age (from the launch of Sputnik through the collapse of the USSR) was characterized by exclusively government space exploration. *Id*. The second space age (from 1991 through 2015) the space industry was still dominated by the government, but policies began to encourage and accelerate private industry in space. *Id*. In the third space age, the commercial industry is outpacing both the DoD and NASA, with the DoD now relying on the private sector to bolster the resilience of critical space infrastructure. *Id*.

131. *See generally* Licata, *supra* note 8; Jensen, *supra* note 129.

132. 2018 NDS, *supra* note 30, at 10.

133. *Id*.

134. Gerstein, *supra* note 59. In 2015, DIU was the first organization formed for the purpose of fostering defense innovation; it was created to serve as a bridge between the military services and the tech industry that had taken the lead in research and development. *See* Smith, *supra* note 86, at 12. Soon after, the DoD established AFC in 2018 to improve Army acquisitions in the pursuit of modernization. *See id*.

135. Vego, *supra* note 84, at 84.

and implementation of these ideas into the system.[136] This critical integration and implementation of new capabilities and methods will only happen with bottom-up input, as top-down organizations are divorced from the reality that Soldiers face on the ground.[137] Unfortunately, warfighters are often viewed by these organizations as neutral at best and as a conceptual drag at worst, when these organizations should be desperately seeking a way to incorporate the expertise of the combat-informed warfighter. Large bureaucratic organizations are inherently resistance to bottom-up feedback because they disrupt established procedures. In these organizations, the procedures became the ends, creating a self-licking ice cream.[138]

Academics like Kollars and Vego are not the only advocates for bottom-up input. Military officers have also identified the gap between advanced technology and successful implementation. In 2008, then-Major Michael B. Siegl proposed culture as the bridge to this gap:

> Military culture is the linchpin that helps determine the ability to transform because it influences how innovation and change are dealt with. Its implications for U.S. military transformation are thus profound. The ability to harness and integrate technological advances with complementary developments in doctrine, organization, and tactics is dependent on the propensity of military culture to accept and experiment with new ideas. Therefore, focusing on developing and shaping a military culture amiable to innovation and continuous change will help create the conditions for current transformation efforts to be effective and successful.[139]

A decade later, then-Colonel John Cogbill acknowledge the importance of a culture of innovation, as it "enables critical thinking and the application of the myriad emerging military and commercial technologies" which is necessary to "address the full spectrum of national security challenges that exist in an increasingly hostile and complex world."[140] A culture of creativity would provide warfighters with "the top cover they need to experiment, the psychological safety to fail, and the rewards and recognition to motivate and sustain their efforts when the innovation journey becomes long and difficult."[141]

Developing a culture of innovation is no simple task. The very nature of the military pushes against the creativity needed to innovate as the highly stratified organization requires prompt, unquestioning obedience in the execution of

136. Kollars, *Genius and Mastery*, *supra* note 37, at 135. Kollars advocates for the active participation of Soldiers in the innovation process, because "actual innovation" requires experienced practitioners to "reorder existing systems to incorporate" any top-down innovations. *Id*. at 126.

137. *Id*. at 125. As an example of the distance between top-down organizations and the warfighter on the frontline, Kollars notes how the Defense Innovation Board (an independent advisory board created to propose creative solutions to DoD challenges) is staffed not by seasoned veterans, but by corporate geniuses such as Amazon's Jeff Bezos and astrophysicist Neil deGrasse Tyson. *See id*.

138. *Id*. at 126.

139. Major Michael B. Siegl, *Military Culture and Transformation*, 46 JOINT FORCES Q. 103-106, 103 (2008), https://perma.cc/7BLE-ZLE5.

140. Colonel John P. Cogbill, 101st Airborne Division, *Innovation in the Army needs to come from the top down and the ground up*, U.S. ARMY (Jun. 12, 2018), https://perma.cc/MKD4-FNMR.

141. Theodotou, *supra* note 57.

orders.[142] Elaborating on this conundrum, Vego identifies the military's inherent hierarchical command structure as preventing innovation.[143] Vego describes this structure as "authoritarian" and its thinking as exemplified by "groupthink, parochialism, dogmatism, intolerance, and anti-intellectualism."[144]

The inherent contradiction of the military's nature is that it operates on conformity, but has a paramount need for creativity lest it be "doomed to failure" in the supreme test of war.[145] Highlighting this paradox, and in a somewhat ironic move, the Army has recently ordered subordinate units to innovate.[146] In response, division and corps commanders are empowering their soldiers by establishing innovation cells, which in turn is fostering an innovative culture.

C. The Current State of Bottom-Up Innovation: Division Innovation Cells

While the recently published Continuous Transformation EXORD has officially ordered operational units to begin innovating, Soldiers within the XVIII Airborne Corps have been innovating much longer.[147] Soldier innovation with university partners began as early as 2018 when members of the 3d Brigade Combat Team of the 101st Airborne Division (Air Assault) used a 3-D printer at Vanderbilt University's Mechanical Engineering Department to create demolition components in response to the "product acquisition challenges" that they were facing in their unit.[148] Soon after, the XVIII Airborne Corps created EagleWerx at the 101st Airborne Division (Air Assault) and later followed with the Airborne Innovation Lab at the 82nd Airborne Division, thus beginning the era of the division innovation cell.[149]

1. Division Innovation Cells

Division innovation cells were created to capture end-user solutions to Soldier-defined capability gaps.[150] The physical makerspace housing EagleWerx was dubbed the Applied Tactical Innovation Center (ATIC) when it opened its doors in 2021 as part of The U.S. Army Combat Capabilities Development Command

142. Vego, *supra* note 84, at 84.
143. *Id.*
144. *Id.*
145. *Id.* at 85.
146. *See* EXORD 138-24, *supra* note 63.
147. *Id.*
148. Major John Moore, *"Rak Solid" Rakkasans Design 3-D Parts at Vanderbilt University*, DEFENSE VISUAL INFORMATION DISTRIBUTION SERVICE (DVIDS) (Aug. 9, 2018), https://perma.cc/FU63-VF6K. Later the Soldiers successfully tested these 3-D printed components on a demolitions range. Kyle A. Davis, *WATCH: Fort Campbell soldiers test explosives with 3D-printed materials*, CLARKSVILLE NOW (Aug. 30, 2018), https://perma.cc/7PZ7-QG6Z. While there are many potential risks inherent to 3-D printing explosive components (e.g. liability, intellectual property rights, etc.), these risks will not be discussed in depth as they detract from the focus of this paper. For further discussion on the importance of oversight in innovation, see *infra* Section III.B.
149. Ethan Steinquest, *Fort Campbell's EagleWerx Empowers Soldiers' Innovative Solutions*, U.S. ARMY (Sep. 10, 2021), https://perma.cc/7LV2-L4CY.
150. *See generally* Roederer, *supra* note 34.

Army Research Laboratory's (DEVCOM-ARL) Catalyst-Pathfinder (Cat-Pat) program.[151] In addition to standing up innovation cells across the XVIII Airborne Corps, DEVCOM-ARL's Cat-Pat program has advanced relationships with the innovation cells at the 10th Mountain Division and the 25th Infantry Division.[152] These makerspaces are supported by DEVCOM-ARL, which provides equipment and personnel to include entry level AI access, robotics equipment, digital fabrication capability, engineer support, and design thinking education.[153] As one manger stated, innovation hubs are "a great place for [S]oldiers to explore their ideas and generate solutions for immediate impact within their units."[154]

Empowered by the opportunity, warfighters have developed solutions as remarkable as they are varied. Some of these solutions work to protect gear or provide replacement parts, such as the cases for Joint Battle Command Platform (JBCP) hard drives or the boresight end caps created for Abrams tanks.[155] Some are focused on increasing the efficiency of warfighter tasks, such as the modular ammo bag designed by assistance gunners that enabled them to simultaneously feed the rounds faster while still keeping them free from dirt and debris.[156] Some have addressed gaps in safety, such as the 3-D printed mortar iron sight developed by infantrymen to make the direct fire process both safer and more accurate.[157] Some solutions are novel training aids, such the low-cost ($64) emitter that enabled realistic electromagnetic warfare (EW) training.[158] In addition to the above, below are a few examples of Soldier-led innovations that have made a difference.

2. Soldier Innovations

In August of 2022, a young non-commissioned officer (NCO) won the seventh iteration of Dragon's Lair, a Shark Tank style competition developed by the XVIII Airborne Corps to showcase and promote innovation within its formation.[159] Relying upon his skills as a 91E (an Allied Trade Specialist according to the U.S. Army, but a Welder and Machinist, according to him,) Sergeant Roger

151. *See* Staff Sgt. Sinthia Rosario, *EagleWerx ATIC opens its doors to Screaming Eagle Soldiers*, U. S. ARMY (Dec. 7, 2021), https://perma.cc/NPA7-RHEV.

152. *See* Dr. Arwen DeCostanza, Catalyst Pathfinder Program Overview, at slide 7 (Mar. 9, 2023) (unpublished PowerPoint presentation) (on file with author).

153. *See* Rosario, *supra* note 151.

154. *3rd Infantry Division Opens Marine Innovation Center*, CIV.-MIL. INNOVATION INST. [hereinafter *Marine Innovation Center*], https://perma.cc/AM2P-H7G6.

155. *Marine Innovation Center*, *supra* note 154.

156. *See* Colin Demarest, *How 101st Airborne Soldiers Are Using EagleWerx Makerspace to Innovate*, C4ISRNET (Apr. 25, 2023), https://perma.cc/SN2W-XA28.

157. *See id*. Prior to their invention of the mortar sight, the Soldiers were taught to use their thumbs to aim the mortar, being sure to "sweep the tube" of their hand before firing. *Id*. This had led to "gruesome" injuries in the past, such as a Soldier whose hand had been split "like a hoagie sandwich bun" after failing to pull his hand away in time for the projectile to leave the tube. *Id*.

158. *See* Lauren Hansen-Armendariz, *Innovation Culture: Competitions and Conflicts*, LINKEDIN (Oct. 17, 2023), https://perma.cc/MA5F-74WN.

159. Specialist Jasmalyn Sihakhom, *NCO, Welder Selected as Winner for Dragon's Lair 7*, U.S. DEP'T OF DEF. (Aug. 17, 2022), https://perma.cc/XSU2-VHHG.

Litton fabricated a post pile driver attachment to a hydraulic excavator that increased bridge building efficiency by 25%.[160] He identified an area for improvement (increasing the efficiency with which bridges, ports, and docks are built) and worked tirelessly to develop a solution to support the engineer Soldiers in his unit.[161]

In March of 2023, 1st Lieutenant Chris Aliperti and Private Salem Ezz won Dragon's Lair 8 with their Mold Conditions Awareness Tool (MCAT).[162] The idea for the MCAT came to Ezz when his fellow Soldiers, having just returned from deployment, began complaining of mold in their barracks rooms that had grown while they were downrange.[163] The Soldiers took to social media, posting photos of barracks' walls covered with rings of black mold and fungus-lined air vents that had spread to the Soldiers' uniforms and furniture in their absence.[164] In collaboration with Lieutenant Aliperti, Ezz created the 3-D printed device, which monitors the temperature and humidity levels within the rooms and alerts barracks managers when levels reach thresholds favoring mold growth.[165]

Later that year, the Government Accountability Office (GAO) recognized the barracks mold issue in their report, noting that the DoD conducts "insufficient oversight," citing its failure to track barracks conditions or enable collaborative initiatives that would improve barracks.[166] Private Ezz's MCAT tool enables both tracking and collaboration – it tracks metrics that are predictive of mold (storing them in an app for future analysis of historical trends) and it empowers multiple decisionmakers with data, allowing Soldiers, NCOs and the Department of Public Works (DPW) to collaborate in the fight against barracks mold.[167]

III. THE CHALLENGE: FUNDING DIVISION INNOVATION CELLS AND SCALING THEIR SOLUTIONS

Clearly, Soldiers are up to the challenge of filling in the gaps where they see them, but some analysts still dismiss their work as "innovation theater."[168] A stinging critique of division innovation efforts asserts that such innovations are "all presentation with little purpose" that allow commanders to put their legacies

160. *See* 91E *Allied Trade Specialist*, U.S. ARMY, https://perma.cc/S3MH-D3R5; Sergeant Summer Keiser, *Sgt. Roger Litton presents Pile Driver Attachment for Dragon's Lair 7*, ENERGY, INSTALLATIONS, AND ENV'T. (Aug. 11, 2022), https://perma.cc/G57E-GBX4; Sihakhom, *supra* note 159. For a picture of the post pile driver attachment in action, see *infra* Appendix B-1.

161. *See* Keiser, *supra* note 160.

162. Sergeant Jameson Harris, *Innovation Champion: 3rd Infantry Division Soldiers Named Winners of Dragon's Lair 8*, U.S. DEP'T OF DEF. (Apr. 10, 2023), https://perma.cc/NR4A-3PN3.

163. Patty Nieberg, *To battle moldy barracks, Fort Stewart soldiers built their own mold detectors*, TASK & PURPOSE (Oct. 6, 2023), https://perma.cc/UC9H-63VU.

164. *Id.*

165. *Id*. For a depiction of the MCAT interface, see *infra* Appendix B-2.

166. U.S. GOV'T ACCOUNTABILITY OFF., GAO-23-105797, MILITARY BARRACKS: POOR LIVING CONDITIONS UNDERMINE QUALITY OF LIFE AND READINESS (2023).

167. *See generally* Nieberg, *supra* note 163.

168. *See generally* Todd Harrison, *Bad Idea: Innovation Theater*, DEFENSE360 (Feb. 27, 2023), https://perma.cc/3X3N-V42G. While the DoD leadership seems enthusiastic about soldier-led innovation, Harrison points out how very few if any of these ideas are produced at echelon.

on show "but, after the credits roll, nothing moves into research, development, procurement or implementation for the force."[169] After eight iterations of Dragon's Lair, not a single innovation has made it back to the troops as neither the Army nor the XVIII Airborne Corps have implemented any of the presented warfighter solutions.[170]

While this fact may be surprising to some, those who have experienced defense procurement might have predicted that each winning idea would eventually run into "the brick wall of Defense Department bureaucracy."[171] The problem remains that corps and divisions were not designed to conduct research activities, and as a result, they are ill-equipped to do so. Two of the biggest challenges standing in the way of successful warfighter innovation are the lack of funding and the lack of organizational support.[172]

A. Funding Division Innovation Cells

Fiscal Law was designed to be inherently restrictive.[173] As a power check over the Executive Branch, the Legislature reserves the "Power of the Purse" in Article 1, Section 7, Clause 1 of the U.S. Constitution, which provides, "[n]o Money shall be drawn from the Treasury, but in Consequence of Appropriations made by Law . . . ."[174] An appropriation is the statutory authorization for an organization to incur obligations and make payments out of the U.S. Treasury. Before an organization can spend money, it must be appropriated by Congress.[175] Section 1301(a) of Title 31 of the U.S. Code states, "[a]ppropriations shall be applied only to the objects for which the appropriations were made except as otherwise provided by law."[176]

The current appropriations structure assumes a linear lifecycle of products, but due to the accelerated development of technology, this structure no longer fits the way business is done today.[177] In recognition of this, Congress established the Commission on PPBE Reform in the Fiscal Year 2022 National Defense Authorization Act (NDAA), charging the commission with finding ways to

169. *See generally* Colonel (Retired) Joe Buccino, *Innovation Overload: Army Units Are Drowning in Ideas*, MILITARY.COM (Sep. 19, 2023), https://perma.cc/LC3S-S6R7.

170. *Id.*

171. *Id.* See Appendix C-2 for a depiction of the defense procurement system expressing frustration with the intricate bureaucracy that has developed over time.

172. These issues have not gone unnoticed. Much ink has been spilled on the glaring need for defense acquisition reform as the current system rewards the professionalizing of the process over the delivery of results. *See* Hon. Mac Thornberry et al., *An Innovation Strategy for the Decisive Decade*, DEF. INNOVATION BOARD 3 (Jul. 17, 2023) [hereinafter DIB Innovation Strategy], https://perma.cc/UH46-YVHG.

173. U.S. CONST, Art. I, § 9, cl. 7.

174. *Power of the Purse,* U.S. HOUSE OF REPRESENTATIVES: HISTORY, ARTS & ARCHIVES, https://perma.cc/9JXA-CMNS.

175. United States v. MacCollom, 426 U.S. 317, 319 (1976). "[T]he established rule is that the expenditure of public funds is proper only when authorized by Congress, not that public funds may be expended unless prohibited by Congress." *Id.*

176. 31 U.S.C. § 1301(a) (2024).

177. See Section II.B.1. for a discussion on the proliferation of technology and its impact on national security.

improve the funding portion of the "Big A" acquisitions process.[178] The results were stunning.

The commission recommended the creation of an entirely new process that enables the DoD to effectively respond to emerging threats while leveraging technological advances.[179] In describing the problem, the commission cites how appropriations reflect the traditional lifecycle phases of industrial production (i.e., Research, Development, Test and Evaluation (RDT&E), Procurement, and Operation and Maintenance (O&M)).[180] This is problematic because the traditional industrial production cycle no longer reflects the reality of modern procurement.[181] In the current defense environment, decisionmakers focus on capabilities, and this mismatch between the incumbent system and the needed system cripples the Department's ability to get equipment to warfighters in a timely manner.[182]

1. The Lack of RDT&E Funds at Divisions Creates Inefficiencies

An example of how funds can get tangled is beautifully illustrated by the Commission on PPBE Reform's report:

> Financial managers and fiscal attorneys spent considerable time assessing and determining [what] represented a true upgrade in capability (RDT&E funded) vice basic sustainment (O&M funded), even though there is no such distinction to the [capability] developer. A realignment of funding was required to fully fund the [project], creating execution delays and further pressure on the program since O&M funds would soon be expiring.[183]

While this describes the specific issue surrounding software patches, the same issues apply to hardware solutions. For example, a Soldier additively manufactures a propeller system to increase the flight time and reduce the noise signature of the RQ-11B Raven (Raven) Unmanned Aircraft System (UAS).[184] Is this a true upgrade in capability?

Even with hardware, concurrency (the overlap of development and procurement) has been identified as the "new norm."[185] In practice this is a problem as the progressively blurring line between O&M and RDT&E appropriate expenditures

178. *Defense Resourcing for the Future*, COMMISSION ON PLANNING, PROGRAMMING, BUDGETING, AND EXECUTION REFORM 1 (Mar. 6, 2024) [hereinafter *Commission on PPBE Reform*], https://perma.cc/S27Q-9BU2. *See supra* note 104 and accompanying text tor a discussion on the "Big A" acquisitions system.

179. *Commission on PPBE Reform*, *supra* note 178.

180. *Id.* at 7.

181. *Id.*

182. *Id.*

183. *Commission on PPBE Reform*, *supra* note 178, at 84.

184. Steinquest, *supra* note 149.

185. *Commission on PPBE Reform*, *supra* note 178, at 88.

can expose commanders to unnecessary risk in the form of Antideficiency Act (ADA) violations.[186]

2. The Lack of RDT&E Funds at Divisions Exposes Commanders to Risk

Funds must be used for their proper purpose.[187] A proper purpose is found either through express statutory purpose or by meeting the necessary expense rule.[188] The necessary expense rule has three requirements: (1) that the expense is logically related to the appropriation's purpose; (2) that the expenditure is not prohibited and (3) that the expenditure is not otherwise provided for by another appropriation.[189]

The express statutory purpose is provided by Congress through appropriation acts.[190] RDT&E funds are appropriated for "expenses necessary for basic and applied scientific research, development, test and evaluation, including maintenance rehabilitation, leave, and operation of facilities and equipment."[191] O&M funds are defined in the negative, as being appropriated for "expenses, not otherwise provided for, necessary for the operation and maintenance of the [Service] as authorized by law."[192] More specifically, the Defense Acquisition University (DAU), posits that O&M funds are for expenses "not related to military personnel or Research, Development, Test, and Evaluation (RDT&E) efforts."[193]

Failure to use these funds for their designated purpose can result in violations of the ADA. The ADA prohibits federal employees from obligating or expending federal funds in advance or in excess of an appropriation.[194] Furthermore, it requires agency heads to immediately report "relevant facts and a statement of actions taken" all the way up to both the President and Congress.[195] Violations are taken seriously and can result in both criminal and administrative penalties.[196] Practically applied, this means that commanders are exposed to unnecessary administrative and penal risk due to the discrepancy between their mandate to innovate and the fiscal structure that was not built for innovation.

186. *Id*. at 84 (noting that 13 reported ADA violations between FY 2011 – FY 2022 involved the incorrect use of O&M funds).

187. 31 U.S.C. § 1301(a) (2024).

188. Secretary of Interior, B-120676, 34 Comp. Gen. 195 (1954).

189. *Id*.

190. CONTRACT AND FISCAL L. DEP'T, JUDGE ADVOC. GEN.'S LEGAL CTR. & SCH., FISCAL LAW DESKBOOK para. IV.B (2023). Through two annual appropriations acts, Congress grants multiple appropriations for the DOD to successfully execute its mission. *Id*.

191. Consolidated Appropriations Act, 2023, Pub. L. No. 117-328 Div. C, Title IV (2023).

192. *Id*. at Title II.

193. *Operations and Maintenance (O&M) Funds*, DEF. ACQUISITION U. https://perma.cc/K6PS-6STE.

194. 31 U.S.C. § 1341(a)(1)(A) (2024). See also Major Russel R. Henry, *Keep Your Commanders off the Fiscal Naughty List–How to Spot and Prevent Common Antideficiency Act Violations*, ARMY LAW. 16-24 (2016) for an in-depth discussion of the ADA as it relates to military commanders.

195. 31 U.S.C. § 1517(b) (2024).

196. 31 U.S.C. § 1349(a) (2024) (authorizing appropriate administrative discipline to include removal from office); 31 U.S.C. § 1350 (2024) (authorizing fines up to $5000 and imprisonment for two years).

B. Scaling Solutions: Bridging the Valley of Death

Assuming that division innovation cells can avoid the trap of ADA violations, how can they rise above "innovation theater" and implement their novel solutions across the formation, or even across the entire force?[197] Even in the commercial sector, the scaling of prototypes is notoriously difficult. This gap between an innovative concept and its full-scale production is colloquially known as the "valley of death."[198] As applied to the government, the valley of death can be described as the gap between the end of public funding (e.g. the creation of the innovative concept or product by the DoD) and the start of private-sector funding (ex. a government contractor producing a prototype for the military).[199]

There are many theories behind what causes the dreaded valley of death. One theory is that good ideas fail to launch due to the government's inflexible program planning system and protracted execution timelines.[200] Another posits that it is the result of the shift in government focus from traditional contractors to start-up companies in the pursuit of innovation.[201] One insider quipped that the valley of death does not exist, but it is simply a phrase developed to gloss over the DoD's gross mismanagement of acquisitions.[202]

According to then-Captain Lauren Hansen, the former Deputy Innovation Officer of the 101st Airborne Division (Air Assault), part of the valley of death problem is attributable to the organizational resistance to bottom-up input.[203] This makes sense as it relates to division innovation cells because they are untethered from the broader institution that was designed with the capabilities and resources to implement novel concepts and technology.[204] This untethering from the broader institution provides freedom from bureaucratic processes that would otherwise slow the innovative process. While nobody would argue with the fact that these bureaucratic processes "take too long," they are in place for a reason.[205] Many of these processes represent a judicious balance of competing values, and following some of these processes is essential to scale these innovations.[206]

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197. *See generally* Buccino, *supra* note 169.

198. *See generally* Yoshitaka Osawa & Kumiko Miyazaki, *An empirical analysis of the valley of death: Large-scale R&D project performance in a Japanese diversified compan*y, 14 ASIAN J. OF TECH. INNOVATION 93-116 (2006).

199. See Appendix C-3 for a diagram depiction of the concept, labeling the "valley of death" as a "GAP" between the government and private-sector efforts.

200. *See* DIB Innovation Strategy, *supra* note 172.

201. *See* Richard Tippitt & Sherman Williams, *The US Government's Innovation Valley of Death*, AIN VENTURES (Apr. 1, 2022), https://perma.cc/29EE-E2E4.

202. *See* Colonel (Retired) Bull Holland, *Research is Reconnaissance*, ARMOR & MOBILITY 22 (Oct. 2020).

203. Captain Lauren Hansen-Armendariz, Soldier Innovation for Transformation (Mar. 9, 2022) [hereinafter *Soldier Innovation for Transformation*] (unpublished paper) (on file with author).

204. Buccino, *supra* note 169.

205. Memorandum from Acting Sec'y of the Army to Principal Offs. of Headquarters, Dep't of Army et al. on Army Directive 2017-33 (Enabling the Army Modernization Task Force) encl. 1, para. 1 (Nov. 7, 2017).

206. *See* DR. ROBERT G. SPULAK, JR, INNOVATE OR DIE: INNOVATION AND TECHNOLOGY FOR SPECIAL OPERATIONS (Dec. 2010) (acknowledging the many competing values balanced by the conventional

1. Ethics

Hidden ethical violations could have negative effects to not only the ability to implement innovations across the force, but also on individual Service Members who risk facing criminal liability for violating statutory restrictions. As the targeted audience for division innovation cells, junior Soldiers and Officers may not understand their ethical obligations as federal employees. Congress has placed representational restrictions on all officers and employees of the United States so that they cannot request or offer any compensation on behalf of another person or entity (such as a start up created to champion an innovation.)[207] Soldiers can also unknowingly create a conflict of interest when developing a concept or technology that they might later seek to sell back to the military.[208] Additionally, Service Members are prohibited from receiving payment from non-federal sources if the work was performed as part of their official duties.[209] While it may seem easy and obvious to avoid these behaviors in the abstract, those who are not primed to spot these issues can often miss them. Arguably, division legal staff could screen for these issues when reviewing innovation activities at their installation, but these offices are often stretched thin and lack specialization in this area.

2. Contracting and Intellectual Property

If the unit intends to provide an innovation for later purchase by a government entity, such as the unit or the Army, it must take great caution in its execution of innovation. This is because if they are executed in certain manners, units can unknowingly prevent the innovation's later procurement due to the statutory and regulatory structure that has developed around defense acquisition. For example, the government contracting system operates from the premise that "full and open competition" will achieve the best return on the government's investment, thus "sole sourced" cannot be purchased without following the proper processes and providing the proper justifications.[210] Additionally, providing excessive feedback to potential contractors (such as during collaboration with university students and professors), could disqualify the potential contractor from the competition.[211]

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acquisition process, to include cost, performance, interoperability, availability, fair competition, affordability, and supportability).

207. 18 U.S.C. § 203 (2024); 18 U.S.C. § 205 (2024); 18 U.S. Code § 216 (2024) (authorizing penalties for the violation of these statutes, to include imprisonment and fines).

208. *See* 18 U.S.C. § 208 (2024); 5 C.F.R. § 2635.402 (1992) (integrating the statutory prohibition on substantial participation in matters under which the federal employee has a disqualifying financial interest).

209. 18 U.S.C. § 209 (2024); *see also* DOD DIRECTIVE 5500.07-R, JOINT ETHICS REGULATION, para 5-404.

210. *See* U.S. GOV'T ACCOUNTABILITY OFF., GAO-10-833, FEDERAL CONTRACTING: OPPORTUNITIES EXIST TO INCREASE COMPETITION AND ASSESS REASONS WHEN ONLY ONE OFFER IS RECEIVED (Aug. 25, 2010).

211. Major Christina K. Colclough, Legal Issues Related to Operational Unit Innovation Efforts for Legal Offices 15 (Apr. 19, 2023) (unpublished information paper) (on file with author).

To ensure fair competition, Army policy restricts Soldier feedback on emerging products to within the current acquisitions bureaucracy.[212]

In the digital and information age, the creation of new processes and products often elicit issues with intellectual property (IP). Intellectual Property law is a complicated and niche practice, thus the assistance of experts should be sought early on to avoid either the violation of IP rights or the potential loss of IP.[213] An example of the complications that could arise can be seen in a single iteration Dragon's Lair. When warfighters submit their ideas through public-facing websites, this could create an inadvertent and intentional disclosure of details that could result in the loss of a future patent, claims to trade secrets, copyrights, and trademarks.[214]

3. Technology, Transfer, and Transition (T3)

Assuming that, having navigated all potential ethical, contractual, and other legal obstacles, the next question becomes: what tools are available for a division to scale their winning ideas? Once an operational unit has identified a capability gap and demonstrated their need to industry, it has limited options for T3 (i.e. prototype development and maturation). Division innovation cells currently rely on two rapid acquisition authorities: Educational Partnership Agreements and Cooperative Research and Development Agreements.

Educational Partnership Agreements (EPAs) are formal agreements between an educational institution and a defense laboratory that enable technology transfer "for the purpose of encouraging and enhancing study in scientific disciplines at all levels of education."[215] With EPAs, defense laboratories can loan equipment and make personnel available to educational institutions, such as local universities.[216] No funds can be exchanged through EPAs as they are not contracts for goods or services.[217] The biggest advantage of EPAs is that operational commanders can enter into them without the need for approval from a higher level as the statute includes "operational commands" under the statute's definition of "defense laboratory."[218]

Cooperative Research and Development Agreements (CRADAs) are agreements between "Federal laboratories" and "non-Federal parties" under which the Government and the non-Federal party "provide funds, personnel, services, facilities, equipment, intellectual property, or other resources" for the purposes of research and development efforts.[219] The purpose of CRADAs is to facilitate licensing of inventions developed during the collaboration between the

212. OFF. OF THE SEC'Y OF THE ARMY., DIR. 2022-07, ARMY MODERNIZATION ROLES AND RESPONSIBILITIES 3 (2022).
213. *See* Colclough, *supra* note 211, at 9.
214. *See id.*
215. 10 U.S.C. § 2194 (2024).
216. *See id.*
217. *See id.*
218. *See id.*
219. 15 U.S.C. § 3710a(d)(1) (2024).

government lab and the non-government entity, which can be state or local governments, industrial organizations, nonprofits, or other persons.[220] In contrast to EPAs, operational units do not qualify as a federal "laboratory" under the CRADA statute, and therefore, they cannot enter into these agreements directly and must seek out a federal laboratory to facilitate the relationship.[221]

IV. THE SOLUTION: FLEXIBLE FUNDING AND ORGANIZATIONAL INFRASTRUCTURE FOR SOLDIER INNOVATIONS

In 2024, Lt. Gen. Chris Donahue, the then-XVIII Airborne Corps Commander, was featured on the Defense Mavericks podcast where he discussed the innovation efforts within his formation. Lt. Gen. Donahue observed that, "[i]nnovating is easy, making it part of a process . . . That's the real magic." [222] This observation speaks to the biggest roadblock to innovation. The end goal should be a system that effectively and efficiently encourages and absorbs innovations by Soldiers such as Sergeant Litton and Private Ezz so that it can rapidly distribute the advantages to the wider force.[223] However, in order for this to happen, two different lines of effort must be supported to overcome the aforementioned challenges: (1) flexible funding and (2) the ability to bridge the valley of death to bring impactful innovations to scale, as provided by a designated organizational infrastructure for Soldier innovations.

A. Flexible Funding: an RDT&E Addition to the Expense/Investment (E/I) Threshold

The Continuous Transformation EXORD acknowledges the "budget" as one of the confines of our system that commanders must work within.[224] This is especially true given the restrictive fiscal law system that Congress has prescribed.[225] Currently, Army innovation cells operate without specific innovation or research designated funds at the division or even corps level.[226] While the Army could provide an analog to the Squadron Innovation Funds (SIF) that the Air Force has provided for their operational innovation cells, this would still not solve the problem as these funds are still the wrong "color" for use in prototyping.[227] In reviewing the first two years of the AFWERX program (the Air Force's response to the

220. *Id*. at (a)(1) (2024).

221. 15 U.S.C. § 3710a (2024).

222. Defense Mavericks, *Empowering Soldiers in the Digital Age with LTG Chris Donahue*, DEF. MAVERICKS (Feb. 13, 2024), https://perma.cc/F6VH-CWLV.

223. *See generally infra* Section II.C.2.

224. EXORD 138-24, *supra* note 63.

225. *See generally* Major David M. Jones, *To Buy or Not to Buy? So Many Questions: How Judge Advocates Can Find Purpose to Spend Appropriated Funds*, ARMY LAW. (Jan. 2017).

226. Roederer, *supra* note 34, at 5.

227. *The Air Force Innovation Handbook*, AFWERX 68. "[O]ne of the important ground rules of the SIF program is that all purchases made with Squadron Innovation Funds must meet Operations and Maintenance (O&M) funding rules at a minimum. Additionally, SIF funds should not be used to fill unmet needs that should be funded with other funding sources. *Id*. "Color" of money refers to the appropriations as corresponding to their lifecycle phase (i.e., Research, Development, Test and

mandate to organize for innovation) the lack of RDT&E funds was identified as an issue given that this limited the expenditure of SIF to O&M type-expenditures such as travel, professional services, and purchasing of commercial off the shelf (COTS) items.[228] The inherent problem with funding operational innovation is that there are no organic RDT&E funds available for the operational units that host division innovation cells.[229]

Currently, operationalized innovation is supported by DEVCOM-ARL's Cat-Pat program. However, there are two issues with this method. The first is that the most expedient and efficient way for operational units to resource innovation is organically, with their own funds. DEVCOM-ARL currently provides the equipment to set up division innovation cells, but many more expenses are accrued from the makerspace (e.g. the cost of the building, utilities, expendables such as lubricants and materials). As previously detailed, modern technology is not only changing the character of warfare, it is also making it incredibly difficult to discern whether any changes made are upgrades (and thus require RDT&E dollars) or if they are merely acts of sustaining (and thus it is permissible to expend O&M).[230] If organic units had the capability to spend on research, design, technology and engineering efforts, the scope of their abilities would expand, as would the ability for Soldiers to provide their solutions to identified capability gaps. The second issue is more pressing—the lack of RDT&E availability at the operational level leaves commanders open to inadvertent ADA violations.[231] Thus commanders seeking to execute their mission to innovate are caught in between the Continuous Transformation EXORD and an outdated fiscal structure.[232]

To solve this issue, this paper proposes an RDT&E addition to the Expense/Investment (E/I) threshold. Statutory authority to execute low-cost research and development efforts with O&M funds would free commanders from the ADA trap and increase efficiency at division innovation cells. Since 1986, every DoD appropriations act has contained a provision authorizing the use of O&M funds for investment items up to a certain dollar amount.[233] Recently, the E/I was increased, allowing commanders to use O&M funds on investment items (that would otherwise be funded with Procurement funds) costing up to $350,000.[234] By expanding the current E/I threshold authority to include RDT&E, division and corps level units could flexibly fund the low-cost research and development

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Evaluation (RDT&E), Procurement, and Operation and Maintenance (O&M)), as described in *infra* Section III.A.

228. Dr. Brian E. A. "Beam" Maue, *Empowering Next Generation Innovators and Innovations*, AFWERX 69 (2021).

229. *See* Roederer, *supra* note 34, at 5.

230. *See infra* Section III.A.1.

231. *See infra* Section III.A.2.

232. *See generally* EXORD 138-24, *supra* note 63.

233. Cora, *supra* note 43, at 10.

234. Memorandum from Under Sec'y of Defense to Principal Offs. of Headquarters, Dep't of Army et al., on OUSD(C) Interim Guidance Regarding Increased Threshold for Determination of Expense and Investment Costs (FPM 23-02) (Mar. 22, 2023).

efforts of their warfighters.[235] The major drawback of this solution is that it does not provide additional funding to commanders, nor does it support the research and development of high-cost projects. However, the primary benefit is that it is a minor change to the appropriations framework and does not require additional funding, therefore it is more likely to receive congressional approval.

While flexible funding for innovation cells would be a huge step in the right direction, the ingenious products and procedures developed by our talented warfighters will continue to languish until an organizational structure is created to capture and scale them.

B. Organizational Infrastructure: A Soldier-Innovation Cross Functional Team (CFT) at Army Futures Command (AFC)

As illustrated by the example of gun trucks in Vietnam, and then again in Iraq, it is not enough to simply encourage Soldier-led innovation.[236] Because the innovators in Vietnam made no concerted effort to centralize their field adaptations, the developed solutions varied largely and failed to build upon each other.[237] Even worse, solutions were "lost, or reinvented and duplicated under the fog of war."[238] Conversely, the unintentional, yet centralized innovation hubs in Iraq resulted in truck designs and unified tactical manuals.[239]

In her paper, then-Captain Hansen-Armendariz, a former EAGLEWERX innovation officer, suggested a Soldier Innovation CFT as a way to unify the management and oversight of the activities at division innovation cells.[240] The advantage of a Soldier-Innovation CFT is it would capture the accumulated small wins of end-user solutions and enable these efficiencies to be spread across the force. Without a strategic-level champion to prioritize and push their ideas, the reality is that most of these Soldiers' innovations will simply never bear fruit. The ability for operational units to directly coordinate with a CFT would open doors that could enable senior leaders to capitalize on the ingenuity of their entire workforce.[241]

1. The Rise of CFTs

Vego once wrote that "[n]ew technologies must be followed by creative, corresponding changes in force organization."[242] This is true in the DoD where Congress identified that "longstanding organizational and management challenges" were inhibiting the collaboration necessary to keep up with U.S. pacing threats.[243]

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235. See Appendix D-1 for draft language.

236. *See infra* Section II.A.1.

237. *See* Kollars, *War's Horizon*, *supra* note 13, at 548.

238. *Id.*

239. *Id.*

240. *Soldier Innovation for Transformation*, *supra* note 203.

241. *See* Hansen-Armendariz, *supra* note 158.

242. Milan Vego, *On Military Creativity*, 70 JOINT FORCES Q. 83-90, 84 (2013), https://perma.cc/6MKT-KJL2.

243. U.S. GOV'T ACCOUNTABILITY OFF., GAO-20-312, DEFENSE MANAGEMENT: MORE PROGRESS NEEDED FOR DOD TO MEET OUTSTANDING STATUTORY REQUIREMENTS TO IMPROVE COLLABORATION (Jan. 30, 2020).

To overcome the DoD's inherent obstacles to collaboration, Congress added Section 911 to the 2017 National Defense Authorization Act (NDAA), requiring the DoD to create cross-functional teams to address priority issues, thus ensuring "comprehensive and fully integrated policies, strategies, plans, resourcing, and oversight."[244]

Cross Functional Teams promised to deliver "better and faster solutions to complex and fast-moving problems" by bringing together a diverse group of experts to work toward a common goal.[245] To be successful, CFTs require individual members to be held accountable to the CFT, as opposed to their home unit, branch, or installation.[246] Of course, the CFT must be well-resourced, but they must also have senior-leader support and clear lines of authority.[247] Most importantly, the team must have a well-defined mission to work towards.[248]

2. A Soldier-Innovation CFT Under AFC

When the Army changed its focus to regaining the U.S's historical technological advantage, it created CFTs as a way to bring together the necessary resources, experts and officials to solve its toughest acquisition challenges.[249] AFC's eight CFTs reflect the Army's six modernization priorities and its two crosscutting support capabilities.[250] Each CFT was designed to most efficiently and effectively develop a capability and transition it to the force.[251]

What is missing from the CFTs is a way to capture the bottom-up ingenuity that senior leaders are calling for.[252] Arguably, any Soldier-led innovation could simply be referred to as the appropriate program executive office (PEO) or corresponding CFT. However, not every Soldier-inspired solution will fit into one of those categories, and it would be a drain on resources to send the uninitiated into what some have called a "Byzantine acquisitions system" without the prerequisite insider knowledge.[253] Hansen-Armendariz argued that the Army's capability development system fails to incorporate Soldier-developed solutions because it is "not adequately structured or resourced to receive or process bottom-up input."[254] Specifically, she pointed to operational units' lack of understanding "of capability development processes and levers" and unavailability of "personnel that enable

244. Christopher J. Lamb, STRATEGIC FORUM 298, NAT'L DEF. U., CROSS-FUNCTIONAL TEAMS IN DEFENSE REFORM: HELP OR HINDRANCE? 7 (Aug. 30, 2016); *see also,* GAO 20-312, *supra* note 243.

245. U.S. GOV'T ACCOUNTABILITY OFF., GAO-17-523R, DEFENSE MANAGEMENT: DOD HAS TAKEN INITIAL STEPS TO FORMULATE AN ORGANIZATIONAL STRATEGY, BUT THESE EFFORTS ARE NOT COMPLETE (Jun. 23, 2017).

246. *Id*.

247. *Id*.

248. *See id*.

249. *See* Jen Judson, *US Army to Stand Up Cross-Functional Team for Deep Sensing*, DEF. NEWS (Mar. 7, 2024), https://perma.cc/SB7V-89B3.

250. *See AFC Research Program Realignment, supra* note 124, at 2.

251. *Id*. at 1.

252. *See generally* Section II.B.1.

253. *See* Waddell, *supra* note 85.

254. *See* Captain Hansen-Armendariz, *supra* note 203.

the transition of unit-validated prototypes to Army acquisition pathways."[255] Rather, we need a way to prioritize innovation efforts, resolve duplication of effort, and connect innovation teams to others in the defense innovation ecosystem with shared goals.

In Hansen-Armendariz's paper, she recommends a Soldier-Innovation CFT as a way to narrow capability gaps by transitioning Soldier innovations, with an eye towards tactical-level priorities.[256] This organizational infrastructure would allow division innovation cells with direct liaison authority to normally off-limits strategic organizations, such as Army Futures Command and AFWERX.[257] The CFT would establish clear lines of communication and points of entry for operational units to request the advancement of validated prototypes through the acquisition system.[258] The CFT would also create a digital platform as a space for collaboration amongst operational units, preventing the duplication of effort or loss of ideas.[259]

It could be argued that all this could be accomplished at the corps or division level. For example, XVIII Airborne Corps' sees its primary role as a facilitator and coordinator of its subordinate unit's innovation activities.[260] Additionally the division innovation cells are already monitoring Soldier-submitted ideas and working to develop, produce and implement worthy innovations.[261] However, the fact remains that these units are manned and equipped for execution, not transformation.[262] The Soldier-Innovation CFT must sit at AFC with the other CFTs to create access to the resources and relationships available at that level. Because of the existing relationship between Cat-Pat and division innovation cells, the Soldier-CFT would fall under DEVCOM-ARL.[263] Additionally, the elevation of Soldier-Innovation efforts to the strategic level would provide the visibility and leadership necessary to accomplish the difficult task of managing innovation. Colonel (Retired) Liam Collins, former Green Beret and director of West Point's

255. *Id.*

256. *See* Captain Hansen-Armendariz, *supra* note 203. See Appendix D-2 for a diagram of the Soldier-Innovation CFT.

257. *Id.*

258. *Id.*

259. *Id.*

260. *See* Roederer, *supra* note 34, at 3.

261. *See Id.*

262. *See Paul J. Kern et al., U.S. Army Futures Command Research Program Realignment,* COMMITTEE ON U.S. ARMY FUTURES COMMAND RESEARCH PROGRAM REALIGNMENT (Nat'l Acad. Press 2022), https://perma.cc/DP9D-CLQY. The amount of expertise that is required for a CFT would not be available at the operational level. The required legal expertise is a good example of this. For the legal realm alone, support to innovation activities require more than a single substantive expert as the problem set implicates, at a minimum: contract law, fiscal law, national security law, and administrative law. This sheer amount and level of expertise requires communities of interest collaborating together, networking to external entities such as the patent counsel at U.S. Army Legal Services Agency (USALSA) or sister service counterparts at NavalX and AFWERX.

263. For a diagram of where the Soldier-Innovation CFT would fit into DEVCOM-ARL's organization chart, see Appendix D-3.

Modern War Institute, posits that that innovations are not likely to succeed without key senior leader support.[264]

V. CONCLUSION

As leaders face the complexities of contemporary warfare, they no longer have the luxury of waiting for great ideas to surface. The operating picture is changing at a rapid pace: near-pear adversaries are closing in on the U.S.'s traditional military advantage; emerging technologies are changing the character of warfare; and international world order is devolving as global giants like Russia invade their neighbors without provocation.[265] As America returns to the Great Power Competition with an ever-changing threat environment, we are reminded that "[i]n war more than anywhere else things do not turn out as we expect."[266] To prepare for the uncertainty of the future fight, the Army must harness the resourcefulness inherent to Soldiers. And leaders must foster innovation at every level to make the most of our human capital and to guarantee victory.

264. *See* Collins, *supra* note 86, at 106.

265. *See infra* Section II.B.

266. Carl Von Clausewitz, ON WAR, 193 (Michael Howard & Peter Paret eds. & trans., Princeton Univ. Press 1989).

APPENDIX A – HISTORICAL SOLDIER-LED INNOVATIONS

APPENDIX A-1 – EXAMPLE OF A "RHINO TANK" FROM THE BATTLE OF THE BOCAGE AND THE HEDGEROW IT DEFEATED[267]

267. Roederer, *supra* note 34, at 2.

APPENDIX A-2 – EXAMPLE OF A VIETNAM-ERA GUN TRUCK, EQUIPPED WITH M134 MINIGUN AND OPERATION IRAGI FREEDOM GUN TRUCK[268]

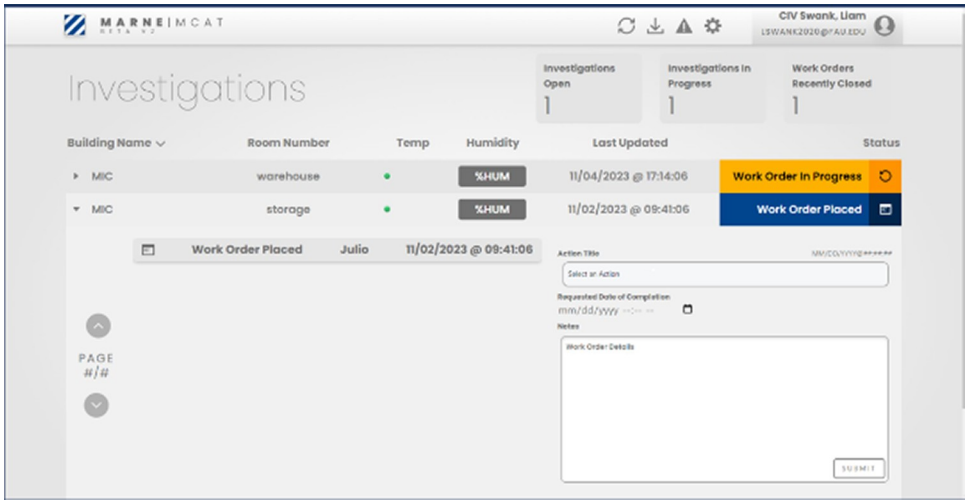
268. Fratus, *supra* note 19; *See* Lukas Visingr, *Bizarre American "Gun Trucks in Iraq*, RADIO DIXIE (Nov. 2015), https://perma.cc/3ZPH-S68C.

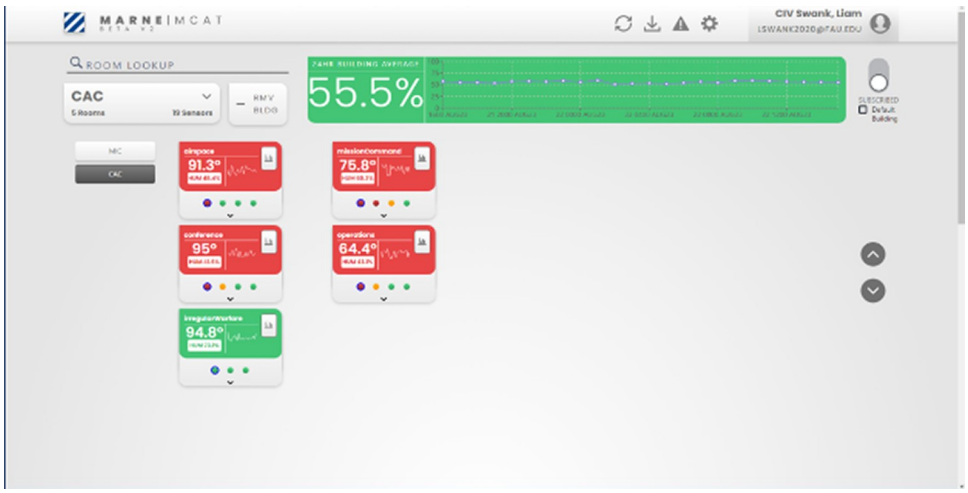
APPENDIX B – RECENT SOLDIER INNOVATIONS

APPENDIX B-1 – THE PILE DRIVER ATTACHMENT[269]

269. Keiser, *supra* note 160.

APPENDIX B-2 – THE MOLD CONDITIONS AWARENESS TOOL (MCAT) INTERFACE[270]

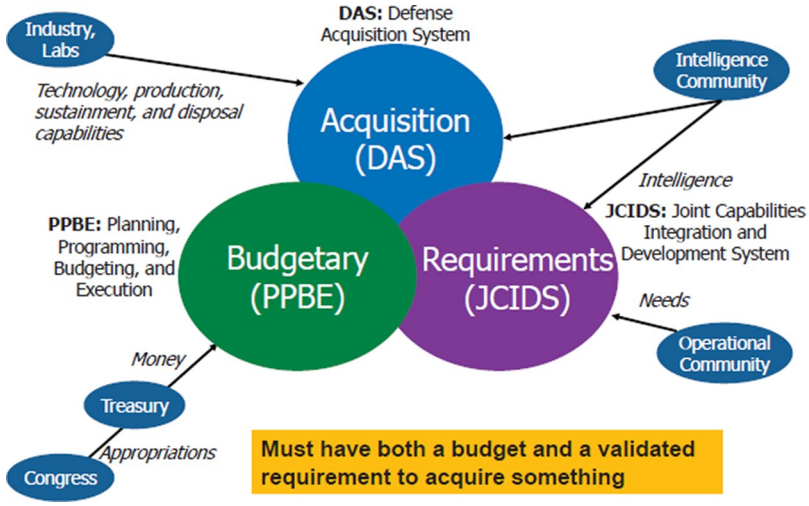




270. *Senior Design Showcase*, FLA. ATLANTIC UNIV., https://perma.cc/39EY-RTFM.

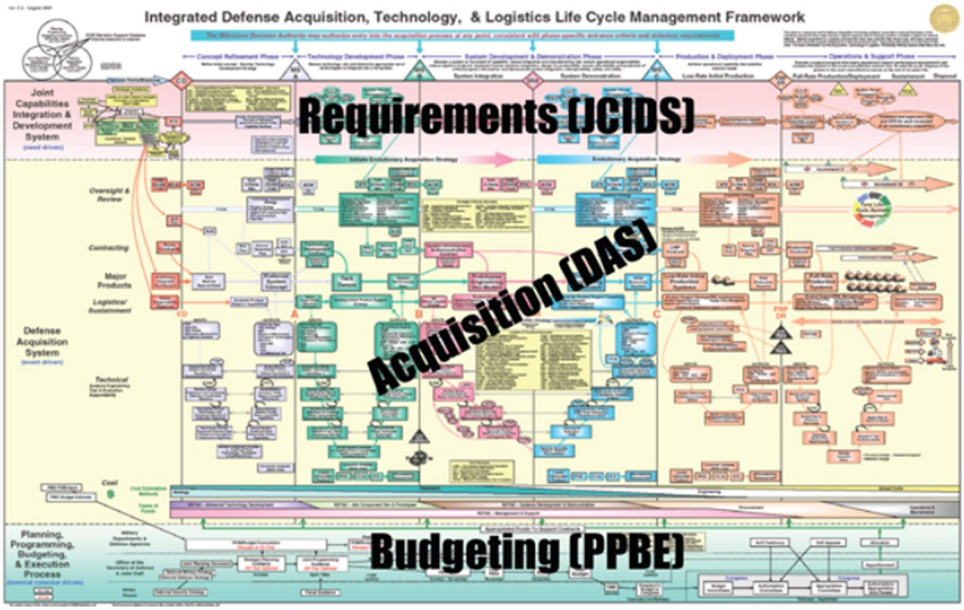
APPENDIX C – DEFENSE ACQUISITIONS DIAGRAMS

APPENDIX C-1 – COMMUNITIES AFFECTING DEFENSE ACQUISITIONS[271]



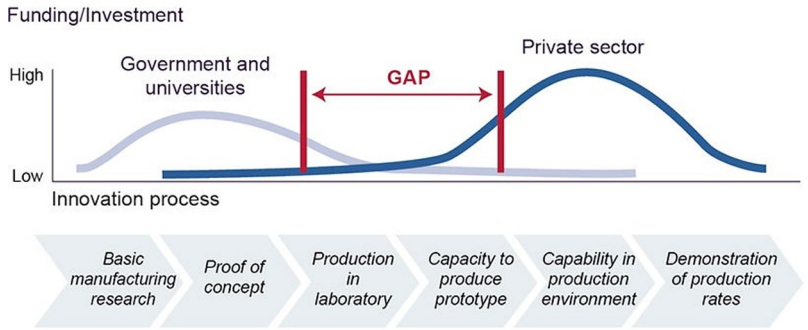
271. NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE, EMPOWERING THE DEFENSE ACQUISITION WORKFORCE TO IMPROVE MISSION OUTCOMES USING DATA SCIENCE 99 (Nat'l Acad. Press 2021), https://perma.cc/9MA6-8569.

APPENDIX C-2 – A DEFENSE ACQUISITION FRAMEWORK "BUILT FOR THE RISK AVERSE."[272]



272. NATIONAL RESEARCH COUNCIL, RESPONDING TO CAPABILITY SURPRISE: A STRATEGY FOR U.S. NAVAL FORCES 89 (Nat'l Acad. Press 89 2013), https://perma.cc/2ECP-26L4.

APPENDIX C-3 – THE VALLEY OF DEATH[273]



273. U.S. GOV'T ACCOUNTABILITY OFF., GAO-21-202, DEPARTMENT OF ENERGY: IMPROVED PERFORMANCE PLANNING COULD STRENGTHEN TECHNOLOGY TRANSFER (Feb. 2, 2021).

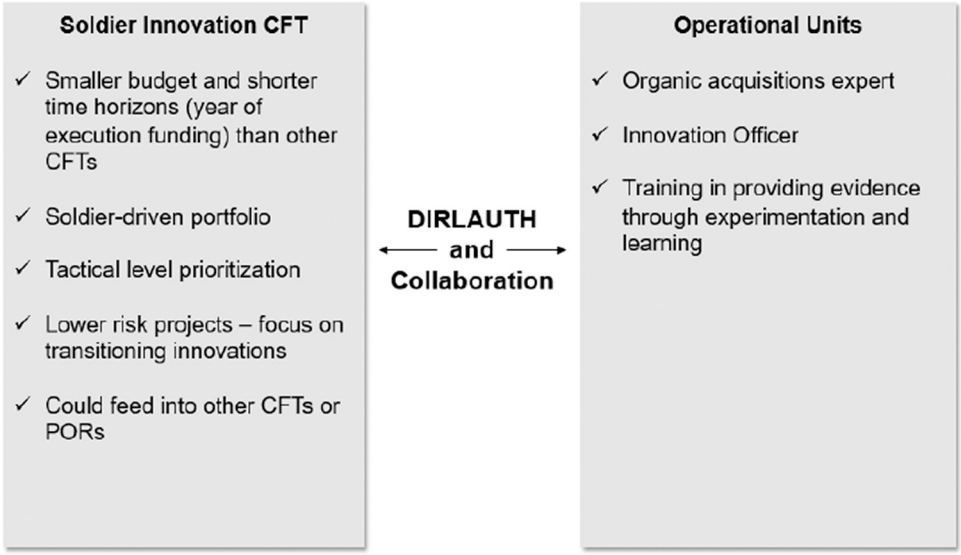
APPENDIX D – PROPOSED SOLUTION: FLEXIBLE FUNDING AND ORGANIZATIONAL INFRASTRUCTURE

APPENDIX D-1 – FLEXIBLE FUNDING: DRAFT STATUTORY LANGUAGE FOR THE ADDITION OF RDT&E TO THE E/I THRESHOLD[274]

2022 DOD APPROPRIATIONS ACT, SEC. XXXX. Funds made available in this title to the Department of Defense for operation and maintenance may be used to purchase items having an investment unit cost of not more than $250,000, and for any Research, Development, Test and Evaluation effort having a total cost of not more than $250,000: Provided, That, upon determination by the Secretary of Defense that such action is necessary to meet the operational requirements of a Commander of a Combatant Command engaged in contingency operations overseas, such funds may be used to purchase items having an investment item unit cost of not more than $500,000, and to perform any Research, Development, Test and Evaluation effort having a total cost of not more than $500,000.

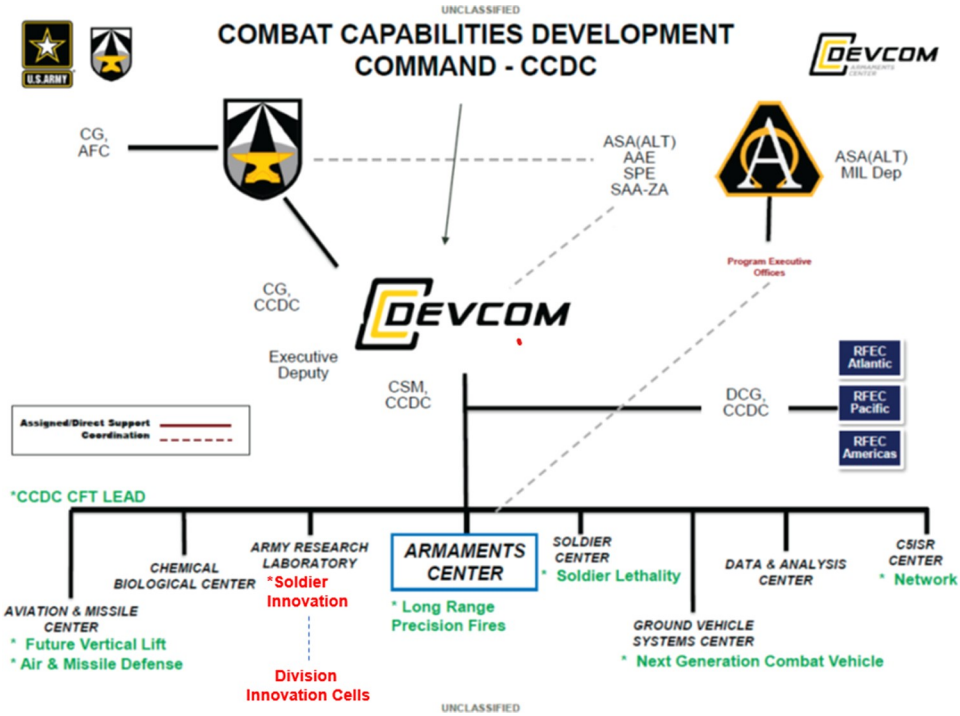
274. Cora, *supra* note 43, at 15.

APPENDIX D-2 – ORGANIZATIONAL INFRASTRUCTURE: SOLDIER INNOVATION CFT DIAGRAM[275]



275. *Soldier Innovation for Transformation*, *supra* note 203, at 4.

APPENDIX D-3 – ORGANIZATIONAL INFRASTRUCTURE: DEVCOM ORGANIZATIONAL CHART (WITH ADDITION OF SOLDIER INNOVATION CFT) [276]



276. *AFC Research Program Realignment, supra* note 124, at 25.