Before the Crucible

The Diffusion and Adoption of Select Synthetic Training Applications among US Partners and Allies

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King's College London

BEFORE THE CRUCIBLE: THE DIFFUSION AND ADOPTION OF SELECT SYNTHETIC TRAINING APPLICATIONS AMONG US PARTNERS AND ALLIES

A dissertation presented by

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to

The Department of War Studies in fulfillment of the requirements for the degree of Doctor of Philosophy in the subject of War Studies

Word Count: 100,000

King's College London
London, UK
Submitted: 12 December 2022

ABSTRACT

This dissertation explores the diffusion and adoption decisions of synthetic training among US partners and allies. The adoption of synthetic training—in particular live, virtual, and constructive training and a multi-domain synthetic training environment—among US partners and allies is puzzling as it runs counter to diffusion theories, such as adoption capacity theory. If the size of the defense budget and organizational agility does not cause adoption, what does? To assess the drivers of synthetic training diffusion and adoption, this dissertation systematically tests five alternative hypotheses from the diffusion literature: 1) the presence of geostrategic competition, 2) the propensity for organizational reform within the defense bureaucracy, 3) the existence of bureaucratic civilian and military champions, 4) military-to-military contact, and 5) cultural similarity. Two sets of comparative country case studies are used to test the alternative hypotheses, representing a high and low adopter of synthetic training—Australia & Japan and Israel & Canada. By systematically testing the five alternative hypotheses against the two comparative case studies, this dissertation serves four purposes. First, it represents the first in-depth study of synthetic training within Political Science scholarship, opening the aperture for future investigation and analysis. Second, it is one of the few studies of *in-process diffusion* within the field, thereby helping to expand literature which has to date suffered from a pro-innovation bias. Third, it bolsters the diffusion scholarship in two ways: by demonstrating that state perceptions of their geostrategic threat environment play an outsized role in adoption decisions and that diffusion studies would benefit from a deeper assessment of the diffusion differences between hardware and software. Finally, it demonstrates that state adoption decisions can be idiosyncratic, and, as a result, a level of intellectual humility must be employed when applying theory to policy, like in the case of synthetic training.

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ACKNOWLEDGEMENTS

Writing a dissertation is an incredibly time-consuming, humbling, difficult, and emotionally draining process. I was lucky to receive so much support throughout the process from my family, supervisor, committee members, and many friends and colleagues.

I first started working on military synthetic training in 2014 when I was asked to manage a program led by the former head of the Royal Canadian Air Force, LGen (ret.) Yvan Blondin on live, virtual, and constructive (LVC) training. Together, Yvan and I crisscrossed the globe, interviewing many military officials on their planned use of LVC. My work on synthetic training began in large part because of Yvan's mentorship, and now, friendship.

In 2017, I was awarded a RADM Fred Lewis doctoral scholarship in modeling and simulation from I/ITSEC—the world's largest military training and simulation conference—and a large research grant from a defense training company. The willingness of these two institutions to invest in my work opened many doors for me within the military training community. I'd like to thank Janet Spruill and Gene Colabatissto for their guidance and friendship.

During my dissertation research, I was privileged that many military and industry officials shared their thoughts with me. Many friends, colleagues, and even family supported my research by facilitating introductions for case study interviews. I'd like to thank Brig. Gen. (ret.) Barry Barksdale, Ilan Berman, Dr. Zack Cooper, Chris Dougherty, Lt. Col. Dave Lyle, Colonel Doug DeMaio, Michael Eisenstadt, Col. Robert Epstein, Lt. Col. Peter Garretson, Daryl Gilbertson, Dr. Mica Hall, Dr. Lionel Ingram, Brent Johnson, Dr. David Johnson, Dr. Thomas Kehr, Wing Commander Steven Laredo, Barry McArdle, Chuck Morant, Russel Ryan, Sharon Stirling, Col. Gabi Siboni, and Philip Temby. Additionally, I would like to thank Dr. David Wells, the Royal Australian Air Force, SENEDIA, and NATO for providing opportunities to test my initial ideas related to synthetic training in various public forums.

I'm blessed to have colleagues who supported me throughout my revisions as I worked full-time. I thank Caitlin Dohrman, Mark Johnson, Eric Hilmer, Kathryn Harris, Mike Lee, Todd Levine, Dave Smith and Vincent Petrarca.

I'm lucky to have Dr. Walter Ladwig as my supervisor. Walter is a brilliant scholar and an incredibly thoughtful supervisor. This dissertation would not have been possible without his guidance and mentorship. I also thank my second supervisor, committee members, and an external reviewer, whose thoughtful feedback made this a far stronger piece of work, Dr. David Betz, Dr. Anthony King, Dr. Tom Dyson, and Dr. Tim Hoyt.

Finally, I'd like to thank my husband. Iskander has picked me up and pushed me forward even when I thought this dissertation may be out of reach. He is, in short, my rock. I dedicate this dissertation to my parents, Barry and Jessica, who have always championed me. Thank you, mom and dad.

INTRODUCTION

The soldiers prepared for the day's training exercise—a force-on-force armored battle against their Soviet adversary. Yet, instead of maneuvering through the sands of the Mojave Desert—the location of the US military's Fort Irwin training ground—the soldiers entered a virtual battlespace, called SIMNET. Ethernet cables snaked out from their M1 Abrams tank simulators, plugging the First Company of the 12th Armored Cavalry Unit into one collective virtual training ground. As the commander injected Soviet computer-generated tanks and armored vehicles into the scenario, emulating Soviet doctrine to the best of his ability, the US troops ranged across the virtual desert, in a bid to outwit and out-fire their adversary. As the Soviet and US forces engaged, clashing in a fierce melee of man and material, the US command and control began to disintegrate. US troops began to virtually die at the hands of the adversary or, amid the generalized confusion, via fratricide. The troop screens in the tank simulators turned blank, as if to signal the onset of their mass extinction. The battle had ended, but for these soldiers the training had not yet finished. SIMNET allowed the soldiers to play and replay the battle "Groundhog Day-style" and pinpoint their mistakes and failings. They could experientially learn before the crucible of combat, and not via a prohibitively costly, one-off exercise, but rather through a repeated, iterative process.[1]

SIMNET, an acronym for simulator networking, was sponsored by ARPA (the precursor to the US' Defense Advanced Research Projects Agency (DARPA) in partnership with the US Army between 1983 and 1990. First conceptualized by Jack Thorpe in 1978, SIMNET was the first proof-of-principle demonstration of a large-scale, man-in-the-loop simulator networking for collective team training and mission rehearsal.[2] The core technology crucial to SIMNET was a large synthetic environment—complete with graphic systems, host computers, operating systems, and a network—that allowed participants to enter a common virtual world via a simulator as a porting device. Once together, participants could engage in a non-scripted, free-play virtual battle, constrained solely by their chain of command and rules of engagement.

Prior to the 1980s, simulators were developed as stand-alone systems designed for specific training outcomes. These simulators acted as a substitute for live training, allowing trainees to practice emergency procedures or other training goals in a safe environment. Jack Thorpe, however, felt that simulation could actually augment live training, rather than just act as a substitute. Simulation could teach necessary combat skills that warfighters were unable to learn in peacetime. For instance, due to the difficulty and expense of organizing large groups, warfighters often have little to no experience in large-scale collective coordination. As a result, these organizational deficits regularly resulted in disproportionately higher causalities in early missions.[3] Thorpe's SIMNET

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[1] For a narrative overview of the use of SIMNET, see: Bruce Sterling, "War is Virtual Hell," *Wired,* 1 January 1993, https://www.wired.com/1993/01/virthell/.

[2] Duncan Miller and Jack Thorpe, "SIMNET: The Advent of Simulator Networking," *Proceedings of the IEEE* 83.8 (August 1995): 1114-1123, Neale Cosby, "SimNet: An Insider's Perspective," *IDA Document D-1661* (March 1995), and Earl Alluisi, "The Development of Technology for Collective Training: SIMNET, a Case History," *Human Factors* 31.3 (1991): 343-362.

[3] This is not solely related to ground combat. For pilots, these skills could also include flying low to the ground in dogfights or avoiding missiles closing in at high-speed. See: Fred Hapgood, "SimNet," *Wired,* 1 April 1997, https://www.wired.com/1997/04/ff-simnet/ and Tim Lenoir and Henry Lowood, "Theaters of War: The Military Entertainment Complex," in Jan Lazardig et al. *Kunstkammer, Laboratorium, Bühne--Schauplätze des Wissens im 17. Jahrhundert* (Berlin, Germany: Walter de Gruyter, 2003).

sought to solve that problem by developing a scalable, and cost-effective, virtual architecture that networked simulators together. In time, SIMNET's virtual world(s) were employed for more than just collective training, to include strategy definition, force planning, battle reenactment, tactical assessments of new weapons, logistics, acquisitions, experimentation, and long-term research and development.

While today, SIMNET is considered a clunky "historic" piece of technology, in the 1980s its development and usage was considered by some to be a technological "revolution," changing "the way the military does business" and also, as a result, changing "the simulation industry."[4] Indeed, synthetic training—the use of digitally based virtual and constructive simulations as training tools—has significantly changed since SIMNET was first deployed for training in the 1980s. Like SIMNET, distributed warfighters can still train together for combined operations. Yet, radical improvements in software that enhance computer networking, runtime performance, advanced computing, artificial intelligence, model development and composition, and immersive three-dimensional virtual environments have rendered former training tools obsolete. The combination of these technologies has unlocked synthetic training solutions that allow warfighters to train for tactical and operational scenarios—like cyber operations—that would otherwise prove impossible in a live (i.e., physical) training environment.

The Puzzle of Synthetic Training Adoption

Referred to as live, virtual, and constructive (LVC) training and a multi-domain synthetic training environment, these new training capabilities have diffused—and continue to diffuse—to US partners and allies. The diffusion of these synthetic training tools, however, is puzzling. The leading theory of innovation diffusion in international relations, Michael Horowitz's adoption capacity theory, proposes that the diffusion of complex technical tools is attributable to two overarching factors—a country's financial capacity and the organizational burden of that technology's adoption.[5] The defense industry, likewise, while not following any grand theories, has implicitly coalesced around similar attributes, choosing to target countries from a market standpoint that are deemed to have larger defense budgets.[6] The standard quip: follow the money. According to adoption capacity theory, and the defense industry more generally, one would expect to see higher rates of synthetic training adoption among states that have a larger defense budget. But the data shows that is not necessarily the case.

After selecting for countries that possess a defense budget over $10 billion, which was deemed the baseline budgetary level to adopt complex synthetic training capabilities, the adoption results were noticeably mixed.[7] The size of the defense budget had little to no bearing on adoption rates among

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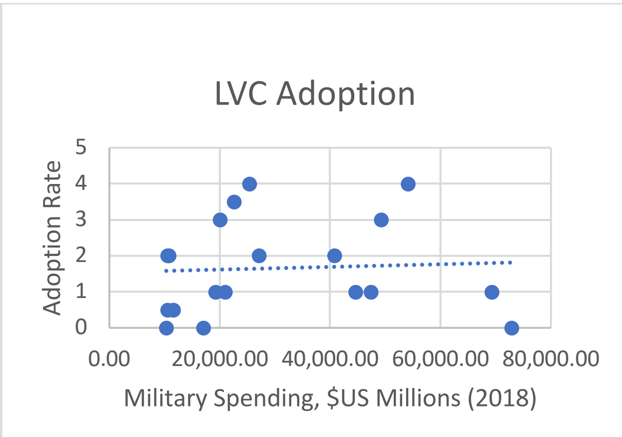
[4] Cosby, "SimNet: An Insider's Perspective," 1.

[5] Organizational burden in this context refers to associated changes to recruitment, training, and warfighting doctrine that are required for that technology's adoption. Michael Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics* (Princeton, NJ: Princeton University Press, 2010).

[6] Preliminary evidence would suggest this is the case within the defense synthetic training industry based on company market penetration decisions, particularly among non-US companies. Most choose to first expand to the US, select European countries, like Germany or France, and Middle Eastern countries like Saudi Arabia. See, for example, CAE Defense & Security's market expansion decisions as a Canadian based company. CAE, "Defense and Security," accessed 30 July 2022, https://www.cae.com/defense-security/.

[7] A defense budget of over $10 billion was selected because not all coalition countries have the financial assets to support acquiring very complex synthetic training applications like LVC or a multi-domain synthetic training

US partners and allies (see figures one and two).[8] Additionally, as this dissertation will show, while the adoption of LVC and a multi-domain synthetic training environment does require some changes to military training execution, they do not necessitate a fundamental shift in present warfighting paradigms—from operational concepts, to recruitment, or even training concepts. They therefore do not necessarily represent, according to Horowitz's definition, a significant organizational burden to adoption.[9] If adoption capacity theory does not explain adoption, what then is driving the adoption of these two types of synthetic training—LVC and a multi-domain synthetic training environment? This dissertation sets out to uncover this puzzle.



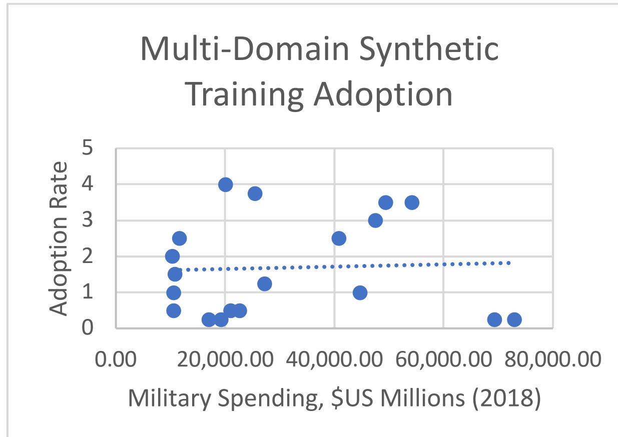


Figure 1: LVC Adoption by Country Defense Budget

Figure 2: Multi-Domain Synthetic Training Adoption Rates by Country Defense Budget

Why Does the Diffusion of Synthetic Training Matter?

Before explaining why studying the diffusion of these two types of synthetic training matter, it is best to start with why LVC and a multi-domain synthetic training environment matter, more generally. What makes these two types of synthetic training worthy of scholarly inquiry?

Scholars, policymakers, and military leaders have long been interested in what contributes to battlefield effectiveness. Battlefield effectiveness is generally defined as the success by which states achieve their war aims through the execution of actual campaigns and the application of

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environment. For those that don't have the budget, the interoperability of methods, systems, and procedures frequently falls on the US. In 1997, the US National Defense Panel argued that significant investment is required by the US to pursue a military transformation strategy. The estimated budget "wedge" for this strategy was calculated at $5 to $10 billion dollars. As a result, a $10 billion yearly defense budget seems reasonable for a country to attempt to achieve transformation over time. United States National Defense Panel, *Transforming Defense: National Security in the 21st Century* (1997). More detail on selection methods can be found in chapter three on methods.

[8] More detail on country selection can be found in chapter three on methods and appendix one and two.

[9] Conversely, given these technologies facilitate training for new operational concepts (and can also support training for past and current warfighting paradigms), it is more likely that militaries will adopt new platforms (like the F-35) or new operational concepts, like multi-domain training first, and then seek to new training technologies to meet those new needs. Training, and training technologies, are often described pessimistically as "after-thoughts" by the military training community. However, that does not mean that adoption does not require some organizational change, as this dissertation will discuss, it just does not meet the threshold of the significant change highlighted by Horowitz in his theory.

combat techniques in battle.[10] Operational and tactical prowess on the battlefield have been explained by a range of factors. A "bean-counting" approach to military effectiveness attributes military power to quantitative indicators of force on the battlefield, such as the number of weapons platforms a military possesses. Such a view is closely linked to those that tie military effectiveness to a state's raw military-industrial power.[11] Stephen Biddle, conversely, attributes military power to the "modern system," what is defined as, "a tightly interrelated complex of cover, concealment, dispersion, suppression, small-unit maneuver, and combined arms at the tactical level, and depth, reserves, and differential concentration at the operational level."[12] Others have pointed to organizational behavior, the quality of leadership, peacetime innovation, wartime adaption, society, civil-military relations, human capital such as education, wartime coalitions, and even the nation's culture and normative framework that shapes a military in peacetime and throughout conflict.[13] More recent scholarship has highlighted the role of training and military professionalism as key factors in battlefield effectiveness.[14] According to these authors, particularly those that study training in-depth, training matters because it inculcates not only individual skills, but a collective approach to combat, a form of teamwork, cohesion, and adaptivity, that manifests

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[10] Caitlin Talmadge, *The Dictator's Army: Battlefield Effectiveness in Authoritarian Regimes* (Ithaca, NY: Cornell University Press, 2015): 15.

[11] See for instance, Stephen Rosen, *Winning the Next War: Innovation in the Modern Military* (Ithaca, NY: Cornell University Press, 1991), Matthew Evangelista, *Innovation and the Arms Race: How the United States and the Soviet Union Develop New Military Technologies* (Ithaca, NY: Cornell University Press, 1988), Scott Sigmund Gartner, *Strategic Assessment in War* (New Haven, CT: Yale University Press, 1997), Michael Desch, *Power and Military Effectiveness: The Fallacy of Democratic Triumphalism* (Baltimore, MD: John Hopkins University Press, 2008), and Michael Beckley, "Economic Development and Military Effectiveness," *Journal of Strategic Studies* 33 (February 2010): 43-79.

[12] Stephen Biddle, *Military Power: Explaining Victory and Defeat in Modern Battle* (Princeton, NJ: Princeton University Press, 2004): 3.

[13] See for instance, Allan Millet and Williamson Murray, *Military Effectiveness: Volume 1, The First World War* (Cambridge, UK: Cambridge University Press, 2010), Allan Millet and Williamson Murray, *Military Effectiveness: Volume 2, The Interwar Period* (Cambridge, UK: Cambridge University Press, 2010), Allan Millet and Williamson Murray, *Military Effectiveness: Volume 3, The Second World War* (Cambridge, UK: Cambridge University Press, 2010), Dan Reiter, *The Sword's Other Edge: Trade-offs in the Pursuit of Military Effectiveness* (Cambridge, UK: Cambridge University Press, 2017), Risa Brooks and Elizabeth Stanley, *Creating Military Power: The Sources of Military Effectiveness* (Stanford, CA: Stanford University Press, 2007), Ralph Rotte and Christoph Schmidt, "On the Production of Victory: Empirical Determinants of Battlefield Success in Modern War," *Defence and Peace Economics* 14.3 (2003): 175-192, Stephen Rosen, "Military Effectiveness: Why Society Matters," *International Security* 19.4 (1995): 5-31, and Stephen Biddle and Stephen Long, "Democracy and Military Effectiveness," *The Journal of Conflict Resolution* 48.4 (2004): 525-546.

[14] For studies that view training and professionalism as key components of battlefield effectiveness, see: Anthony King, "On Combat Effectiveness in the Infantry Platoon: Beyond the Primary Group Thesis," *Security Studies* 25.4 (September 2016); Anthony King, *The Combat Solider: Infantry Tactics and Cohesion in the Twentieth and Twenty-First Century* (Oxford, UK: Oxford University Press, 2013), Elizabeth Kier, "Homosexuals in the US Military: Open Integration and Combat Effectiveness," *International Security* 23.3 (1998); Stephen Biddle, "Allies, Airpower, and Modern Warfare: The Afghan Model in Iraq," *International Security* 30.3 (March 2006); Hew Strachan, "Training, Morale and Modern War," *Journal of Contemporary History* 41.2 (2006); Talmadge, *The Dictator's Army: Battlefield Effectiveness in Authoritarian Regimes;* William Hix and Robert MacCoun, "Cohesion and Performance," in *Sexual Orientation and U.S. Military Personnel Policy: An Update of RAND's 1993 Study*, (Santa Monica: RAND, 2010); Robert MacCoun, Elizabeth Kier, and Aaron Belkin, "Does Social Cohesion Determine Motivation in Combat?: An Old Question with An Old Answer," *Armed Forces and Society* 32.4 (July 2006); Uzi Ben Shalom and Ariel Vainer, "Cohesion During Military Operations: A Field Study on Combat Units in theAl-Aqsa Intifada," *Armed Forces and Society* 32.1 (October 2005); and Anthony King, "The Word of Command: Communication and Cohesion in the Military," *Armed Forces and Society* 32.1 (July 2006).

through repetition, drill, and experiential learning.[15] Creating repetitive training experiences where those individual, and particularly collective skills can manifest is an important element of ensuring success on the future battlefield. While some of those experiences can be created in a live environment, the military has long realized that synthetic training can augment, and in some cases, substitute for live training to achieve individual and collective training goals. Indeed, in the last decade, changes in the character of warfare have created new incentives for military operatives to favor synthetic training over live options, as new weapon systems and domains of warfare cannot be realistically—or securely—exercised in a live environment.[16] As a result, synthetic training—and more particularly LVC and a multi-domain synthetic training environment—matters and is worthy of scholarly inquiry as is the only environment that can generate a collective approach to combat for certain specific types of tactical and operational scenarios.

While LVC and a multi-domain synthetic training environment will be covered in more depth in chapter one, in short, these two types of synthetic training can be defined as follows:

- **Live, Virtual, and Constructive Training (LVC)**: LVC can be thought of as the integration of live, virtual, and constructive simulation assets into one training environment through onboard or off-board sensors. LVC allows training providers to increase the complexity of live training, by incorporating additional virtual and constructive models, entities, or assets that would not be possible, or prove too expensive, in a live environment.
- **Multi-Domain Synthetic Training Environment**: A multi-domain synthetic training environment integrates a synthetic environment (i.e., a digitally based virtual or constructive environment) used by conventional warfighters with a synthetic environment used for those tasked with cyber operations, information operations (i.e., social media, etc.), and space operations. By linking the two environments together, conventional warfighters can train in tandem with warfighters tasked with cyber, information, or space operations. Effects then propagate across the two environments, allowing, for instance, conventional warfighters to better understand how cyber may affect and enhance mission effectiveness, and vice versa.

This dissertation is not solely interested in why LVC and a multi-domain synthetic training environment matter, and therefore warrant scholarly inquiry, but also *why their diffusion matters*.

Diffusion, which will be covered in more depth in chapter two, can be succinctly defined as "the process by which an innovation is communicated through certain channels over time among the members of a social system."[17] To security studies scholars, diffusion is identified as a complex process, whereby military knowledge "to include hardware (e.g. technology) and software (e.g. doctrine, tactics, organizational form, etc.) diffuses throughout the international system, or what factors enhance or inhibit the ability of states to incorporate innovation into their defense

[15] See, in particular, King, Strachan, and Talmadge.
[16] Cyber, electronic, space, and information effects can't be realistically introduced into live training exercises for a variety of reasons, to include safety concerns or the risk of sabotaging local civilian or military networks and applications. Additionally, certain weapon systems, like the F-35 can't be exercised to their full potential in a solely live environment. For a deeper exploration of these issues, see pages 49-50.
[17] Everett Rogers, *The Diffusion of Innovations* (New York, NY: The Free Press, 1995): 5-6.

structures."[18] Closely linked to diffusion is the concept of adoption. Indeed, adoption has been considered the "original dependent variable in innovation research."[19] In short, adoption is some act of decision, whether that is conscious or subconscious, on an individual's part. It is a decision to adopt, reject, or re-invent an innovation.[20]

If LVC and a multi-domain synthetic training environment are the only means to create a collective approach to combat for certain types of tactical and operational scenarios, like joint all domain operations, then their diffusion and adoption are of consequence. Indeed, states that choose to adopt these technologies should prove more effective on the battlefield when performing missions or campaigns that require the employment of certain types of high-tech weaponry, like the F-35, or the collective employment of cross-domain capabilities, such as cyber alongside more traditional air or ground effects.

The diffusion of these technologies to US partners and allies is of extreme importance to the US. As academic scholarship has shown, great powers like the US, contrary to conventional wisdom, are more likely to participate in multilateral combat actions—and are more likely to fight as a coalition.[21] As a result, the diffusion of these synthetic training innovations to partners and allies would enhance future allied effectiveness on the battlefield. Perhaps more importantly, the adoption of similar synthetic training architectures, like LVC or a multi-domain synthetic training environment among partners and allies can facilitate coalition interoperability through shared and integrated joint coalition exercises.[22]

Achieving an interoperable fighting force is no easy task, even among the closest of coalition partners. Indeed, recent literature has demonstrated that while the fielding of international combat coalitions can reap rich dividends on the political level, it can also occasionally present severe tactical and operational challenges.[23] For instance, in March 2003, at the start of the Iraq war, two American A-10 fighter pilots misidentified four British patrol vehicles as the enemy, subsequently unleashing a salvo of armor piercing shells. The British troops attempted, in vain, to notify the pilots that they were friendly forces, but received no response. The American pilots were on a different radio frequency. The tragic result was fratricide.[24] Throughout time, incidents like these, among other tactical and operational failures, have caused military professionals to vent their

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[18] Note, this is difference from technology that is software based. Emily Goldman and Leslie C. Eliason, *The Diffusion of Military Technology and Ideas* (Stanford, CA: Stanford University Press, 2003): 7.
[19] J.D. Eveland, "Issues in Using the Concept of 'Adoption of Innovations,'" *Journal of Technology Transfer* 4.1 (1979): 1.
[20] The first definition of adoption was defined by Everett M. Rogers and F. Floyd Shoemaker as "making full use of a new idea as the best course of action available." See: Everett M. Rogers and F. Floyd Shoemaker, *Communication of Innovations: A Cross-Cultural Approach* (New York: Free Press, 1971).
[21] Renato Corbetta and William Dixon, "Multilateralism, Major Powers, and Militarized Disputes," *Political Research Quarterly* 57.1 (March 2004).
[22] See, for instance NATO's experience facilitating interoperability through joint planning, training, and exercises. NATO, *Backgrounder: Interoperability for joint operations* (July 2006).
[23] Olivier Schmitt, *Allies that Count: Junior Partners in Coalition Warfare* (Washington, DC: Georgetown University Press, 2018) and Nora Bensahel, "International Alliances and Military Effectiveness: Fighting Alongside Allies and Partners," in Risa Brooks and Elizabeth Stanley, *Creating Military power: The Sources of Military Effectiveness* (Stanford, CA: Stanford University Press, 2007): 186-206.
[24] Patricia Weisman, "With a Little Help from Our Friends: The Costs of Coalition Warfare," *Origins* 2.4 (January 2009), https://origins.osu.edu/article/little-help-our-friends-costs-coalition-warfare.

frustrations at the seeming unwieldiness of coalitions. General Eisenhower, writing in his memoirs, thus groused that

> *history testifies to the ineptitude of coalitions waging war. Allied failures have been so numerous and their inexcusable blunders so common that professional soldiers had long discounted the possibility of effective allied actions*.[25]

In reality, things are somewhat more complex. Coalitions can be tactically and operationally effective, but this is dependent on a variety of factors, ranging from adequate and realistic multinational training, to a history of military cooperation, and equipment and technology that can effectively connect and communicate.[26] The adoption of LVC and a multi-domain synthetic training environment by partners and allies, apart from shedding light on their adoption decisions, also serves a warfighting purpose. When training for high-end conflict, these select synthetic training applications provide the only environment, short of an actual shared wartime experience, for allies and partners to build interoperability across the force. For that reason, uncovering the puzzle of synthetic training diffusion among US partners and allies' matters, as it can help to inform future US coalition combat expectations.

Research Design

This dissertation systematically tests hypotheses from the diffusion literature against state adoption of LCV and a multi-domain synthetic training environment—two training applications that are presently in the diffusion process. Five key hypotheses are employed: 1) the intensity and presence of local geostrategic competition, 2) the organizational propensity for reform within the defense bureaucracy, 3) the existence of bureaucratic civilian and military champions, 4) military-to-military contact, and 5) cultural similarity. By tracking adoption across five alternative (but not mutually exclusive) hypotheses, this dissertation falls into what Stephen Van Evera terms a "theory testing" dissertation. It uses empirical evidence to evaluate existing theories via case studies and therefore, according to Van Evera, is a valid exercise.[27]

For each type of collective synthetic training, two country case studies are selected for assessment—a high adopter and a low adopter. This ensures that country case studies represent what Dan Slater and Daniel Ziblatt call "typological representativeness." They represent the full range of outcomes across the dependent variable.[28] Indeed, as political theorists have noted, if one wants to better gauge the causative factors that lead to adoption, the full range of adoption outcomes must be studied, both high and low.[29] Given adoption capacity theory hypothesizes that, all other things being equal, financial and organizational capital will determine a technology's diffusion, it seemed reasonable to use the defense budget as a control. If two states display markedly different synthetic training adoption rates, but have similar defense budgets, some other contributing factor, or a combination of factors, must be driving diffusion. As a result, when

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[25] Schmitt, *Allies that Count: Junior Partners in Coalition Warfare,* loc. 273.

[26] Bensahel, "International Alliances and Military Effectiveness: Fighting Alongside Allies and Partners" and Schmitt, *Allies that Count: Junior Partners in Coalition Warfare,* loc. 391.

[27] Stephen Van Evera, *Guide to Methods for Students of Political Science* (Ithaca, NY: Cornell University Press, 1997): 90.

[28] Dan Slater and Daniel Ziblatt, "The Enduring Indispensability of the Controlled Comparison," *Comparative Political Studies* (January 2013).

[29] Phillips Shively, *The Craft of Political Research* (New York, NY: Routledge, 2017): 109.

selecting case study pairs, this dissertation first identified the high and low adopters of each type of synthetic training before selecting pairs based on the size of the defense budget—Australia & Japan and Israel & Canada.

Using the two controlled comparative case studies, this dissertation employs process tracing to test the five alternative hypotheses to identify which hypotheses proves more explanatory, and, conversely, which lack explanatory power. While this is a new area of exploration, and the information available for an in-process diffusion study is necessarily constrained relative to studies that explore completed instances of diffusion, it is possible to employ process tracing to make preliminary assessments of the comparative strengths and weaknesses of these explanatory factors. Indeed, by employing two tests within the process tracing literature— "straw-in-the-wind" and "hoop tests"— across four case studies one can begin to establish some important affirmative evidence of causality.[30] While the causes why a state chooses to adopt each type of synthetic training may begin before 1990, 1990 is used as a point of departure, as it represents the first time a collective distributed synthetic training application—SIMNET—was demonstrated.

As will be shown, by systematically testing the five hypotheses, it becomes evident that state perceptions of their geostrategic threat environment play an outsized role in adoption decisions—it passes the "hoop test" across all cases. An organization's propensity for reform appears relevant, but is not a necessary factor, passing the "straw-in-the-wind" test. The presence of high-level champions and military-to-military contact appear necessary in most cases, but in one, is solely a relevant factor. Finally, cultural similarity does not appear to pass the evidentiary threshold, except in two cases (Australia and Canada), where normative based groupings, like the Five Eye intelligence grouping, seem of relevance.

Contribution

This dissertation makes four main contributions to the political science literature. First, it represents the first in-depth study of synthetic training within the field. It draws extensively on literature from combat engineering and modeling and simulation to make technical topics that were previously studied solely by the scientific and engineering communities accessible to a far wider audience. Such accessibility is necessary. If these collective training tools have implications for future battlefield effectiveness and coalition interoperability then the broader academic and policy communities need to be far more engaged in understanding and debating their development, application to training, and diffusion. What's more, their ramifications should be studied in far greater depth, as synthetic training likely has ramifications for international security beyond just diffusion.

Second, LVC and a multi-domain synthetic training environment represent two complex collective training regimes that are currently in the diffusion process. As a result, this dissertation represents

[30] While in a single case, a straw in the wind test is not compelling, when a hypothesis passes multiple straw in the wind tests across a series of case studies (like in this dissertation), it does add up to important affirmative evidence. Hoop tests set a more demanding threshold than straw in the wind tests, the hypothesis must "jump through the hoop" to remain under consideration, therefore the hypothesis, while not sufficient, becomes a necessary factor when exploring causality. David Waldner, "What makes process tracing good? Causal mechanisms, causal inference, and the completeness standard in comparative politics," in Andrew Bennett and Jeffrey Checkel, *Process Tracing from Metaphor to Analytic Tool* (Cambridge, UK: Cambridge University Press, 2014): 128.

the only in-depth study within the political science literature that studies *in-process diffusion*.[31] While there has been a proliferation of scholarship across disciplines related to diffusion, significant limitations exist, the most prevalent of which is a "pro-innovation" bias within the literature. As Adam Grissom noted in his review of the military innovation literature, military innovation studies tend to be consequentialist, as military practitioners and scholars only study changes to practices that result in positive outcomes.[32] Due to the positive value-laden aspects of innovation studies, scholars often implicitly assume that adopters are more agile. Yet, some actors may not benefit from adoption and some new ideas may not necessarily yield improvement. Due to this limitation in the scholarship, we know very little about technologies or ideas that diffuse slowly, about choices of rejection, or even the discontinuance of a new idea or technology. This dissertation chose to study in-process diffusion to help fill that gap. By employing process tracing to better understand the ongoing diffusion of synthetic training, one can begin to better understand why some countries may, for real and rational reasons, choose *not* to adopt those technologies. Indeed, it shows, particularly in the case of Japan, that the Japanese Self Defense Force (JSDF) may have chosen to not adopt LVC for geostrategic reasons. The JSDF's preference for live exercises over synthetic options may be due to its desire to signal its developing military capabilities to the Chinese and North Koreans. As a result, collective training activities may be serving dual purposes—both deterrence and training. LVC could theoretically undermine elements of that signaling-based deterrence mission.

Third, this dissertation helps to revise and extend some widely accepted diffusion theories. Contrary to adoption capacity theory, a country's financial and organizational capital do not appear to be main factors driving the adoption of synthetic training. This could partially be related to the type of technology that is under examination in this study—notably a capability that, while partially drawing on hardware, is primarily software based. Indeed, software development—particularly for synthetic training—is not so much a function of financial capital, but of human capital, in the form of skilled labor. In short, software development can be challenging, but it is not necessarily cost prohibitive in terms of material, or labor. While a broader examination of the diffusion differences between software and hardware warrants further examination and is beyond the scope of this dissertation; this dissertation can nevertheless claim to be one of the first in-depth studies in the diffusion literature that assesses capabilities that are primarily software based.[33]

Additionally, this dissertation demonstrates that the perceived presence of geostrategic competition consistently acts as the greatest explanatory factor when assessing whether a country chooses to adopt a technology that can aid in future battlefield effectiveness. This has several implications. First, the findings run counter to the main research programs within technological innovation studies—comparative political economy, production regimes, and systems of innovation—that omit the geostrategic threat environment as a variable in country innovation.[34]

[31] The exception may be Michael Horowitz article on the diffusion of artificial intelligence. See, Michael Horowitz, "Artificial Intelligence, International Competition, and the Balance of Power," *Texas National Security Review* 1.3 (May 2018).
[32] Adam Grissom, "The Future of Military Innovation Studies," *Journal of Strategic Studies* 29.5 (2006): 350.
[33] Horowitz' article on diffusion and artificial intelligence is the exception. See, Horowitz, "Artificial Intelligence, International Competition, and the Balance of Power."
[34] See, for instance Michael Porter, *The Competitive Advantage of Nations* (New York, NY: Free Press, 1990), Dan Breznitz, "National Institutions and the Globalized Political Economy of Technological Change: An Introduction,"

Rather, it bolsters an emerging field of study that demonstrates that geopolitical competition acts as a determining factor when understanding state level technological change, by showing that state diffusion and adoption decisions mirror indigenous state innovation practices.[35] Second, it also adds two important nuances to the extant international security studies literature exploring the relationship between geostrategic competition and the diffusion of military best practices. Scholarship within this field finds that international competition drives state-level emulation—a movement towards homogeneity on the part of states.[36] However, the case studies in this dissertation demonstrate that is not the case. First, as will be shown, particularly in the case of Japan, state level adoption decisions are not based on the geostrategic threat environment itself, but more specifically on elite *perceptions* of that threat environment.[37] Second, while the geostrategic threat environment may act as the main driver for adoption decisions, it does not incentivize emulation. States, for a variety of reasons, may choose to not adopt or reinvent aspects of their synthetic training regime—much like Japanese decisions to not adopt LVC. A sameness in synthetic training regimes across states, even when facing a similar competitor or potential adversary, does not emerge.

Finally, this dissertation argues for the importance of intellectual humility when engaging in theory development or theory testing, particularly when theoretical findings may have strong policy implications. While overarching trends may emerge that act as drivers for state adoption practices—like geostrategic competition—states often make decisions for a range of state-specific and idiosyncratic reasons. For that reason, while theory can be a useful guiding tool when developing policy best practices, it is important to also dive into a state's unique history, geography, and strategic culture before choosing to apply or execute against those policy proposals.

Plan of Dissertation

This dissertation is divided into four sections. The first section provides the foundation of this dissertation. Chapter one draws heavily on literature from engineering and modeling and simulation to provide a historic overview of synthetic training, to include LVC and a multi-domain synthetic training environment. Chapter two details the academic literature on diffusion, while also highlighting the various alternative hypotheses that may explain the diffusion of synthetic training innovations. Chapter three outlines this dissertation's methodology and country case selection. In particular, it provides an overview of how this author intends to answer the difficult question of *why* states make specific synthetic training adoption decisions.

Review of Policy Research 26.1 (2009): 1-11, and Peter Hall and David Soskice, *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage* (New York, NY: Oxford University Press, 2001).

[35] See for instance recent studies that track the presence of geopolitical competition against indigenous innovation rates. Matthew Brummer, "Innovation and Threats," *Defence and Peace Economics* 33.5 (2022): 563-584 and Mark Taylor, "Toward and International Relations Theory of National Innovation Rates," *Security Studies* 2.1 (2012): 113-152.

[36] See, for instance, Kenneth Waltz, *Theory of International Politics* (Reading, MA: Addison-Wesley, 1979), Joâo Resende-Santos, *Neorealism, States, and the Modern Mass Army* (New York: NY, Cambridge University Press, 2007) and Joâo Resende-Santos, "Anarchy and Emulation of Military Systems: Military Technology in South America, 1870-1930," *Security Studies* 5.3 (1996).

[37] This mirrors Taylor Fravel's findings on Chinese military elite perceptions, see, Taylor Fravel, *Active Defense: China's Military Strategy since 1949* (Princeton, NJ: Princeton University Press, 2019).

Section two assesses the diffusion of LVC through two case studies in chapters four and five—Australia and Japan, a high and low adopter respectively. By testing the alternative hypotheses, chapter four demonstrates that Australia's adoption of LVC can primarily be explained by the state's perceived geostrategic threat environment, in particular China's military rise. It also shows that the presence of high-level civilian and military champions and ongoing military-to-military contact with the US are necessary factors in its adoption decisions, while organizational agility and cultural similarity, via normative groupings like the Five Eye groupings, are relevant, but not indispensable factors in the adoption of LVC. Chapter five assesses Japan's low, to non-existent, adoption of LVC. It shows that Japan's historic perception of its geostrategic environment is a necessary factor when assessing the JSDF's adoption of LVC. Counterintuitively, in lieu of driving increased adoption, Japanese threat perceptions may be causing the JSDF to choose not to adopt these technologies, as the JSDF favors live training options over synthetic ones as a form of deterrence and signaling vis a vis its more assertive neighbors. It finds that the lack of champions, both civilian and military, may also help explain why the force has also chosen to not adopt these capabilities thus far. Military-to-military contact with the US should also appear to be a necessary factor in its adoption decisions, but once again, it could paradoxically shed light on why the JSDF chooses to not adopt LVC. Indeed, the presence of American LVC capable ranges on Japanese soil may provide opportunities for the JSDF to take advantage of these capabilities without making the requisite technical investments. Organizational propensity for reform and cultural similarity do not appear to pass the evidentiary threshold in the case of Japan.

Section three explores the diffusion and adoption of multi-domain synthetic environments within Israel, a high adopter, and Canada, a low adopter of the technologies. Chapter six demonstrates that Israel's pronounced threat environment acts as the greatest contributing factor for its adoption of a multi-domain synthetic training environment. The presence of organizational agility within the force, military-to-military contact, particularly with the US, and military champions appear relevant to their adoption decisions, but not indispensable. Civilian champions and culture do not appear to pass the evidentiary threshold. Interestingly, religion also appears to be a relevant factor when assessing Israel's adoption decisions, but it does not pass the "hoop test." Chapter seven assesses Canada's lack of adoption of a multi-domain synthetic training environment. It concludes that Canada's secure geostrategic environment acts as the greatest explanatory factor when assessing Canada's low adoption to date. Additionally, Canada's lack of civilian champions and ongoing military-to-military contact with the US act as necessary factors when identifying why the Canadian Armed Forces (CAF) possess a low adoption rate. Organizational agility and shared normative grouping, like the Five Eye grouping, appears to be relevant when assessing reasons for CAF adoption of synthetic training, generally, but is not a necessary factor. Finally, shared culture does not appear to pass the evidentiary threshold.

The conclusion—section four and chapter seven— summarizes this dissertation's key findings and empirical results. It demonstrates that aspects of the diffusion literature are ripe for expansion or refinement. It shows that adoption capacity theory does not suffice in and of itself when assessing software-based technologies. Instead, the perception of geostrategic competition acts as the strongest explanatory factor when assessing the adoption of technologies that can contribute to enhanced battlefield effectiveness.

SECTION ONE: UNDERSTANDING THE DIFFUSION OF SYNTHETIC TRAINING

Figure 3: Soldiers from Britain's Royal Artillery train in a "virtual world" during Exercise Steel Sabre, 2015. Image from Google Images, Creative Commons

CHAPTER ONE: WHAT IS SYNTHETIC TRAINING?[1]

In 1992, the US Army stood up their Simulation Training and Instrumentation Command (STRICOM) the precursor to today's Program Executive Office for Simulation, Training, and Instrumentation. STRICOM, in many ways, was born out of the technological improvements in distributed simulation that emerged at the end of the Cold War, most notably SIMNET.[2] Drawing on advancements, like SIMNET, STRICOM's mission was to usher the future of military simulation into the Army, and its website reflected that '90s science fiction style aspiration— complete with a spinning logo that, on one side, depicted a soldier in a futuristic space-style suit equipped with a laser gun and, on the other, a traditionally clad soldier wielding a lightning bolt. The rim of the logo highlighted the command's mantra: "All But War is Simulation."[3]

While some academics have picked STRICOM's maxim apart, noting its lack of nuance and techno-centricity, the mantra does in many ways reflect a broader truism— militaries are primarily in the business of war.[4] Humanitarian assistance, and various forms of diplomacy aside, everything that they do is to prepare for the next conflict. Military training is simply a simulation of what the military believes war is or will become. From the meticulous "bloodless battles" of ancient Roman legionaries, to Maurice of Orange's 17th century drill formations, Prussia's tabletop *Kriegsspeil* wargame, and Ed Link's 20th century "Blue Box" pilot trainer, these training simulations sought to replicate the tactics, maneuvers, or technologies that were to define the battlefields of their respective times.[5] However, if all training is a form of simulation, then how does one begin to differentiate between training in the traditional sense and synthetic training? When do training simulations cross over from live drills, table-top exercises, or large-scale maneuvers into synthetic training simulations? Is it simply the presence of technology that differentiates synthetic training from other types of training? And if so, what types of technology? To understand the diffusion of synthetic training, one needs to first come to grips with synthetic training is. In short, what is synthetic training?

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[1] This chapter is structured in a quasi-narrative format to better illustrate types of synthetic training. It draws on the work of James Der Derian as a model. See, James Der Derian, *Virtuous War: Mapping the Military-Industrial-Media-Entertainment Network* (New York: NY, Routledge, 2009).
[2] For more on SIMNET, see: Miller and Thorpe, "SIMNET: The Advent of Simulator Networking," Cosby, "SimNet: An Insider's Perspective," and Alluisi, "The Development of Technology for Collective Training: SIMNET, a Case History."
[3] For a strong overview on the development of PEO STRI and the military's overlap with the entertainment complex, see Tim Lenoir, "All But War is Simulation: The Military-Entertainment Complex," *Configurations* (Fall 2000).
[4] Der Derian, *Virtuous War: Mapping the Military-Industrial-Media-Entertainment Network,* 82.
[5] Raymond R. Hill and J. O. Miller, "A History of United States Military Simulation," *Proceedings of the 2017 Winter Simulation Conference* (2017): 346-364, Flavius Josephus (translated by G.A. Williamson), *The Jewish War: Revised Edition* (London, UK: Penguin Books, 1959), Geoffrey Parker, "Military Revolution, 1560-1660—a Myth?" *The Journal of Modern History* 48.2 (June 1976): 195-214, Milan Vego, "German War Gaming," *Naval War College Review* 65.4 (2012): 106-1447, and Susan van Hoek and Marion Clayton Link, *From Sky to Sea: A Story of Edwin Link* (Flagstaff, AZ: Best Publishing Co., 1993). There is a rich literature on the historic use of wargames as a form of training simulations, see, for instance: Peter Perla, *The Art of Wargaming* (Annapolis, MD: United States Naval Institute Press, 1990), John Dunnigan, *Wargames Handbook 3rd ed.* (London, UK: Writers Club Press, 2000), and Matt Caffrey, *On Wargaming* (Newport, RI: The Newport Papers, 2019).

To truly understand what synthetic training is, the technologies that underlie it, and the various means by which it is employed, this author spent seven years crisscrossing the globe—meeting with and witnessing training demonstrations from military training providers and industry officials; testing various synthetic training applications, to include flying (and crashing) an inordinate number of virtual sorties; accompanying undersea warfighters on their various synthetic training missions; and now, shepherding new synthetic training technologies into existence and use. This chapter is meant to highlight that journey of discovery, taking the reader from military surface and subsurface training centers in the UK and US, to industry training centers in Canada and Israel, training headquarters in Australia and France, and the largest military training and simulation conference in the world in Orlando, FL, among many other places.[6] At the same time, it draws extensively on literature from modeling and simulation, human systems, and combat engineering, among other disciplines, translating technical training literature to a broader audience—something that has not yet been done in the field of political science or any other related social science discipline.

This chapter proceeds in three main parts. It first breaks down the difference between live and synthetic training, using a rough taxonomy, or rubric, that is largely employed by the training and modeling and simulation communities. Through this high-level rubric it attempts to surface the key differences between live and synthetic training and the types of technologies that are broadly considered to undergird synthetic training. Second, it then applies this rubric to various types of military training at the individual and collective level to provide further clarity on the various ways that synthetic training may manifest. Finally, it concludes by examining two types of synthetic training that are presently in the diffusion process— LVC and a multi-domain synthetic training environment. These two synthetic training applications are the subject of this dissertation from a comparative case perspective.[7]

A note on sources related to synthetic training before this chapter begins. The most reliable sources that cover longer-term trends in synthetic training are technical texts and publications from federally funded research and development centers (FFRDCs), like the Institute for Defense Analysis.[8] When covering in-process diffusion, however, it is important to not just draw on texts

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[6] Places visited over the course of the research for this dissertation to better understand synthetic training included: I/ITSEC—the biggest modeling and simulation conference in the world, Orlando, FL (2015), HM Naval Base, Portsmouth, UK (2016), HMNB Clyde, Faslane, UK (2016), CAE Defence UK, Burgess Hill, UK (2016), CAE Defence Canada, Montreal, Canada (2016), Australian Ministry of Defense, Canberra, Australia (2016), French Ministry of Defense, Paris, UK (2016), I/ITSEC, Orlando, FL (2016), I/ITSEC, Orlando, FL (2017), Le May Center, Maxwell Airforce Base (2018), I/ITSEC, Orlando, FL (2018), Air Education and Training Command Liaison Office, Washington, DC (2019), Shield AI, San Diego, CA (2019), Air Force Modeling and Simulation Agency, Orlando, FL (2019), Kratos, Orlando, FL (2019), Tel Aviv, Israel (2019), US-Israeli Advanced Urban Combat Training Facility, Negev, Israel (2019), I/ITSEC, Orlando, FL (2019), US Army Training and Doctrine Command, Ft. Eustis, VA (2021), Catalyst Campus, Colorado Springs, CO (2021), I/ITSEC, Orlando, FL (2021), and US Army Combined Arms Center- Training, Ft. Leavenworth, Kansas (2022).

[7] As will be explained in the conclusion of this chapter, LVC is slightly different than synthetic training since it includes the integration of the live component. However, the term is often employed under the rubric of "synthetic training" within the training community and therefore is included under synthetic training in this dissertation. The differences, most notably related to run-time and clock speeds, between LVC and solely synthetic (i.e., virtual and constructive simulation) applications will be covered in the final section of this chapter.

[8] FFRDCs are often charged by the government to assess their training regimes, develop standards-based architectures to facilitate synthetic training interoperability (like in the case of the Institute for Defense Analyses and

that capture long-term trends, but more recent documents that highlight the technical state-of-the-art in the field. These documents are not academic in nature. Indeed, as industry is the best source of cutting-edge research and development in modeling and simulation, the best sources are from industry in the form of press releases or via magazines—like the *National Defense Magazine* or *Military Training International.*[9] Conference publications and presentations, both by government and industry officials, are used by the synthetic training community to publicize ongoing programs and recent advancements, and, as a result, papers from the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC) or the Simulation Interoperability and Standards Organization (SISO), among others are highly credible and useful when identifying developing technical trends. Apart from government request for proposals or requests for information, the military will often choose to publicize their various emerging synthetic training programs to a broader audience via press releases or partnerships with media outlets granting journalists or defense editors immense access. Some of the most in-depth coverage of new synthetic training programs have occurred in defense media outlets.

All Training is Simulation

It's impossible to understand synthetic training, simulation, or even training more broadly without first discussing models. If all training is simulation, then all training is also the implementation of models. Modeling and simulation are so frequently referred to together, and used within such diverse contexts, that their precise meaning has become somewhat difficult to delineate.

> *Military modeling...is a term which is so general as to be nearly meaningless out of context. On the one hand, it may represent an attempt to calculate the effects of a nuclear weapon detonation on a target; on the other hand, it may be a representation of a global war scenario in order to predict wartime field test exercises, or it may be a sophisticated advanced mathematics representation of selected decision processes…But such diverse applications have many things in common. Each model is an abstraction of a small portion of reality*.[10]

Indeed, in general, modeling is the purposeful simplification of reality. Models abstract reality, while simulations implement those models *over time*.[11] Military simulations allow warfighters or commanders to interact with a simplified abstraction of combat for analytic or, in the case of training, experiential purposes.

LVC), or to assess synthetic training applications. MITRE is known for being a test and evaluation body for modeling and simulation applications for the US Department of Defense.

[9] The modeling and simulation community is very small. Journalists that cover the synthetic training industry tend to have been embedded in the community for years and possess some technical understanding. As a result, their analysis tends to be highly credible, particularly when compared against the technical understanding of some social science texts that have attempted to cover the industry. See, for instance, Der Derian's misreading of the Distributed Interactive Simulation (DIS) as a simulation when in reality it is a well-known technical standard for simulation interoperability. Der Derian, *Virtuous War: Mapping the Military-Industrial-Media-Entertainment Network,* 84.

[10] John Battilega and J.K. Grange, *The Military Applications of Modeling* (Wright Patterson Air Force Base, Ohio: Air Force Institute of Technology, 1984): 7.

[11] In 1998, the US Department of Defense Joint Publication defined a simulation as a "represent[tation] [of] activities and interactions over time. A simulation may be fully automated (i.e., it executes without human intervention), or it may be interactive or interruptible (i.e., the user may intervene during execution)." US Department of Defense, "DoD Modeling and Simulation Glossary: DoDD 5000.9M," *Undersecretary of Defense for Acquisition Technology* (1998).

When Publius Flavius Vegetius Renatus penned book one of his military manual *Epitoma Rei Militaris* around 390 AD, he was describing an idealized form of Roman military training; what was, at its core, an abstraction of Roman fighting—a simulation of combat complete with wooden weapons and tactics that modeled those employed by Roman legionaries in combat.[12] Throughout the Middle Ages, the training of professional mounted knights, dictated that a rigorous system be developed for training—from mock weapons and targets to mock combat, such as jousts and melees, and other events. While these training events were, in many ways, part and parcel of medieval chivalric culture, they also sought to model and simulate feudal warfare.[13] In early modern Europe, when Maurice of Naussau devised a tactical system based on smaller more maneuverable units of men arranged in shallow linear formations, their success was dependent on a disciplined and highly trained force. By implementing a drill training regime, Naussau was abstracting his warfighting tactics, modeling collective fighting efficacy in illustrated drill books, that could subsequently be simulated in training prior to combat.[14] Prior to WWII, when Edward Link designed his "Link trainer," he was, in essence modeling various elements of an aircraft, that could simulate the experiences a pilot may encounter in live flight.[15] Likewise, the Germans, in an attempt to experiment and simulate maneuver warfare during the interwar years, employed bicycles and simple trucks in lieu of mechanized assets to train for their lightning-thrust Blitzkrieg tactics, which would define WWII.[16] With various levels of fidelity, training, throughout history, has sought to abstract and simulate expectations of combat.

The story of synthetic training, however, at least how it is commonly understood in the modeling and simulation community today, can largely be traced back to the advent of computer modeling, and its subsequent implementation in training.[17] Indeed, by the 1970s, models, solely as abstracted elements of combat, gave way to a desire for greater precision in training. Computer modeling

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[12] Vegetius was not writing a history, but instead a manual that sought to remedy alleged military failures in recruitment and training, army organization and strategy, and arms and equipment. It is also selective—focusing on areas that Vegetius felt were areas of military weakness and methods of warfare that were specific to the "barbarians" of his time—the Goths, Huns, and Alans. See, N.P Milner (translated), *Vegetius: Epitome of Military Science* 2nd edition (Liverpool, UK: University of Liverpool Press, 2001).

[13] Craig Taylor, *Chivalry and the Ideals of Knighthood in France During the Hundred Years War* (Cambridge, UK: Cambridge University Press, 2013), and John Barnie, *War in Medieval Society: Social Values and the Hundred Years War, 1337-99* (New York: Cornell University Press, 1974), and David Trim (Ed.) *The Chivalric Ethos and the Development of Military Professionalism* (Leiden, Netherlands: Brill, 2003).

[14] Daniel Riches, "Early Modern Reform and the Connection Between Sweden and Brandenburg-Prussia," *Scandinavian Studies* 77.3 (Fall 2005): 347-364, Parker, "Military Revolution, 1560-1660—a Myth?," and Robert B. Manning, "Styles of Command in Seventeenth Century English Armies," *The Journal of Military History* 71.3 (July 2007): 671-699.

[15] van Hoek and Link, *From Sky to Sea: A Story of Edwin Link*.

[16] On German experimentation and training during the interwar years, see: James S. Corum, *The Roots of Blitzkrieg* (Lawrence, KS: University of Kansas Press, 1992).

[17] The first digital models called Carmonette were used as part of an air defense simulation created by the Army Operations Research Office at John Hopkins University in 1948. For a more detailed discussion of the history of digital models within this military see, Roger Smith, "The long history of gaming in military training," *Simulation and Gaming* 41.1 (2010): 6-19. Non-deterministic, "Monte Carlo" simulation methods that included the use of probability and chance also emerged in the mid-1940s when physicists at Los Alamos Laboratory were investigating radiation shielding. Monte Carlo simulation methods undergird many training simulations today. See, Margaret Loper and Charles Turnista, "History of Combat Modeling and Distributed Simulation," in Andreas Tolk, *Engineering Principles of Combat Modeling and Distributed Simulation (*Hoboken, NJ: John Wiley & Sons, 2012): 342.

allowed engineers and training designers to attempt to model all components of perceived importance to a given military operation. Physics models sought to capture in physical detail the various features of platforms from aerodynamics and hydraulics to atmospherics. Logical models undergirded many adjudication functions in combat. While, stochastic models, allowed for the inclusion of random variables and outcomes—a key feature when attempting to simulate the "fog and friction" of combat.[18]

The rise of digital models within training broadly coincided with advances in computer networking. Prior to the 1960s, computer simulation was unidirectional—it provided input to users in a single direction to provide experiential learning opportunities. Users, or warfighters, could not interact with others while playing the simulation. By 1961, that changed with the creation of *Spacewar*—a two-player game that allowed players to fire photon torpedoes from their warring spaceships.[19] Advances throughout the 1960s and 1970s, in particular, the development of UNIX and the Advanced Research Projects Agency Network (ARPANET) opened the door for asynchronous game play in the former instance, and distributed network simulation in the latter.[20] For the first time, simulators, that acted as stand-alone systems designed for specific training outcomes, could be networked together for team training. SIMNET, sponsored by ARPA in partnership with the US Army between 1983 and 1990 was the first project to attempt to exploit these advances in distributed simulation.

Soon after SIMNET was installed, it became apparent to the Army that it was impractical to have many operators controlling both friendly and opposing forces. The military needed a means to add objects to the battlefield without relying on human operators in simulators. Semi-automated forces (SAF)—a computer program that mimics the performance characteristics of different entities on the battlefield—was developed to meet that need. Inspired by the film, *Night of the Living Dead*, the Army wanted a simulation that could produce many "dumb" targets that would roam that battlefield, much like how "dumb" flesh-eating zombies staggered across western Pennsylvania in the movie.[21] SAF met that need, adding greater complexity to SIMNET, and with time, became increasingly more intelligent. Today, SAF can detect and engage targets, plan routes, avoid obstacles, and mimic the pattern of life of different operational areas.

The complexity associated with SIMNET, particularly the inclusion of networked virtual simulators and SAF, spurred the creation of the 1989 Interactive Networked Simulation for Training conference, which soon after became the Distributed Interactive Simulation Workshops.[22] Participants recognized that this emerging community of training providers—

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[18] Jerry Banks, *Handbook of Simulation: Principles, Methodology, Advances, Applications and Practices* (New York, NY: John Wiley & Sons, Inc., 1998).

[19] Loper and Turnista, "History of Combat Modeling and Distributed Simulation," 342.

[20] UNIX is a portable, multi-tasking and multi-user operating system that could handle asynchronous events, such as non-blocking input/output and inter-process communication. ARPAnet was the first wide-area packet switched network with distributed control. It is largely considered the precursor to the Internet today. *Ibid,* 344.

[21] Loper and Turnista, "History of Combat Modeling and Distributed Simulation," 345.

[22] Today, the workshops have become SISO. SISO is an international organization that develops and supports modeling and simulation standards to foster simulation interoperability. SISO is a recognized standards development organization by NATO and by the Institute for Electrical and Electronics Engineers (IEEE). For more information on SISO, see: Simulation Interoperability Standards Organization, "About," accessed 2 August 2022, https://www.sisostds.org/AboutSISO/Overview.aspx.

modeling and simulation experts, distributed simulation experts, training designers, among others—needed a means to effectively communicate about the advances in simulation that were occurring. Out of the workshops came a taxonomy that has been largely adopted by the synthetic training community—live, virtual, and constructive simulations. [23] Understanding synthetic training today starts with this taxonomy.

Simulation	People	Systems	Operation
Live	Real	Real	Simulated
Virtual	Real	Simulated	Simulated
Constructive	Simulated	Simulated	Simulated

Table 1: Live, Virtual, and Constructive Simulations[24]

Synthetic training is generally identified as the use of virtual and/or constructive simulation in training. While this seems simple enough, the taxonomy is far from useful, particularly when assessing it against historic training simulations. Is the Link "blue box" pilot trainer a virtual simulation? It involves real people operating a simulated pilot trainer, resembling a blue box, in a simulated environment, so according to the taxonomy, it should. However, if one were to ask anyone within the synthetic training community today, their response would likely be that the Link trainer was a precursor to virtual simulation. What about the German use of bicycles to practice blitzkrieg maneuvers prior to WWII? Certainly, the soldiers were real, the bicycles simulated tanks, and the operation was simulated, so it would seem to meet the definition of a virtual simulation. However, it is unlikely that anyone today would define those interwar training maneuvers in that way. What then makes a training simulation a virtual and/or constructive simulation?

The implicit element when discussing what qualifies as synthetic training is the inclusion of digital technologies—most notably software-based capabilities, from computer models to interfaces, and 2D or 3D-engines. As a result, while never overtly stated, the synthetic training community has largely coalesced around a shared understanding of what qualifies as live, virtual, and constructive training:

[23] While the live, virtual, and constructive simulation taxonomy, or construct, is the most common classifier within the community for models and simulations, there are three other emerging classifiers that are worth mentioning: gaming, augmented reality, and mixed reality. In many ways, these three classifiers fall under the virtual and constructive rubric, but since these classifiers are used extensively within the synthetic training community today, it is worth defining them separately. See appendix five.
[24] Adapted from Andreas Tolk, "Terms and Application Domains," in Andreas Polk (ed.) *Engineering Principles of Combat Modeling and Distributed Simulation* (Hoboken, NJ: John Wiley & Sons, 2012): 61.

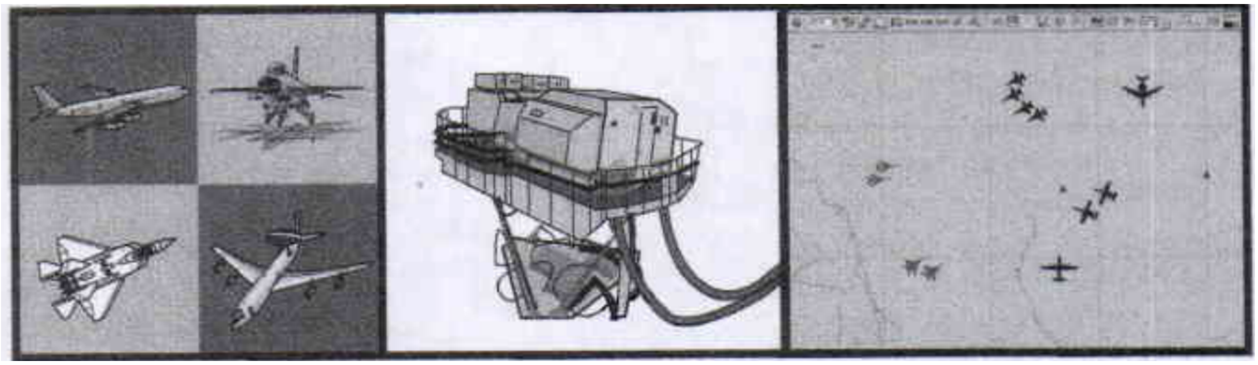

Figure 4: Depictions of Live, Virtual, and Constructive Training Simulation Assets. Image from Daniel Walker and Kevin Geiss, "Future Air Force Training"[25]

- *Live Simulations: Real People Operating Real Systems*

Live simulation involves real people training on physical ranges with actual assets. Like Maverick in the 1986 drama *Top Gun*, live training allows people—and their platforms—to train in the real environment, allowing them to experience the dirt, dust, and sweat of combat on their equipment.[26]

- *Virtual Simulations: Real People Operating Synthetic Systems*

Popularized in society's collective imagination by Orson Scott Card in his novel *Ender's Game,* virtual simulation allows warfighters to perfect their skills in a virtual world prior to the crucible of combat. Virtual simulation can run the gamut of devices from a simple virtual reality headset to a multi-million dollar full-motion simulator that replicates with a high-level of fidelity the interior of a fighter jet, submarine, or other military platform. Simulators will mimic the performance characteristics of military platforms, their instrumentation, support from other combat systems, communication links, and the environment over which a conflict may occur.[27] Like the children that stumble into Narnia in C.S. Lewis' novel *The Lion, the Witch, and the Wardrobe*, virtual training allows the user to enter an entirely different and, at times, evolving combat world.

- *Constructive Simulations: Synthetic People Operating Synthetic Systems*

A constructive simulation is a computer program—the people, platforms, and the environment are simulated. Simulated people and platforms, often called computer generated forces (CGF), model human behavior and act as representations of military entities, to include troops, civilians, and other individuals necessary for the simulation. Constructive simulations can take multiple forms—both semi-automated and fully automated. Semi-automated (SAF) constructive simulations involve some human input prior to the CGFs carrying out their

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[25] Daniel Walker and Kevin Geiss, "Future Air Force Training" in Joseph Cohn et al. (ed), *The PSI Handbook of Virtual Training Environments for Training and Education: Developments for the Military and Beyond* (Westport, CT: Praeger Security International, 2009): 397.

[26] For various sources that break down the differences between live, virtual, and constructive simulation, see, Roger D. Smith, *Military Simulation and Serious Games* (Orlando, FL: Modelbenders LLC, 2009), John A. Sokolowski and Catherine Banks (ed.), *Modeling and Simulation Fundamentals: Theoretical Underpinnings and Practical Domains* (Hoboken, NJ: John Wiley and Sons, 2010), Banks, *Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice,* and Andreas Polk (ed.) *Engineering Principles of Combat Modeling and Distributed Simulation* (Hoboken, NJ: John Wiley & Sons, 2012).

[27] *Ibid.*

assigned function. Fully automated CGFs, on the other hand, employ artificial intelligence as a replacement to human intervention.[28] Constructive simulations can be used for training, defense planning, operations, and acquisitions.[29]

Synthetic training, then, in short, includes the use of digitally based virtual and constructive simulations. The evolution of these technologies has been the key driving force behind the changes that one can witness in synthetic training today.

The Technologies that Undergird Synthetic Training

What then, are the core digital technologies that undergird synthetic training? In general, there are six "layers" of technologies that make up synthetic environments today (see figure five).[30]

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[28] Fully automated CGFs exist, but their intelligence is not strong enough to make high-fidelity decisions for training. When realism is required, semi-automated CGFs are employed. This, however, could change in the future. Mikel D. Petty, "Benefits and Consequences of Automated Learning in Computer Generated Forces Systems," *Information and Security* 12.1 (2003): 63-74.

[29] Ume Dompke, "Computer Generated Forces- Background, Definition, and Basic Technologies," paper presented at the RTO SAS Lecture Series on "Simulation of and for Military Decision Making", (Rome, Italy, 15-16 October 2001) and Nacer Abdellaoui et al., "Comparative Analysis of Computer-Generated Forces Artificial Intelligence," *NATO S&T Organization Meeting Proceedings* (8 October 2009).

[30] This list is partially adapted from Smith, "The Long History of Gaming in Military Training," 8-9.

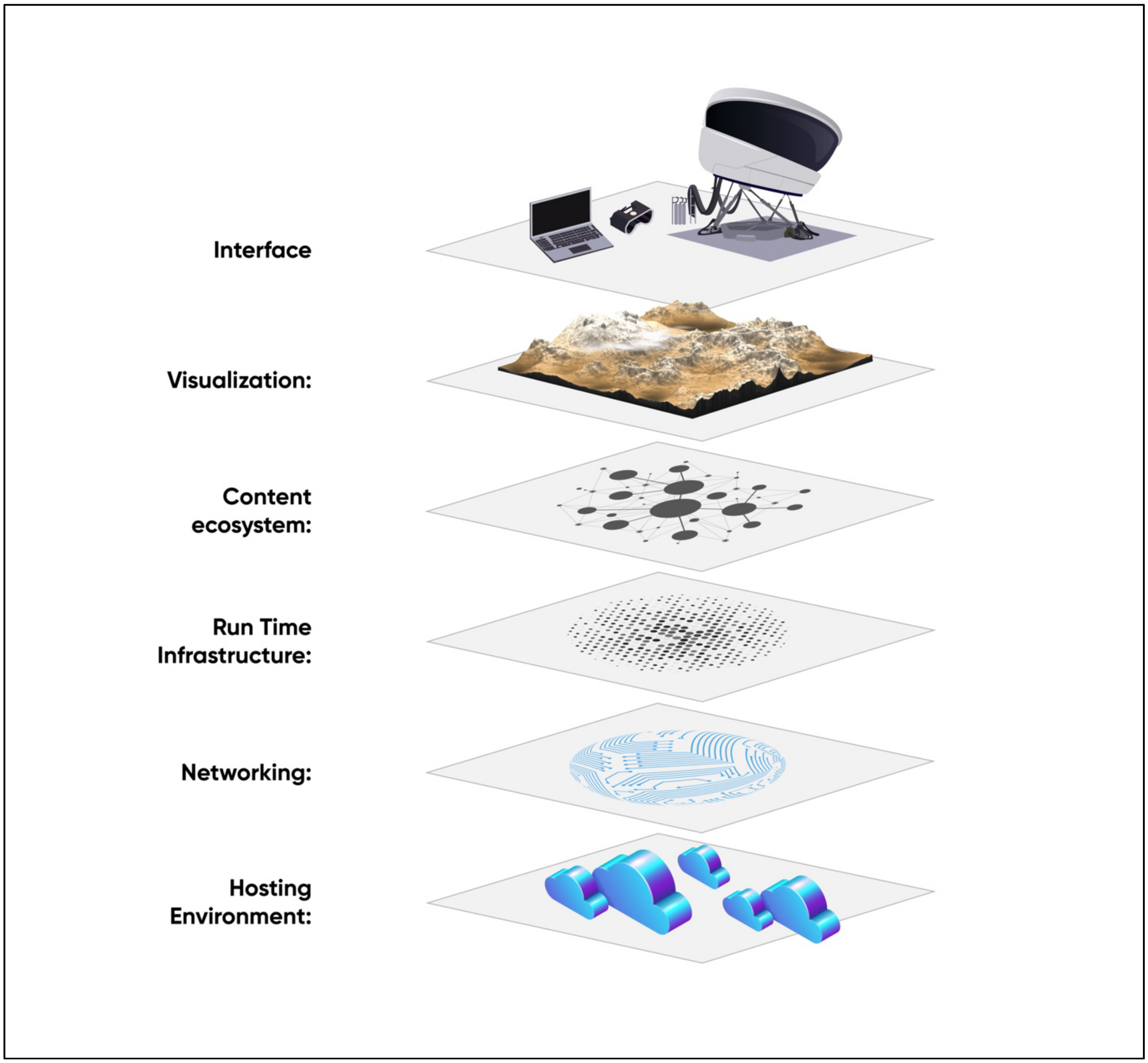

Figure 5: Synthetic Environment Layers, author's own

1. Interface: Warfighters and training providers need a means to "enter" a synthetic environment. Access to a synthetic environment can occur through a range of interfaces depending on the training goal that a synthetic environment is attempting to exercise—from a simple laptop to a virtual reality headset, a mobile device, or a full motion simulator. For instance, introductory training that allows pilots to learn about the various components of an aircraft could be accessed via a tablet or even a mobile phone. While access to SIMNET required members of a platoon to access the environment via tank simulators complete with virtual screens of the battlefield. Synthetic environments that seek to exercise command and control can be accessed via a computer, or if the command-and-control devices are placed in "training mode" they can be accessed via the real command-and-control devices that commanders may use during an operation.

2. Visualization: Visualization of a synthetic environment often takes place via two-dimensional (2D) or three-dimensional (3D) software engines. 2D engines typically

provide a means to visualize events at the operational level of war, helping to train commanders to better exercise command and control. Much like a board game, 2D engines will provide a graphical overview of a given theater, allowing people to better visualize the ebb and flow of assets throughout a campaign. 3D engines provide three-dimensional visualizations of a synthetic environment and therefore can be useful training tools across the tactical and operational levels of war—from first person shooter experiences to command and control.

3. Content: The content that undergirds a synthetic environment will include all the software models that make up a simulation—from physical, to logical, and stochastic models. Models will govern the movement, engagement, and interactions that take place within the simulation. Synthetic environment content can also include data or artificial intelligence that is necessary to properly execute a simulation with fidelity, to include data on weapon systems or friendly and adversary force postures, and artificially intelligent entities that can create a more challenging experiential learning environment.

4. Run Time Infrastructure: The runtime infrastructure of a simulation is the middleware—a series of software services—that allows for a simulation to run, while also ensuring interoperability when implementing a distributed simulation. In essence, the runtime infrastructure is a fundamental component of the various interoperability protocols and information exchange models that allows various simulations to work together as one single federation. In a federation, it appears to the trainee that they are interacting with a single simulation versus many distributed simulations stitched together. The three most widely used standards to ensure interoperability across distributed military training simulations are the Distributed Interactive Simulation (DIS), the High-Level Architecture (HLA), and the Training Enabling Architecture (TENA). These three standards undergird many of the distributed synthetic training architectures that are in use today.[31]

5. Networking: Networking technologies allow synthetic training environments to be distributed to warfighters and training providers, regardless of their physical location. In short, much like in civilian applications, networking technologies allow for the exchange of data across various computing devices via transmission lines, switches, routers, among other devices.[32] Depending on the classification of training, militaries also have access to their own classified networks. For instance, the US military's SIPRNet is a medium security network for handling classified information at the secret level or below. While JWICS (the Joint Worldwide Intelligence Communications System), is a secure TCP/IP network that can handle Top Secret information.

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[31] Gabriel Wainer and Khaldoon Al-Zoubi, "An Introduction to Distributed Simulation," in John Sokolwiski and Catherine Banks, *Modeling and Simulation Fundamentals: Theoretical Underpinnings and Practical Domains* (Hoboken, NJ: John Wiley & Sons, 2010): 373-402, Tolk, *Engineering Principles of Combat Modeling and Distributed Simulation,* 187-330 and 449-478 and Dee Andrews and Herbert Bell, "A Virtual Environment Application: Distributed Mission Operations," in Joseph Cohn et al. (ed), *The PSI Handbook of Virtual Training Environments for Training and Education: Developments for the Military and Beyond* (Westport, CT: Praeger Security International, 2009): 77-84.

[32] Andrew S. Tanenbaum and David J. Wetherall, *Computer Networks 5th edition* (Nodia, India: Pearson India Education Services, 2014).

6. Hosting Environment: Any synthetic environment needs to be hosted from a compute standpoint. Hosting can take place on a public cloud, a private cloud, or via an on-premises bare-metal server.[33] The emergence of hybrid clouds allows the military to leverage private clouds or on-premises infrastructure, while simultaneously utilizing the benefits of the public cloud for their synthetic environments, as appropriate for security and point-of-need requirements. The use of cloud services for hosting provides immense performance benefits for synthetic training environments. Dispersing computer processing across hundreds, if not tens of thousands of machines, can allow multiple simulations to run concurrently and in seamless coordination, facilitating more persistent synthetic environments with greater realism.

A baseline understanding of the various "layers" of technologies that make up a synthetic training environment, however, does not necessarily get an individual closer to understanding what synthetic training means in practice. To come to grips with how synthetic training is deployed, this author traveled extensively around the globe to witness synthetic training events, to better understand how they can—and, at times, cannot—meet various training end goals.

Synthetic Training in Action: Individual and Collective Training

It is impossible to fully understand synthetic training, without first having some rudimentary knowledge of military training. Indeed, synthetic training is simply another means to train at the individual or collective level, whether that is in residence or among operational units. The tools—and technologies—used in training, and the way in which a training environment is designed, is meant to serve various training purposes or end-goals.

	Where Training Takes Place	
Who is Trained	**Residence**	**Operational Units**
Individuals	Training directed by training organizations to cultivate individual skills and knowledge in centralized and formally convened settings.	Training directed by operational units to cultivate individual skills in distributed settings.
Collective	Training to attain crew, team, and unit performance standards in centralized and formally convened settings.	Training to attain crew, team, and unit performance standards in operational units and other distributed settings.

Table 2: Adaption of General Paul Gorman's Matrix: Components of Military Training[34]

Individual Training

For most new recruits within the military, the military is an entirely new professional calling. Unlike most civilian professions, the military's organizational culture is shaped by the exigencies of warfare—it must prepare its recruits to enter harm's way and perform mentally and physically taxing tasks at the highest levels of proficiency. Every service has an initial entry training program

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[33] Examples of public cloud providers include Amazon Web Services or Microsoft Azure Cloud. The cost associated with hosting a synthetic training environment on a public cloud is dependent on the computational requirements, which is directly tied to the complexity of the simulated environment. Private clouds in use by the military include the US Air Force's PlatformOne cloud platform. A bare metal server is a computer server that provides a hosting option when security and classification may be of immense concern. For an overview of cloud computing, see: Erl Thomas et. al, *Cloud Computing: Concepts, Technology, and Architecture* (Upper Saddle River, NJ: Pearson, 2013).

[34] Adapted from J.D. Fletcher and P.R. Chatelier, "An Overview of Military Training," *Institute for Defense Analyses Document* 2514 (2000): IV-1 and Paul Gorman, "The Military Value of Training," *Institute for Defense Analyses Paper* 2515 (1990).

that is typically divided into two phases: a "boot camp" that seeks to inculcate the foundational skills and culture of a given service and then a later, more advanced "residential" phase, that seeks to develop skills specific to a recruit's assigned specialty—whether that is intelligence, cyber warfare, a mechanic, pilot, or even a dental hygienist.[35] Residential training of individuals is typically called "school house training." It is administered by military schools and operational units and takes place throughout a service members career to ensure they obtain and maintain the requisite skills and knowledge to perform their assigned tasks. Unit training of individuals transpires when an individual is assigned to an operational unit. Like residential training, unit training helps to ensure proficiency in an individual's assigned tasks, however, those tasks are specified by the billets and equipment found within the unit, versus the more standardized residential training.[36]

In the labyrinthine corridors of the Pentagon, in a small office attached to Air Education and Training Command (AETC), one can experience individual synthetic pilot training firsthand. Sitting in a seat with a joystick between one's legs and a virtual reality headset, AETC can place the trainee in varied landscapes and weather conditions, forcing the trainee to become better accustomed to the mechanics of flight. Apart from a virtual reality headset (and far more sophisticated visualization), the technology is reminiscent of the Microsoft flight simulators that were released to the public in the 1990s. However, the lack of technical sophistication does not hinder trainee immersion—far from it. After asking to fly an F-35, the AETC liaison placed me over my hometown, Washington D.C. After poorly circling over the Capitol, I attempted to bank left towards my home, only to inadvertently steer the craft in the wrong direction. Patiently the liaison sought to explain how to maneuver the aircraft, and somehow through his instructions and blind luck, I found myself once again over the Capital—feeling very motion sick. Seeing that there was no way I was going to make it to the nearest airfield, the liaison suggested I attempt to land on the Washington mall. Despite the size of the target for landing, I came in at an angle and unceremoniously crashed adjacent to the Washington monument. Ripping off the headset, I staggered from the chair, somewhat breathless, as I tried to regain my footing from the motion sickness.[37] While I may not be a budding pilot to-be, the US Air Force sees these synthetic training devices, under their "Pilot Training Next" program as representative of the future of pilot training—providing more rigorous and tailored training, at the airman's point-of-need, at a fraction of a cost of traditional pilot training (see figure six).[38]

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[35] Jim Greer, "Training: The Foundation for Success in Combat," *Heritage*, 4 October 2018, retrievable at: https://www.heritage.org/military-strength-topical-essays/2019-essays/training-the-foundation-success-combat.

[36] Fletcher and Chatelier, "An Overview of Military Training," IV-4.

[37] Meeting at Air Education and Training Command, Washington D.C., 26 April 2019.

[38] For an overview of the Pilot Training Next program, see: Jennifer Lewis, Kathryn Thompson, and Tobie Smith, "Learning Next: Self Improving Competency-based Training Rooted in Analytics," *Interservice/ Industry Training, Simulation, and Education Conference* 19302 (2019) and Jamie Hunter, "The Truth about the Air Force's Biggest Changes to Pilot Training Since the Dawn of the Jet Age," *The Drive,* 3 August 2021, https://www.thedrive.com/the-war-zone/41789/the-truth-about-the-air-forces-biggest-changes-to-pilot-training-since-the-dawn-of-the-jet-age.

Figure 6: US Air Force Pilot Training Next, author's own

Pilot Training Next devices are just one example of the individual synthetic pilot training tools that can be deployed in residence or at an operational unit. Indeed, at CAE's headquarters in Montreal one can begin to experience the full suite of individual training tools that facilitate the pilot training pipeline. At one end of the spectrum, on a long, cavernous factory floor, are simple touch screens that depict an aircraft's control system, allowing pilots to memorize and begin to build the muscle memory required to control and maneuver an aircraft. At the other end of the spectrum are multi-million dollar full-motion training simulators. From afar these large simulators resemble floating domes suspended by hydraulics, but the inside mimics with a high degree of fidelity the interior of specific military aircraft—depending on the simulators specific design. For classification reasons, CAE offered to let me fly a civilian full motion simulator. While the "switchology" and capabilities of the craft differed, the experience broadly mirrored the types of training that a military pilot may encounter. Much like the "Pilot Training Next" device, the full motion simulator requires the pilot to handle a joystick to control the speed and altitude of the aircraft, but in addition a full panel of aircraft controls are situated in front of the trainee, providing haptic feedback like they would receive in live flight. Sitting in the pilot seat, I was placed in a 737 over Amsterdam. A CAE employee sat next to me in the co-pilot seat and sought to explain how to maneuver the aircraft. Behind us was an empty seat that typically would be assigned to the training provider, allowing them to inject in various effects, such as weather events, or electrical or mechanical failure, that a pilot may need to respond to in-flight. A large virtual screen wrapped around me and my co-pilot resembling the front window of the aircraft. I stared out over the semicircular rings of canals across Amsterdam, the gabled homes, and dual pitched roofs—attempting to focus on the task at hand versus the visual richness of the surroundings. As I directed the aircraft, the simulator moved with me, mimicking the flight of the plane, tilting left as I banked left. With the aid of my co-pilot, I located Schiphol Airport and sought to land the craft. But my attempts at leveling the plane were fruitless, we continuously tilted left and right, until a wing clipped the tarmac and my screen exploded into colors of red and orange. I failed, worse, if this had been a live flight, the damage in lives would have been immense, and the realism of that experience caused my legs to slightly shake. Climbing down the steep metal stairs from the simulator, I gripped the handrails worried that my legs would betray me, and I would fall.[39]

Individual synthetic training devices, however, do not have to be pilot specific. The U.S. Army Training and Doctrine Command (TRADOC) has developed playing cards that upon scanning a QR code, allow a soldier to pull up a virtual image of a US or adversary weapon system on their mobile device, allowing the soldier to manipulate the device in 3D to quickly identify the platform and learn the weapon system's components.[40] At the US Army's National Simulation Center at Ft. Irwin, soldiers are using low-cost commercial off the shelf technologies—like augmented reality headsets and commercial game engine assets—to develop virtual mock-ups of the future battlespace, in an attempt to help soldiers better visualize multi-domain operations (see, figures seven and eight).[41] Using the Unity game engine and open-source terrain models, like TomTom for visualization, soldiers can move within moments from operational level depictions of potential force engagements to tactical visualizations that show street level views of how an urban battle could unfold or how a wet gap river crossing could occur. Military iconography—of artillery or even weapons platforms—can be "picked up" by soldiers and moved around the maps. Upon moving close to certain symbols, like unmanned aerial vehicles, the icon can transform into a 3D image of the weapon system. The hope is that these visual tools can be deployed anywhere and at any time, simply by accessing an edge network with an augmented reality device in a rucksack.[42]

[39] Meeting at CAE headquarters, Montreal, Canada, 26 July 2017.
[40] Meeting at US Army Training and Doctrine Command, Ft. Eustis, VA, 12 August 2021.
[41] This is not unlike traditional tools that have been used in the past to visualize terrain and the movement and maneuver of troops in the field. Indeed, maps, sand tables, and ad-hoc model building tools, to include colored ribbons or blocks, have long been used to build mental models at both the individual and collective level. See, for instance, Anthony King, *The Combat Soldier: Infantry Tactics and Cohesion in the Twentieth and Twenty-First Century* (Oxford, UK: Oxford University Press, 2013): 282-287.
[42] Meeting with the US Army National Simulation Center, Ft. Leavenworth, KS, 8 March 2022.

Figure 7: Operational-level augmented reality view of a multi-domain battle with space, electronic, and cyber assets in the Baltics, author's own

Figure 8: Tactical level augmented reality view of Kansas City, MO to demonstrate how easy it is to visualize different parts of the globe through open-source software, author's own

Additionally, like the simple virtual replicas of flight control systems at CAE, British submarines at Faslane showed me their computer-based virtual mock-ups of the inside of a submarine—

allowing submariners to learn the physical plans and set-up of a submarine before setting foot in the U-boat.[43] In Israel, Bagira Systems—Israel's largest synthetic training provider—employs a mix of virtual screens and laser-guided rifles to provide marksmanship training to soldiers.[44] While, virtual medical training devices allow military medics to hone the tools of their trade prior to operating on a live casualty (see figure nine).[45] Synthetic training can take many different forms.

Figure 9: Virtual chest press trainer, Wikimedia Commons

While training—and synthetic training devices—do equip individuals with skills that will be essential in combat, the core focus of military training is not the individual, but the collective.[46] Indeed, collectives are the defining characteristic of military operations. It is challenging to

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[43] Meeting at Her Majesty's Naval Base, Clyde, Faslane, Scotland, 12 March 2016.
[44] Conversation with Yaron Mizrachi, CEO of Bagira Systems, 26 January 2022.
[45] M.B. Pettitt, M. Mayo, and J. Norfleet, "Medical Simulation Training Systems," in D. Cohn, J. Nicholson, and D. Schmorrow, *The PSI Handbook of Virtual Environments for Training and Education, Volume 3: Integrating Systems, Training, Evaluations, and Future Operations* (Westport, CT: Praeger Security International, 2010): 115-125 and J.A. Sokolowski and C.A. Banks, *Principles of Modeling and Simulation: A Multidisciplinary Approach,* 221-223.
[46] King, *The Combat Soldier,* 223, Strachan, "Training, Morale and Modern War," 225, and Fletcher and Chatelier, "An Overview of Military Training," IV-1.

identify a military operation that does not involve the performance of a unit, team, group, or a crew. As a result, as the Institute for Defense Analysis has noted, "[individual training] is intended only as a means to produce successful—competent and proficient—collectives."[47] For that reason, some within the military view individual training as more of a personnel issue or an infrastructure cost (alongside the costs of transportation or medical costs), rather than a training issue.[48]

Collective Training

Much like individual training, collective training can be divided into two main categories: residential and unit training. Residential training of collectives falls under the purview of local commanders and is primarily conducted within units. Some residential training, however, takes place outside local units and is run by organizations who are charged solely with collective training. Examples of the latter include the US Army's National Training Center at Fort Erwin, which provides force-on-force battalion and brigade training at an instrumented training range in the Mojave Desert and the Red Flag exercises that provide high-fidelity aggressor squadron training at Nellis Air Force base in Nevada. Unit training of collectives is the most common form of military training. While residential schools prepare pilots, infantry, cooks, or mechanics to a certified level of proficiency, the training warfighters receive in units to perform their jobs as a collective with specific equipment is the largely considered the most important element of training.[49]

Collective training exercises can take many forms, which influences the synthetic training tools in use. In general, however, collective training is defined by the training of teams. Teamwork can begin with two warfighters working together, advances into simple complex tasks, and then finally evolves into far more complex collective tasks, with a far greater number of individuals.[50]

In Faslane, UK, in a large dim room, a full-motion simulator provides collective training opportunities to British submariners. A metal staircase connected to metal grates creates a rickety walkway that snakes across the wall allowing a group of individuals to enter the simulator at height. The simulator is cavernous and dark and mimics elements of the control room of a submarine, allowing a team of individuals to command the boat's sonar and periscope, among other tools. Several chairs sit at the front of the simulator adjacent to a large control area for the trainees, and behind, abutting the back of the simulator is a large row of seats for spectators. I was joining a group of submariners as they practiced emergency procedures. Taking my seat in the rear, I buckled in. After one submariner barked out a series of commands, the simulator started to slowly sink as if we were in the midst of a dive, yet, suddenly, we lurched to the side. I slammed against my neighbor who was buckled in next to me and felt relieved I had decided to tighten my belt before the training procedure began. Smoke started to pour into the simulator as if it was on fire. More commands were yelled out in succession amongst the crew and the simulator (or

[47] Fletcher and Chatelier, "An Overview of Military Training," IV-1.
[48] A.S. Collins, *Common Sense Training: A Working Philosophy for Leaders* (San Rafael, CA: Presidio Press, 1978).
[49] Fletcher and Chatelier, "An Overview of Military Training," IV-5.
[50] US Department of the Army, "Train to Win in a Complex World Field Manual 7-0," *Headquarters Department of the Army* (October 2016), 1-5. See also, Susan G. Straus, "Collective Simulation-Based Training in the US Army," *RAND* (2019).

submarine) slowly started to rise and straighten and the smoke started to gradually dissipate. We had reached "periscope depth" and the short emergency training maneuver was complete.[51]

Yet, collective synthetic training events can take on far greater complexity, with a far more diverse range of warfighters involved.[52] Indeed, command post exercises, which focus on the battle readiness of staffs—whether at the strategic, operational, or tactical level—are exercises in which the forces being controlled are simulated. [53] In short, they are constructive (i.e., computer generated) simulations. During a command post exercise, the commanders and staff are being trained on the systems that they would use during a real exercise. The main difference is that all the input—from aircraft tracks to logistics reports— to their systems are being generated by the constructive simulation. As the commanders and staff train, everything they observe seems real.

When walking into a command post exercise, typically there is a large situational display at the front of the room that visualizes the region that a conflict is taking place in. Rows of tables are lined up and each person has their own computer screen—they may be observing a smaller image of what is displayed at the front of the room or something more specific to their area of expertise, like cyber. Each row of tables has a specific operational responsibility. For instance, one table could be assigned to the judge advocate. Any decision to strike a target would go the judge advocate to advise on whether that target is reasonable. Another table may be specific to public affairs—helping to assess what information can be released to the public. While another could be specific to tanker missions. Together, with a feed from the constructive simulation that drives simulation events, the trainees go through the motions as if an operation is underway (see, figure ten and eleven and twelve for examples of computer displays).[54]

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[51] Meeting at Her Majesty's Naval Base, Clyde, Faslane, Scotland, 12 March 2016.

[52] The types of exercises highlighted are not exhaustive. They are simply meant to highlight the different types of synthetic training tools that may be employed by military forces. Other types of training exercises could include emergency deployment readiness exercises, joint training exercises, tactical exercises without troops, logistics coordination exercises, among others. For a more exhaustive list, see: Department of the Army, "Training in Units: Training," *Department of the Army, AR 350-41* (1993).

[53] *Ibid,* 39.

[54] Interview with Barry McArdle, former lead architect of the US Air Warfare Simulation, 19 August 2021.

Figure 10: Example of a Command Post Exercise. Image from US Department of Defense

The world's largest command post exercises took place nearly every year in Korea up until 2018.[55] Entitled Exercise Ulchi Freedom Guardian (previously known as Ulchi Freedom Focus), the exercise acted as a computer-simulated defensive exercise between American and South Korean forces to ensure their readiness to protect and maintain the stability of the Korean Peninsula. During each exercise, up to 30,000 US troops participated (many of which were distributed outside the peninsula) alongside approximately 55,000 Korean.[56] A range of constructive simulation systems were used throughout the exercise, from the US Air Force's Air Warfare Simulation to the US Marine Corps Maritime Tactical Warfare Simulation, and the US Army Corps Battle Simulation.[57] Command post exercises, like Ulchi Freedom Guardian, are typically two weeks long, with the first week focused on the start of hostilities. The second week will focus on the middle or the end of hostilities. Trainees design the air tasking order and the simulation then executes that order. Exercises can be continuous 24-7 events or they can be put on hold at the end of the working day.

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[55] Dagyum Ji, "US, South Korea agree to end Freedom Guardian joint military drill," *NK News,* 3 June 2019, https://www.nknews.org/2019/06/u-s-south-korea-agree-to-suspend-freedom-guardian-joint-military-drill/.

[56] Tolk, *Engineering Principles of Combat Modeling and Distributed Simulation,* 843 and US Department of Defense, "DoD Announces Start of Exercise Ulchi Freedom Guardian," *Department of Defense News,* 18 August 2017, https://www.defense.gov/News/News-Stories/Article/Article/1282738/dod-announces-start-of-exercise-ulchi-freedom-guardian/.

[57] Conversation with Brig. Gen. (ret.) Barry Barksdale, 23 April 2020 and 5, JAPAN//US American training provider, 28 April 2020. Both Brig. Gen. Barksdale and the American training provider served in Korea and participated in Ulchi Freedom Guardian exercises.

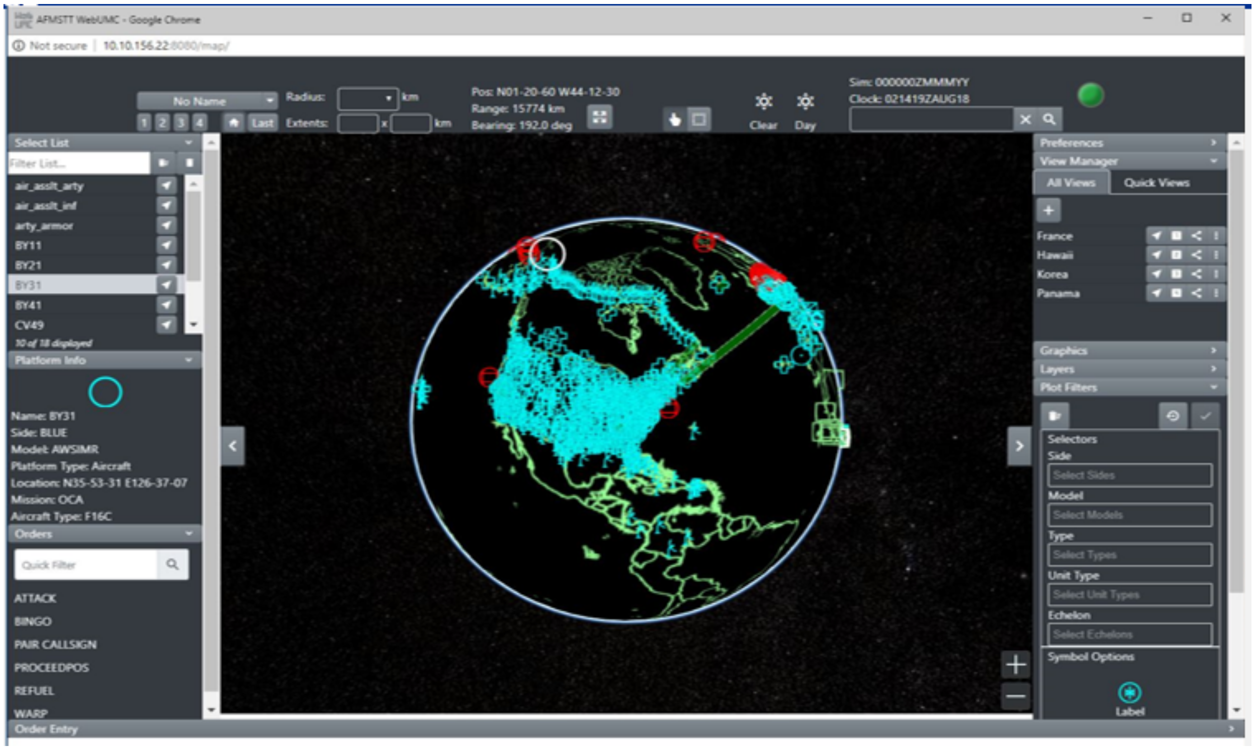

Figure 11: US Air Force Modeling and Simulation Training Toolkit Web Unified Mission Control. Image from Barry McArdle, "CW2SPTT / AFMSTT Comparison Study," US Air Force, 17 November 2017

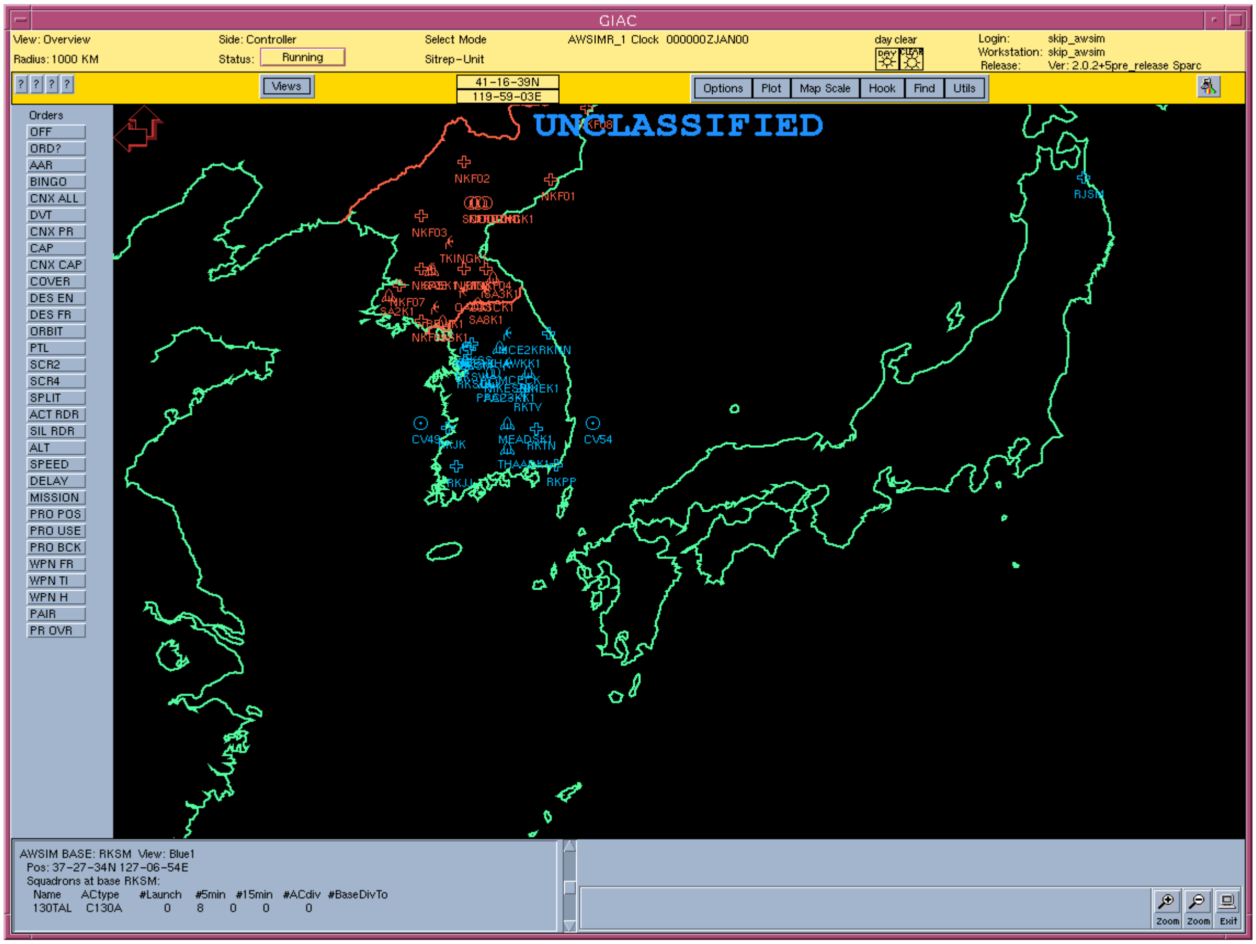

Figure 12: Air Force Modeling and Simulation Training Toolkit Geo-Situational Display. Image from Barry McArdle, "CW2SPTT / AFMSTT Comparison Study," US Air Force, 17 November 2017

Collective synthetic training exercises are becoming increasingly complex as militaries seek to design training events that better mimic their conceptions of future competition and conflict. New weapon systems and operational concepts are forcing training providers to rely more heavily on synthetic training applications, particularly as the live environment can create certain training restrictions, both in terms of range space, but also when incorporating various effects, like cyber. As a result, two types of synthetic training—LVC and a multi-domain synthetic training environment—have become the aspiration for many militaries and are presently in the diffusion process. These two synthetic training applications are the focus of this dissertation from a comparative case standpoint and therefore deserve slightly deeper analysis.

Synthetic Training in the Diffusion Process: LVC and a Multi-Domain Synthetic Training Environment

Live, Virtual, and Constructive (LVC) Training

Like definitions of synthetic training, a simple definition of LVC is elusive. Multiple definitions co-exist. As former US Marine Corps Colonel Walt Yates has noted, "LVC is an acronym that is too casually and too frequently used."[58] To some, LVC is a broad term to describe the integration

[58] Peter Buxbaum, "New Wave LVC," *Military Training International* (28 February 2016).

of simulators or simulations with command and control, intelligence, and communication systems.[59] To others, it is the articulation of a desire for an "on-demand, plug and play training capability."[60] The US Air Force has outlined an LVC "nirvana," whereby all Air Force live weapons platforms "are linked together to enable realistic, distributed mission operations in a live, virtual, and constructive environment."[61] These definitions tend to mix a desired end-goal with what LVC is, which generates an understandable amount of confusion. One can begin to define LVC by relying on the broad taxonomy of simulation types that was previously outlined within this chapter—live simulation, virtual simulation, and constructive simulation (see table one).[62] LVC can be thought of as the integration of live, virtual, and constructive simulation assets into one training environment (see figures thirteen and fourteen).[63]

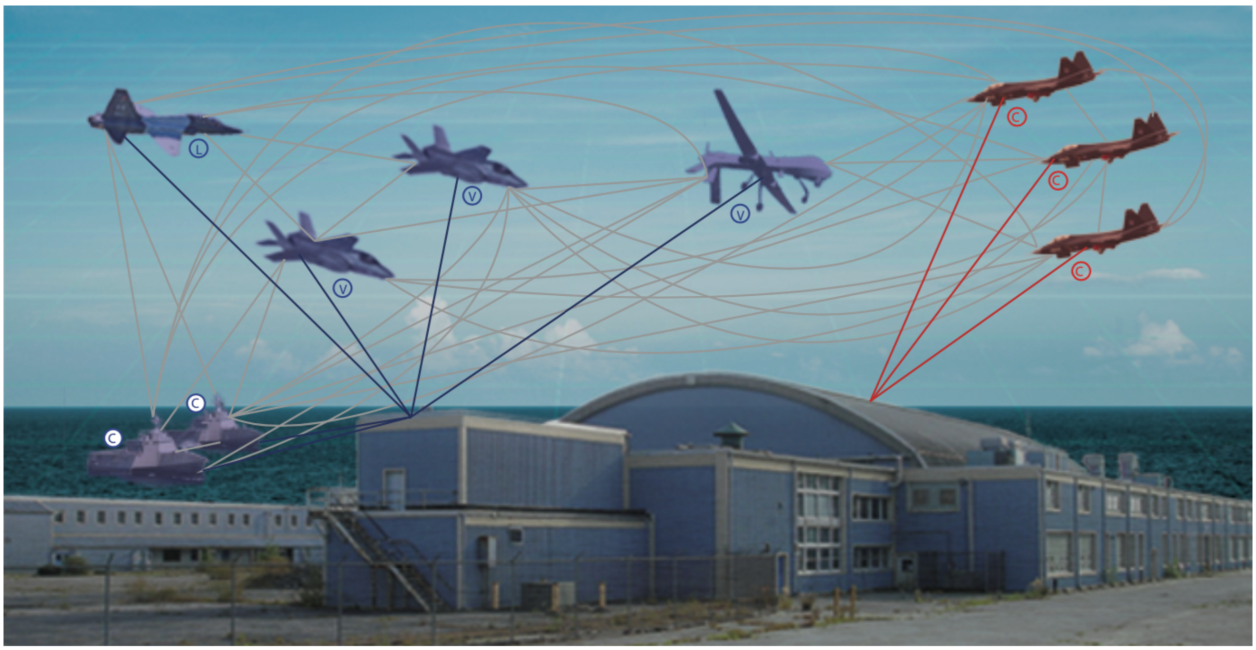

Figure 13: Depiction of Live (L), Virtual (V), and Constructive (C) Assets Integrated in an LVC Environment, Author's Own

[59] Baron Mills, "Live, Virtual, and Constructive Training Environment: A Vision and Strategy for the Marine Corps," *Naval Postgraduate School* (September 2014).
[60] Julie Tilson, "Virtual Construct: LVC strides toward reality," *Jane's International Defence Review* (November 2015).
[61] Committee on Opportunities for the Employment of Simulation in US Air Force Training Environments, "Opportunities for the Employment of Simulation in US Air Force Training Environments: A Workshop Report," *National Academies of Sciences* (2015): 11.
[62] Undersecretary of Defense for Research and Engineering, "DoD Modeling and Simulation (M&S) Management, 5000.59," *Department of Defense Directive* (8 August 2007).
[63] This can be achieved through federated or integrated solutions. Federated solutions involve a bridge or middleware between the two systems. Whereas integrated solutions can operate together without the need for middleware. See: "The Role of Live, Virtual, and Constructive in Training," *Potomac Institute for Policy Studies* (2016): 22.

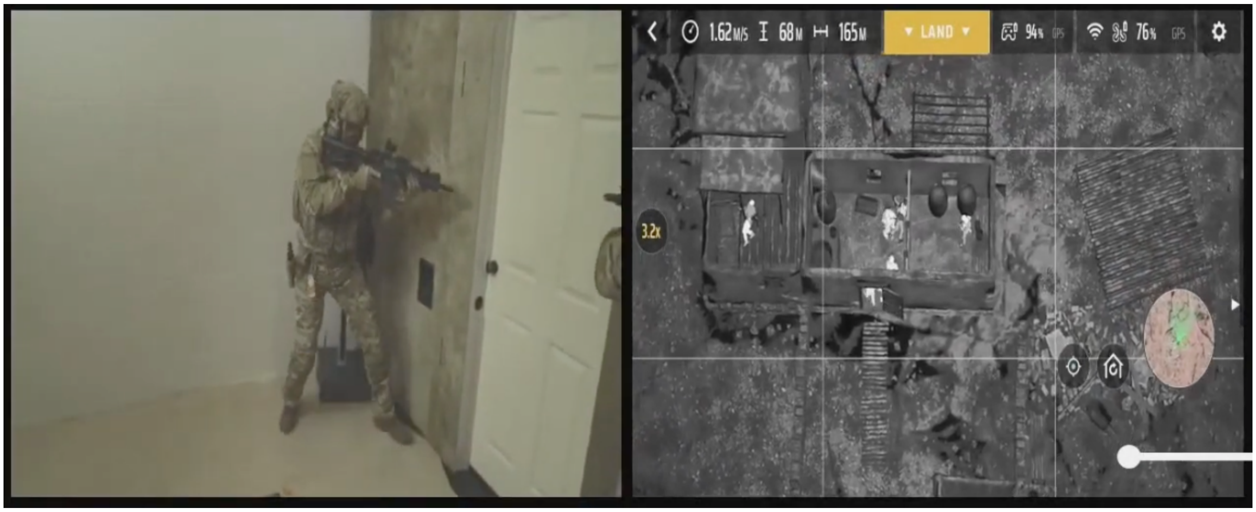

Figure 14: Live close quarters combat training with synchronized constructive overlay allowing for the integration of virtual unmanned aerial vehicles. Image from 4GD, "Discovering the Future of Urban Warfare," 28 January 2021, https://www.youtube.com/watch?v=BJl

Unlike synthetic training, which only includes virtual and constructive assets, today's LVC environment also includes live assets. LVC thus includes the injection of synthetic entities (virtual and constructive) into live platforms or assets (to include assets like augmented reality headsets) from off-board and even on-board sources, and vice versa. In general, LVC can be broken down into two different categories:

1. Tethered operations: Tethered operations inject synthetic entities into live assets from distributed virtual simulators and from constructive platform-based or ground-based synthetic entities.[64] Likewise, the live platform will also inject synthetic entities bi-directionally back to virtual and constructive assets (i.e., L to VC and VC to L). Tethered operations are localized, and dependent upon physical training range and spectrum constraints.
2. Untethered operations: Like tethered operations, untethered operations also involve the injection of synthetic entities bi-directionally between live and virtual and constructive assets. However, unlike tethered operations, untethered operations are not dependent upon a physical training range space. Instead, untethered operations can occur "on-the-fly" within any theater of operations.[65]

While sometimes considered LVC, two other permutations are worth noting, however, they do not meet the threshold of LVC. The first are live injects into simulators (L to VC). Live injects to simulators are downlink only and are not bi-directional. While the live platform can influence virtual and constructive assets, those same assets are unable to influence the live platform. Secondly, while virtual and constructive training environments (classic synthetic training environments), are sometimes referred to as LVC, they lack live assets and therefore are simply a

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[64] Platform based synthetic entities would involve the platform hosting an embedded training system, or an LVC processor, on the platform itself.
[65] Thomas Weaver and Richard Brisbin, "Achieving Air and Surface Dominance through a Joint Secure Interoperable LVC Solution," *Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC)* Paper No. 18214 (2018): 2-3.

virtual and constructive training environment.[66] True LVC (i.e., bi-directional synthetic entities between live and virtual and constructive assets) is a relatively recent, and still, in many cases, developing occurrence because of how technically challenging, and as a result, expensive it can be to implement.[67] Part of the challenge around implementing LVC stems from the fact that the software architectures that have been designed to support distributed simulation are not well suited to support the live component of LVC. When live systems are mixed with virtual and constructive simulations, the demands of the live systems influence the resulting simulation. The clock times (i.e., the speed at which updates within the simulation are occurring) of the virtual and constructive simulations must be in perfect sync with the live simulation environment.[68]

Despite the technical challenges, implementing LVC has become an aspiration for many global military services. Indeed, LVC has been highlighted as providing a range of benefits:

- **Increasing the Complexity of Training:** Ground forces have become increasingly interested in simulating more complex training scenarios—at scale.[69] Live training ranges often include actors charged with simulating the civilian populace or adversary forces, within a physical replica of a village or city. However, it is impossible for a live training environment to simulate the scale of an urban environment—both in terms of the density and size of buildings and infrastructure, but also the sheer numbers of entities (humans, cars, etc.).[70] Integrating constructive simulations that can reach mass entity counts (or simulate critical infrastructure, something that requires an immense number of interconnected models) alongside the live environment, allows for more complex and scalable training, without the same requisite costs or resources.[71]

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[66] Despite the difference between LVC and synthetic training, LVC is often used synonymously in conversations with synthetic training and falls under similar acquisition authorities and structures in various services. As a result, for the purposes of this dissertation, LVC is being assessed alongside a more classic example of synthetic training—a multi-domain synthetic training environment.

[67] Rear Admiral James Rapp, "LVC Training to Enhance Operational Readiness," (Presentation to the Williams Foundation, Canberra, Australia, 10 August 2016), Lance Call and Rob Lechner, "Advancing the State-of-the-Art in Airborne LVC Training," *Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC)* Paper No. 18249 (2018), John M. Kent Gritton et. al., "Washington, We Have a Problem: The Foundation for Live Virtual Constructive (LVC) Exercises Requires Fixing!," *Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC)* Paper No. 16049 (2016), and Kevin Seavey et. al., "Establishing Multinational Live, Virtual and Constructive Interoperability through Mission Partner Environments," *Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC)* Paper No. 16157 (2016).

[68] In the US, DoD created an entire new standard called TENA—Test and Training Enabling Architecture— whose main reason for being is to support the live component of a LVC system. Edward T Powell and J. Russell Noseworthy, "The Test and Training Enabling Architecture (TENA)" in Polk, *Engineering Principles of Combat Modeling and Simulation,* 450.

[69] Kiyoul Kim et al., "Modeling of Complex Scenarios using LVC Simulation," *Proceedings of the 2014 Winter Simulation Conference IEEE* (2014): 2931-2941.

[70] For an overview of the "numbers" and density associated with urban warfare, see Anthony King, *Urban Warfare in the Twenty-First Century* (Cambridge, UK: Polity Press, 2021).

[71] See, for instance the SISO scalability working group—a working group that is focused primarily on the US Army Synthetic Training Environment program. SISO, "SIM-SCALE SG- Simulation Scalability Study Group," accessed 22 February 2022, https://www.sisostds.org/StandardsActivities/StudyGroups/SIM-SCALESG.aspx and Byron Harder, "Defining Simulation Scalability," *Simulation Interoperability Standards Organization Simulation Innovation Workshop Winter 2022* (February 2022).

Rather than preparing for Mahanian fleet-on-fleet engagements on the high seas, modern navies typically focus on missions in the proximity of strategically significant land masses. Yet, those areas also tend to have high amounts of commercial shipping and civilian vessels, which may not be present in a live training space. Incorporating virtual and constructive assets into a live exercise can theoretically increase the complexity of the training environment, helping to mimic a densely crowded maritime environment.[72]

Across the globe, air forces are increasingly limited by their ability to provide live aggressors for tactics development and subsequent training—they do not have enough platforms or pilots to fly "red" (i.e., adversary) air against their "blue" (i.e., friendly) pilots.[73] Indeed, to create an adequate threat scenario, the US Air Force employs a ratio of 4:1 red to blue air for training sorties. Yet, maintaining such a ratio is becoming increasingly problematic with higher-end fourth or fifth generation platforms. As one US Air Force official privately acknowledged,

> *if I have four 'blue air' F-15s, it takes roughly about 12 other aircraft to generate a problem for them. The F-35 is so much more advanced that you need sometimes as many as 20 more airplanes and a bunch of surface threats [to create a dilemma for the pilots].*[74]

While in some cases, air forces have contracted with industry to provide live red air, a more cost-effective solution, that is likewise not limited by platforms, is to insert constructive adversary assets (or a mix of live and constructive adversary assets).[75] As a result, LVC enables tacticians and trainers to develop new complex scenarios that are sufficient in scale and complexity to stress pilots.

- **Increasing Range Space**: Live training ranges are spatially too restricted for fifth generation training and experimentation.[76] As Royal Australian Air Force Air Marshal (ret.) Geoff Brown explained to this author, the phased-based array radars used in the F-35 are "multiple factors better in terms of detection range" than past radars systems, like mechanical scanned array radars. As a result, F-35 pilots, he went on, "always have a radar picture of what is happening in the [training] range…It's just really difficult to do anything to degrade the pilot's situational awareness, unless, of course, he is up against another 5th

[72] Rapp, "LVC Training to Enhance Operational Readiness."
[73] By 2030, US Air Force Air Combat Command estimates that there will be an increasingly significant flight hour shortfall in the required live adversary air. Call and Lechner, "Advancing the State-of-the-Art in Airborne LVC Training."
[74] Gareth Jennings, "Future force philosophy: Operators grapple with the art of fifth-generation pilot training," *Jane's International Defence Review* (25 November 2016).
[75] Smaller air forces have an incentive to outsource training to contractors to fill key training gaps, such as red air. Training gaps can result from a lack of platforms or people (i.e., trained pilots). See the Czech Air Force's presentation on outsourced training, LTC Michael Kudyn, "Outsourced Training," (18th Annual Military Flight Training Conference, London, UK, 27 March 2019).
[76] In the past, the highest end training that could be offered to pilots was at the US Air Force's Red Flag exercises. However, US Air Force officials have acknowledged, "*There is no range in the world that is big enough to do fifth-generation training as you'd really like to do it*." Jennings, "Future force philosophy: Operators grapple with the art of fifth-generation pilot training."

generation platform."[77] The use of LVC can exponentially increase the size of the training range in two ways. First, constructive assets can be injected into the live aircraft feed via off-board or on-board sensors, depicting threats outside the live training range. This allows the platform to exercise and experiment with its detection capabilities—engaging constructive threats at a distance while staying within the physical range. The second is that pilots can also train on fifth generation simulators within a virtual environment; allowing them to partner with other live aircraft within the live training environment, while not suffering from range space limitations. Virtual training, through virtual terrain databases, have unlimited access to maneuver areas unconstrained by environmental restrictions, population areas, or training range space.[78] Constructive entities can be injected into virtual environments, allowing platforms to exercise the full range of their detection and maneuver capabilities.

Range space restrictions are not solely limited to fifth generation platform experimentation and training (and the air domain). Incentives also exist for armies to take advantage of LVC due to physical training range restrictions. After nearly two-decades waging counterinsurgency campaigns, the US Army is shifting and focusing on maneuvers at the division level. Physical training ranges do not possess the space to accommodate two divisions of soldiers—each amounting to 10-15,000 individuals, not including the requisite logistic support—in battle.[79] An LVC environment could theoretically expand the training range environment, allowing virtual and constructive friendly and adversary assets to be incorporated alongside live assets to better simulate large scale maneuvers.

- **Experience the Dirt, Dust, and Sweat of the Live Environment:** While a synthetic environment can be a useful replacement for live training there are certain types of training that must take place live for experiential or physiological reasons. Instead, LVC training serves to augment those experiences, injecting in greater realism, while maintaining the "grit" that makes the live environment so beneficial.

  For ground forces, there is no equivalent to live close quarters combat training—such as entering and clearing a room. Warfighters will not necessarily develop that same spatial understanding that can have critical life or death implications in a virtual environment. Recent advancements in instrumented live and synthetic range spaces have allowed warfighters to take advantage of the live environment to practice and rehearse battle drills, while also having valuable combined arms training. Indeed, by instrumenting a physical range of buildings with sensors, that same environment can be replicated in the virtual world. Warfighters can then access the synthetic environment, through a portal, such as a blue force tracker, or in the future, via the Integrated Visual Augmentation System.[80] Virtual unmanned aerial systems can then be employed throughout the training scenario to

[77] Email correspondence with Air Marshall (ret.) Geoff Brown, 19 June 2018.
[78] James Shufelt, "A Vision for Future Virtual Training," *NATO R&T Organization* RTO-MP-HFM-136 (June 2006).
[79] Meetings at Fort Leavenworth, KS, 8-9 February 2022.
[80] Program Executive Office Solider, "Project Manager: Integrated Visual Augmentation System PM IVAS," *US Army,* accessed 2 August 2022, https://www.peosoldier.army.mil/Program-Offices/Project-Manager-Integrated-Visual-Augmentation-System/.

> provide air support to those within the building, notifying warfighters of potential hostile actors in the surrounding area.[81]
>
> Additionally, while pilot training is increasingly being pushed into a synthetic environment, for some pilots, like fighter pilots, training in an LVC environment is crucial to train for various physiological factors. Fighter pilots must make decisions, often in hostile environments, while conducting high-gravity maneuvers at high speed. These maneuvers put an enormous amount of stress on the human body. As Philippe Perey, the Head of Technology at CAE, explained, "linking the live to the virtual constructive is about the most complete immersive environment you can provide because you get the full sense of flight," which include noise, vibration, and the stressors of gravitation and speed.[82]

The benefits of LVC extend beyond training to test and experimentation.[83] As a result, many of the training ranges that are being used to support LVC training can also be reused for other purposes. Even with these stated benefits, however, LVC is still early in the diffusion process and country-level adoption of LVC differs, even when controlling for budget and the current or planned acquisition of certain platforms, like fifth generation fighters. For this reason, exploring the diffusion and adoption of LVC is worthy of further investigation.

Multi-Domain Synthetic Training Environment

Just as an agreed upon definition of LVC is challenging to pin-down, a clear-cut definition of what would constitute a multi-domain training environment does not exist. Definitions of what a multi-domain synthetic environment entails differ across services, with emphasis understandably being placed on different warfighting functions.[84] Partners and allies have notably different perspectives when describing its implementation—with some stating that a multi-domain synthetic training environment has been deployed for training, and others stating it is a far-off aspiration due to budgetary or legacy system challenges.[85] As a result, it seems likely that a multi-domain training

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[81] 4GD, "Discovering the Future of Urban Training," demo streamed 28 January 2021, https://www.youtube.com/watch?v=BJlNCQEQhY8.

[82] Comments from Philippe Perey in Julie Tilson, "CAE pursues LVC technologies with Rockwell Collins," *Jane's International Defence Review* (7 December 2017).

[83] Assessing weapons testing and experimentation is beyond the scope of this dissertation. However, due to the reusability of technology tools it was plausible that this would come up as a stated reason for diffusion and adoption decisions. Surprisingly, reusability was not mentioned by any interviewees as a driver for adoption during my research. Reusability has been mentioned by the US Space Force as a factor in their planned procurement of a synthetic environment during industry conversations.

[84] See, for instance, the way the US Army focuses on human dimensions and unified land operations, while the Air Force has emphasized the fusion of multi-domain sources to support air operations training and mission rehearsal. US Army, "Synthetic Training Environment," accessible at: https://asc.army.mil/web/portfolio-item/synthetic-training-environment-ste/ and interview with Colonel Robert Epstein, Director of USAF Modeling and Simulation, 15 November 2019.

[85] NATO officials when speaking about their 2018 Trident Juncture exercise argued that it did include a multi-domain scenario as the "*exercise play…included [anti-access/ area denial] in its most comprehensive form, but also challenged the training audience with realistic in-space and cyber incidents*." The US Army, meanwhile, has stated that their current systems preclude them from "*upgrading into what is needed to replicate multi-domain operations without significant funding*." Ed Wijninga, "Training Joint Forces for Multi-Domain Operations," in the Joint Air Power Competence Centre, *Joint Air and Space Power Conference 2019: Shaping NATO for Multi-Domain Operations of the Future* (2019): 59 and Joe Parson, "Cross Functional Team Synthetic Environment," *Army's*

environment could take on a number of different formats, depending on the military service and the intended training audience.

For one, a multi-domain training environment could build on the LVC construct previously outlined. Services could work to integrate cyber, electronic, space, or information effects into a live environment used to train airmen, ground forces, or sailors. This is what NATO's exercise Trident Juncture, the US Air Force's Red Flag, and the US Army's Cyber/Electromagnetic Activity (CEMA) Support to Corps and Below have attempted to do, albeit in a limited fashion.[86] Integrating cyber or electronic effects—even simulated constructive cyber or electronic effects—into some live exercises can be problematic for several reasons. Should a simulated effect degrade, deny, or subvert the use of various elements of a live platform there is the chance it could place the warfighter at risk. For instance, if a pilot had aspects of its flight control system sabotaged in live flight—even if that sabotage is simulated—it could cause the pilot to lose control of their aircraft. For that reason, in many LVC exercises, platform dependent, multi-domain effects are simulated via the use of low fidelity white cards, which involve the literal use of a note card to inject in friction.[87]

The second way in which a multi-domain synthetic training environment can manifest is solely via a virtual and constructive training environment. Such a training environment would likely link via an application programming interface the synthetic environments used by conventional warfighters with those tasked with cyber operations, information operations, electronic, or space operations. Effects would then propagate across environments allowing effects in one synthetic environment (or domain, for instance, a flight simulator) to impact events in another synthetic environment (or domain, like the cyber training environment). An integrated environment, like the one described, allows warfighters to develop a better understanding of how their domain may better support operations in adjacent domains; and likewise, how operations in adjacent domains may better support their own operations.

An example of how this could manifest was demonstrated by the Cyber Operational Architecture Training System (COATS) program, developed by a consortium of industry and academic partners in tandem with US Indo-Pacific Command. COATS linked a cyber range environment to a traditional battlestaff training architecture. The integration of these two synthetic environments allowed US battle staff to develop some understanding of how "blue" (friendly) cyber-attacks can impact "red" (adversary) systems and similarly, how traditional conventional operations, can impact the cyber domain. In essence, COATS took advantage of traditional cyber ranges, battle staff training architectures, operational networks, and an accredited cyber emulation tool to

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Future Command Synthetic Training Environment (Presentation at the Institute for Defense and Government Advancement, Synthetic and Simulation Training Conference, Orlando, FL, 24 September 2019).

[86] Wijninga, "Training Joint Forces for Multi-Domain Operations," 59, Justin Eimers, "Prototype cyber software delivers CEMA dashboard to tactical commanders," *US Army,* 12 August 2020, https://www.army.mil/article/238095/prototype_cyber_software_delivers_cema_dashboard_to_tactical_commanders and Eric Bisel, "Space and Cyber at Red Flag," *Air Force Magazine* (September 2017) and US Army Cyber Command, "Integration of cyberspace capabilities into tactical units," *US Army,* 29 February 2016, https://www.army.mil/article/163156/Integration_of_cyberspace_capabilities_into_tactical_units/.

[87] Jennifer McArdle, "Victory Over and Across Domains: Training for Tomorrow's Battlefields," *Center for Strategic and Budgetary Assessments* (January 2019).

synchronize cyber and traditional effects across the training audience.[88] To make this possible, a network guard was employed to protect and assure data flow between the two synthetic environments and a new unique cyber data exchange model was employed to facilitate interoperability (see figure fifteen).

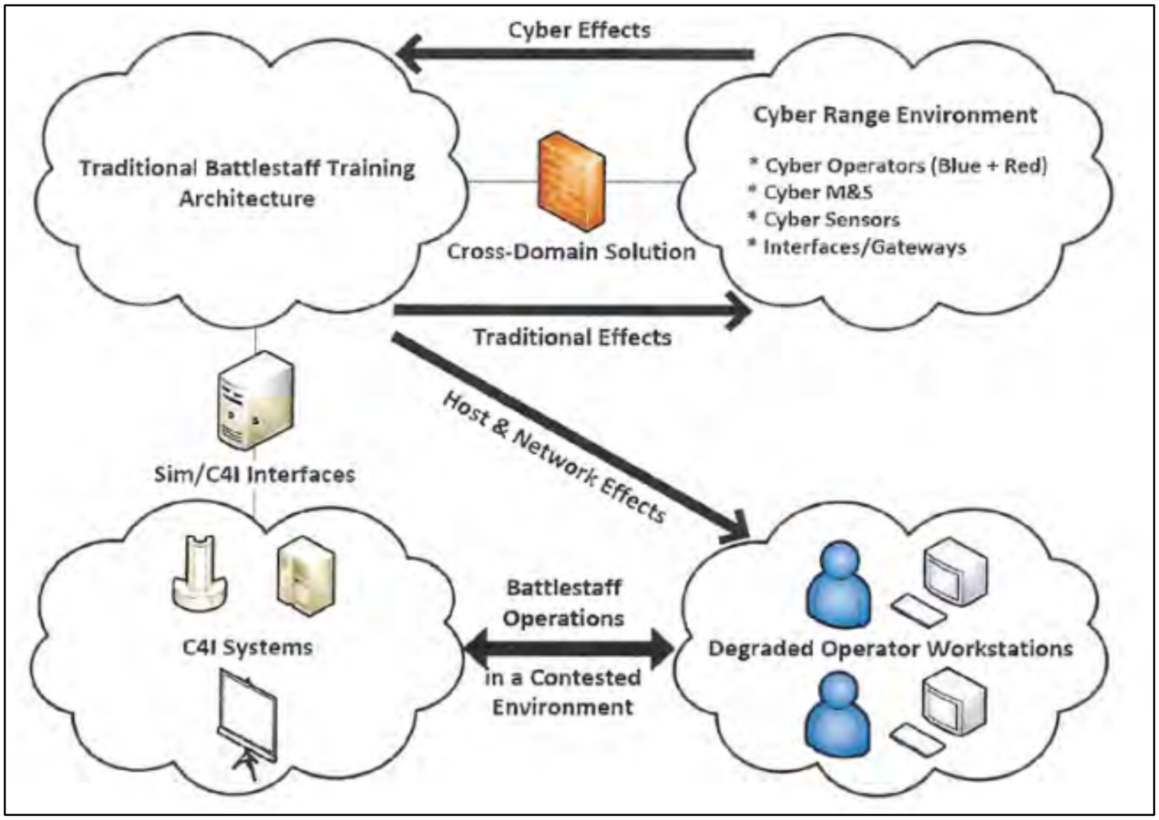

Figure 15: Cyber Operational Architecture Training System (COATS) Schematic. Image from David Wells and Derek Bryan, "Cyber Operational Architecture Training System – Cyber for All"[89]

COATS has generated some initial success. The program architecture and associated technologies have been tested at annual command post exercises during exercises Ulchi Freedom Guardian 2014 and 2015 and Key Resolve 2015.[90] COATS is not unique. Academic institutions, like Carnegie Mellon University, have also experimented with linking synthetic cyber training environments to virtual training applications, like Virtual Battlespace 3.[91]

Despite initial demonstrations of how a multi-domain synthetic training environment may manifest, in large measure it remains aspirational. Developing a multi-domain synthetic training

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[88] David Wells and Derek Bryan, "Cyber Operational Architecture Training System – Cyber for All," *Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC)* 15108 (2015): 4.
[89] *Ibid.*
[90] *Ibid.*
[91] Rotem Guttmann, "Combined Arms Cyber-Kinetic Operator Training," *Carnegie Mellon University Software Engineering Institute SEI Blog,* 20 March 2017, https://insights.sei.cmu.edu/sei_blog/2017/03/combined-arms-cyber-kinetic-operator-training.html and Christopher Daiello, Kyle Hancock, John Surdu, Daniel Lacks, "Cyber Effects within a Kinetic Model," *Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC)* 17181 (2017).

environment can be technically and organizationally challenging. For one, developing models that accurately reflect the space, cyber, or electronic environment are persistent challenges. Despite requests from military services for those models, industry and academia has yet to crack many of the physics problems that are unique to those domains.[92] When it comes to modeling the information environment, modeling complications are amplified, as applied modelers need to address information flows and individual and collective receptiveness to the information, which requires a deeper understanding (and models) of individual and collective behavior.[93] Interoperability between environments remains a persistent problem. Despite efforts to develop common standards, no such agreement exists. As a result, integrating different environments often become one-off and bespoke events.[94] Silos exist between different training environments and integrating those environments requires more than technical known-how, but also organizational drive.[95] Authorities and classification are persistent challenges, as these environments often operate at different levels of classification. This requires not only multi-level security solutions, but also the organizational authority to interconnect those environments.[96] For these reasons, multi-domain synthetic training is at a nascent stage in the diffusion process and is worth exploring from an early adopter's perspective.

Globally, interest exists in adopting multi-domain synthetic training solutions because they seem to provide a number of benefits:

- **Circumvent Limitations of the Live Environment**: A synthetic environment is the only place where the integration of cyber, electronic, space, or information effects can occur with a high degree of fidelity. Avoiding the introduction of genuine cyber effects in live

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[92] Air Force Life Cycle Management Architecture and Integration Directorate, "Request For Information: Synthetic Environment Data Architecture Consortium," *US Air Force,* 6 July 2021 and meetings at Ft. Leavenworth with Combined Arms Center-Training, 8-9 February 2022.
[93] For an overview of developing synthetic populations endowed with unique behaviors, see, Ashley Fehr et al., "Growing People: Generating Realistic Populations and Explainable, Goal Directed Behavior," *Inter-Industry, Training, Simulation, and Education Conference (I/ITSEC)* (2021).
[94] See, for instance efforts to create a Cyber Reference Data Exchange Model (CyRDEM) by SISO. Cyber Modeling & Simulation SG, "Cyber Reference Data Exchange Model Research," accessed 22 February 2022, https://www.sisostds.org/StandardsActivities/StudyGroups/CyberModelingSimulationSG/CyRDEMResearch.aspx.
[95] At present, synthetic environments exist for offensive cyber, information, and space operations training, but these environments are often siloed. They are frequently limited to their specific task (i.e., training cyber warriors) and are not necessarily linked with other simulations that would facilitate cross-domain interactions. For instance, the US has developed realistic closed-network cyber ranges—the DoD Cybersecurity Range, the Joint Information Operations Range, the National Cyber Range, and the nascent Persistent Cyber Training Environment—to train cyber warriors in a range of tactics, techniques, and procedures for offensive computer network operations. While these ranges provide valuable training opportunities for the cyber mission force, they operate independently of traditional kinetic mission training programs for the conventional warfighter and battle staff. Jon Davis and Shane McGrath, *A Survey of Cyber Ranges and Testbeds* (Edinurgh, Australia: Cyber Electronic Warfare Division Defence Science and Technology Organisation, 2013), Mark Pomerleau, "4 Companies Start Work on the Army's Cyber Training Platform," *Fifth Domain,* 19 June 2018, https://www.fifthdomain.com/dod/army/2018/06/19/4-companies-start-work-on-the-armys-cyber-training-platform/, Brett Lindberg, Stephen Hamilton, Brian Lebiednik, and Kyle Hager, "Cyber Integrating Architecture," *Small Wars Journal* (27 July 2018), McArdle, "Victory Over and Across Domains: Training for Tomorrows Battlespace," 23.
[96] See, for instance, Zbigniew Zielinski and Andrzej Staskiak, "An Approach to Automated Verification of Multi-Level Security System Models," *Proceedings of the 8th International Conference on Dependability and Complex Systems* (9-13 September 2013): 375-388 and James E. McGhee, "Liberating Cyber Offense," *Strategic Studies Quarterly,* (Winter 2016): 49-50.

exercises occurs for the same reason live fire isn't used against troops in training. The use of live fire against a military platform could have unintended consequences and potentially put trainees and the platform at risk. Given the importance of military directives aimed at ensuring safety, unit commanders are often hesitant to inject variables into training that could unintentionally have adverse consequences. In addition, live exercises sometimes take place near population centers. In such instances, the use of electronic or cyber weapons might compromise civilian use of the electromagnetic spectrum for things such as cellular devices, television, or even medical devices. Safety concerns—both for warfighters and civilians—are a considerable factor in delaying or preventing the inclusion of cyber and electronic effects in exercises.[97] While simulated effects can be used in an LVC environment, as previously mentioned, training providers are often averse to integrating constructive cyber, electronic, or information effects into a warfighting system or platform, as those effects could cause the system operator to lose control of their system—potentially putting the trainee and others at risk.

Additionally, contrary to conventional wisdom, targets cannot necessarily be prosecuted instantaneously via a cyberattack. Cyber operators often take months or even years to work through the cyber kill chain.[98] Such a timeframe is outside the scope of most training exercises. Synthetic environments provide unique opportunities to speed up the clock time associated with events. Unlike LVC environments that must move at the speed of the live environment, a synthetic environment can be run real time (i.e., at the speed of real-world events) or faster than real time.[99] It is theoretically possible to run models that simulate the effects of cyber, electronic, or information operations faster than real time to better account for different time horizons—particularly with cyber or information operations. The output of these simulations could then be linked, asynchronously or synchronously, to real time or faster than real time simulations for kinetic training.

- **Train as You Fight**: An age-old refrain within the training community is for servicemembers to train as they fight. Military services are identifying ways to provide multi-domain training opportunities to warfighters—allowing them to experience the effects of adversarial multi-domain operations on their platforms and weapon systems, while likewise, similarly fusing capabilities across domains to achieve mission assurance. This is no surprise. Recently declassified information from Joint Task Force Ares—the US' cyber mission in support of kinetic operations against the Islamic State of Iraq and the Levant (ISIL)—highlighted problems throughout the operation with regards to target validation, operational de-confliction, interagency coordination, and data exploitation.[100] As one USAF cyber leader told this author when commenting on challenges around integrating cyber alongside kinetic operations in the Middle East, "the lack of training

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97 McArdle, "Victory Over and Across Domains: Training for Tomorrows Battlespace," 15.
98 Eric M. Hutchins, Michael J. Cloppert, and Rohan M. Amin, "Intelligence-Driven Computer Network Defense Informed by Analysis of Adversary Campaigns and Intrusion Kill Chains," *Computer Science* (2010).
99 XiaoRui Liu et. al, "Faster than Real-Time Simulation: Methods, Tools, and Applications," *9th Workshop on Modeling and Simulation of Cyber-Physical Energy Systems* (9 April 2021).
100 US Cyber Command, "USCYBERCOM: 30-Day Assessment of Operation Glowing Symphony: Executive Summary," 13 December 2016.

> [together], slows down the process. It would be awesome if we could train people up before we deploy."[101]
>
> Building on this, in a recent experiment, the US Army's multi-domain training prototype tested the success of integrating cyber effects in a virtual training simulation for special operations forces. Special operation forces were tasked with rescuing a hostage that was held in a prison complex in a hostile area of operations. Cyber operators within a cyber training environment worked to target local SCADA systems to cut power to the town, while also manipulating video cameras within the prison complex. The success of the cyber operation was then reflected in the virtual training environment for the special operations forces. The warfighters were able to advance to the prison during the town-wide power blackout, undetected. Once at the facility, the subverted camera feeds allowed the operators to enter unnoticed and successfully exfiltrate the hostage. While the experiment was a proof-of-concept to demonstrate that cyber effects could be integrated into a training simulation for conventional warfighters, it also produced some additional findings. Despite running the scenario multiple times with different tactical and operational parameters, the special operators were unable to accomplish this mission without some cyber support.[102]

Like LVC, the benefits of a multi-domain synthetic training environment extend beyond training to test and experimentation. As a result, many of the models that can be used to support a multi-domain synthetic training environment—for instance models of electronic warfare—can also be reused for other purposes, such as experimentation. This is causing some companies to advocate for a "platform" based approach to synthetics—much like the focus on platforms, and its resulting network effects, within the commercial sector.[103] According to these companies, a platform-based approach to a multi-domain synthetic environments would allow for a "marketplace" of models, allowing training providers to easily integrate in new models that mimic the changing character of war, as they emerge.[104] Even with these stated benefits, however, similarly to LVC, a multi-domain synthetic training environment is still early in the diffusion process and country-level adoption of it differs, even when controlling for budget and the current or planned acquisition of certain platforms, like fifth generation fighters that are known to fuse feeds across multiple domains.[105] For this reason, exploring the diffusion and adoption of a multi-domain synthetic environment is worthy of further investigation.

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[101] Interview with 5, USA, USAF Major Cyber, 29 March 2018.
[102] Daiello, Hancock, Surdu, Lacks, "Cyber Effects within a Kinetic Model," 8.
[103] Geoffrey Parker et. al., *Platform Revolution: How Networked Markets are Transforming the Economy and How to Make them Work for You* (New York, W.W. Norton & Company, 2016).
[104] See for instance, Improbable's platform sell and Microsoft Studio Alpha's platform approach to wargaming: Improbable Defense, "Platform," accessed 23 February 2022, https://defense.improbable.io/platform and AlphaStudio, "A Global Platform," *Microsoft,* accessed 23 February 2022, https://alphastudio.com/.
[105] Deborah Lee James and Daniel Goure, "The Implications of Fifth-Generation Aircraft for Transatlantic Airpower," *The Atlantic Council* (October 2019).

CHAPTER TWO: LITERATURE REVIEW AND ALTERNATIVE HYPOTHESES

The defining text on diffusion in the social sciences, *The Diffusion of Innovations* by Everett Rogers, defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system."[1] Diffusion then is a unique communication process—the focal point of the messages are new, or seemingly new, ideas. Participants in a social system create and share new information to reach mutual understanding and achieve certain effects.[2]

Scholarship on the diffusion of new ideas can be traced back to 1903 when Gabriel Tarde, a French sociologist and criminologist, released *The Laws of Imitation*. Tarde observed that certain generalizations applied to the spread of knowledge, which he labeled "the laws of imitation."[3] Tarde believed that scholars should seek to "learn why, given one hundred different innovations conceived at the same time…ten will spread abroad while ninety will be forgotten."[4] Since that time, studies on diffusion have blossomed across multiple disciplines, from rural sociology to public health, and marketing; leading some to label it "as possibly the most fashionable of social science [research] areas."[5] Yet, despite the proliferation of studies in other social science disciplines, academics in the security studies field are just starting to scrutinize the process of diffusion.[6] To security studies scholars, diffusion can broadly be defined as the complex process, by which military knowledge "to include hardware (e.g. technology) and software (e.g. doctrine, tactics, organizational form, etc.) diffuses throughout the international system, or what factors enhance or inhibit the ability of states to incorporate innovation into their defense structures."[7]

Existing literature on diffusion broadly fits within four categories: works that assess the process of diffusion, those that identify causes of diffusion, those that appraise the patterns of diffusion, and finally those that analyze diffusion decisions (or adoption). Within each of these categories differing academic schools of thought exist.

The Process of Diffusion

Scholarship that assesses the process of diffusion tend to address three overarching issue areas: 1) the rate of adoption of different ideas within a social system (or among different social systems); 2) the earliness of knowing about innovations; and 3) various categories of adopters by "innovativeness."[8] Crucial to studies that address the process of diffusion is the concept of an S-

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[1] Rogers, *The Diffusion of Innovations,* 5-6.

[2] *Ibid.*

[3] Gabriel Tarde, *The Laws of Imitation,* translated by Elsie Clews Parsons (Chicago, IL: University of Chicago Press, reprinted 1969).

[4] *Ibid,* 140.

[5] George W Downs and Lawrence B Mohr, "Conceptual Issues in the Study of Innovations," *Administrative Science Quarterly* 21 (1976): 700.

[6] Goldman and Eliason, *The Diffusion of Military Technology and Ideas* and Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics*.

[7] This differs from technical definitions of software. Goldman and Eliason, *The Diffusion of Military Technology and Ideas,* 7.

[8] Rogers separates diffusion research into a typology of approaches, to include the earliness of knowing about an innovation, the rate of adoption within a social system (or among differing systems), innovativeness, opinion

curve, which represents the rate at which an adoption spreads through a given population. When the number of individuals (or countries) adopting a new idea is plotted graphically over time, the resulting distribution is an S-shaped curve. At first only a few forward-leaning individuals adopt a new idea over a certain time-period, but eventually the diffusion curve starts to climb, as more and more individuals adopt the diffusion. Eventually, the curve plateaus as few individuals remain who can adopt the innovation, before finally reaching its asymptote. At this point the diffusion process is complete. Different categories of "innovativeness" have since been attributed to various stages of adoption in the S-curve: innovators, early-adopters, early-majority, late-majority, and laggards (see figure one). Those that develop an innovation are called the innovators, while the other categories directly correlate with the time at which adoption occurs.

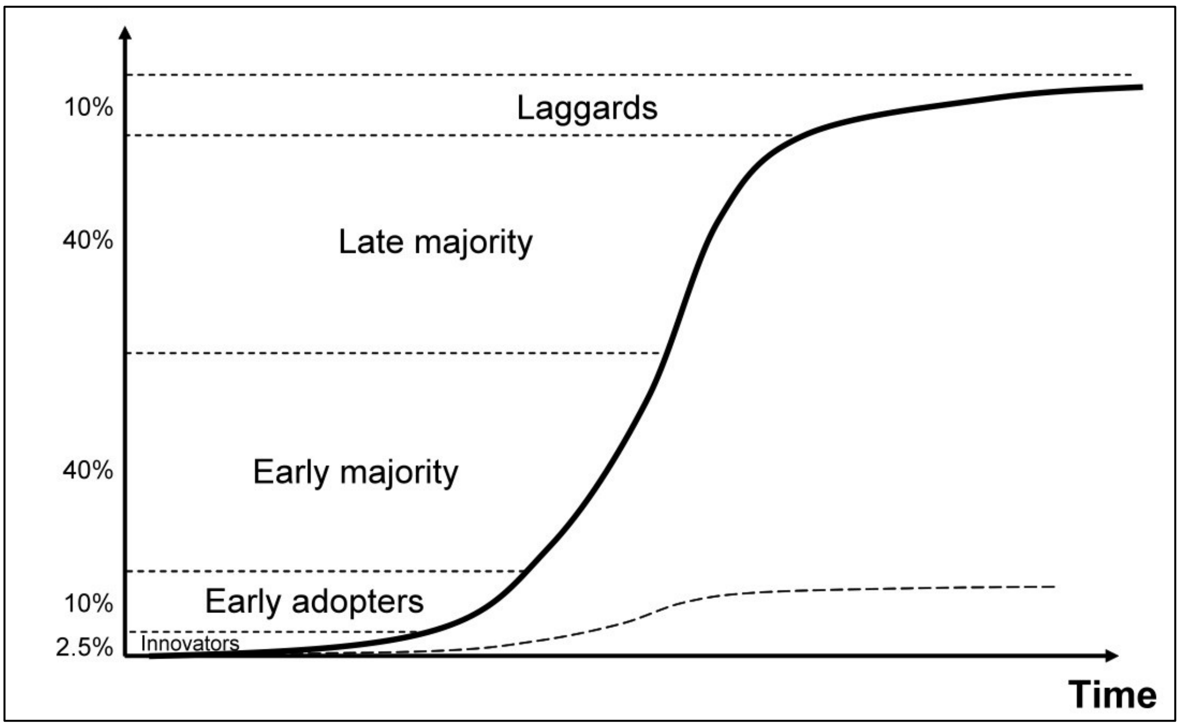

Figure 16: The Diffusion S-Curve. Image from "The Diffusion of an Innovation: Business Planning for Managers," InvestAura: The Art of Business Planning, 2017, http://www.business-planning-for-managers.com/main-courses/forecasting/the-diffusion-of-innovation/

The study of S-shaped curves in the diffusion process has widely influenced diffusion scholarship across disciplines, most notably within the fields of business and marketing.[9] However, the security studies literature has also drawn on this approach through a historical case study method.[10] Indeed, history provides a useful lens when assessing military technological diffusion. Through historic case studies, scholars and practitioners have noted that generational change may need to

leadership, diffusion networks, communication channel use, and the consequences of an innovation. Arguably four elements of his typology fit within research that explores the process of diffusion. See: Rogers, *The Diffusion of Innovations,* 88-91.

[9] Frank Bass, "A New Product Growth Model for Consumer Durables," *Management Science* 13.5 (1969): 215-227.

[10] On the importance of applied history to security studies, see: Hal Brands and William Inboden, "Wisdom Without Tears: Statecraft and the Use of History," *Journal of Strategic Studies* 41.3 (January 2018): 1-31.

occur for new ideas or warfighting techniques to become fully implemented within a defense establishment.[11] As Andrew Marshall stated, when commenting on the time taken for adoption:

> *The reason that large changes in warfare take several decades is that it takes a good time to develop new concepts of operation, to create new military organizations that are required to execute these new concepts, for new skills to be acquired, and perhaps for new military careers and specialties to be created.*[12]

Perhaps the most extensive study of military diffusion to date that draws on the historical case study approach is Michael Horowitz's text, *The Diffusion of Military Power: Causes and Consequences for International Politics.* Horowitz develops a unique theory, which he calls adoption-capacity theory to assess the diffusion of carrier warfare, battle fleet warfare, nuclear warfare, and suicide terrorism.[13] Adoption capacity theory argues that all other things being equal, financial capacity and organizational capital determine how an innovation will spread through the international system.[14] In short, countries with greater financial wealth are more likely to adopt an innovation; while likewise, the level of organizational transformation required to adopt an innovation also has bearing on its diffusion. More recently, Horowitz has applied his theory to newly emergent technologies, such as artificial intelligence (AI), to better predict its diffusion throughout the international system.[15] He posits that his theory remains true: countries with financial capital, or as he characterizes it, "advanced information economies," are more likely to develop and adopt AI. Horowitz does begin to account for differences between AI and previously studied military innovations, like the tank or carrier warfare; notably, the AI is a form of *software,* not *hardware,* but he does not foresee any significant differences in diffusion patterns due to what he views as the significant computational resources required for AI development.[16]

As a result of the first part of Horowitz's theory, one might expect the following hypothesis to be true with regards to *adoption decisions:*

Alternative Hypothesis: States with large defense budgets will have higher synthetic training adoption rates.[17]

However, when one maps the adoption of LVC and a multi-domain synthetic environment by the defense budget, it becomes abundantly clear that it has little bearing on state adoption decisions. Adoption rates do not map in any clear causal way to defense spending (see figures seventeen and eighteen). And herein lies the puzzle of this dissertation: military spending is mentioned continuously in industry and military conversations as a key determining factor for synthetic

[11] Rosen, *Winning the Next War: Innovation and the Modern Military.*
[12] Andrew Marshall, "Foreword," in Goldman and Eliason, *The Diffusion of Military Technology and Ideas,* xiii.
[13] Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics.*
[14] *Ibid.*
[15] Horowitz, "Artificial Intelligence, International Competition, and the Balance of Power."
[16] The necessity of computational resources for future AI and machine learning development is up for debate. New approaches for AI development are far more tailored and efficient. Andrew Lohn and Micah Musser, "AI and Compute: How Much Longer Can Computing Power Drive Artificial Intelligence Progress?" *Center for Security and Emerging Technology* (January 2022).
[17] See also those that advocate a bureaucratic functionalist approach to adoption, for instance: Graham Allison, *The Essence of Decision: Explaining the Cuban Missile Crisis* (Boston, MA: Little Brown, 1971): 78-94.

training adoption. Yet, when synthetic training adoption is mapped against military spending, the hypothesis is significantly weakened—some other casual factors must be driving adoption. This dissertation sets out to solve this puzzle.

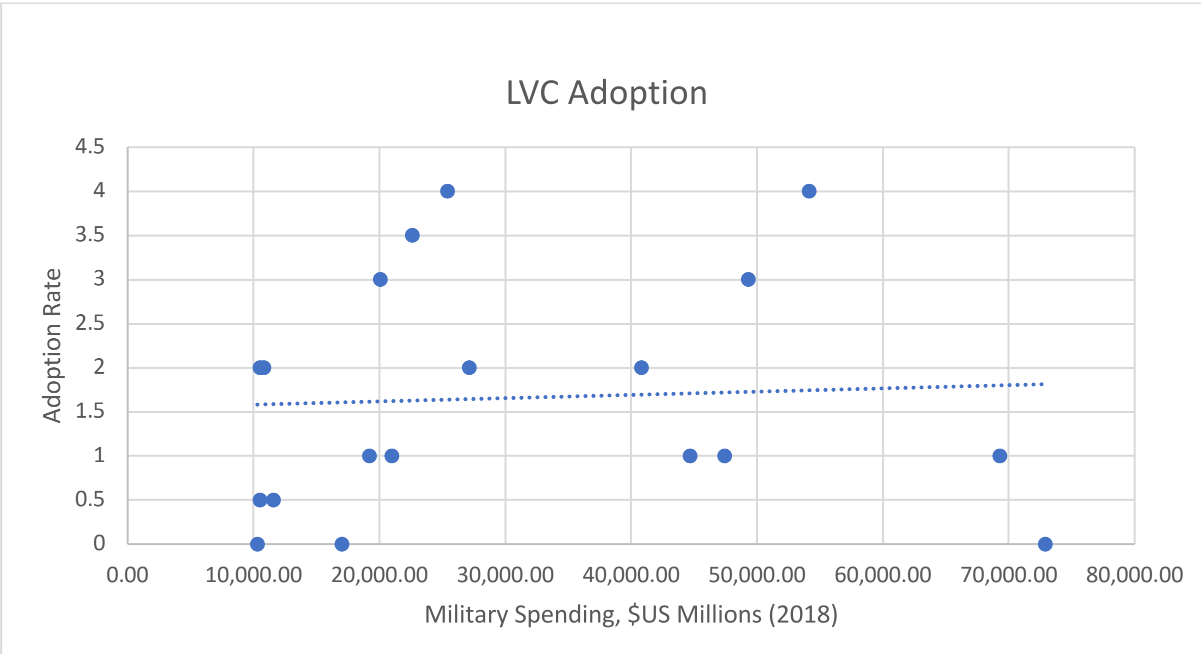

Figure 17: Mapping LVC Training Adoption Against Military Spending

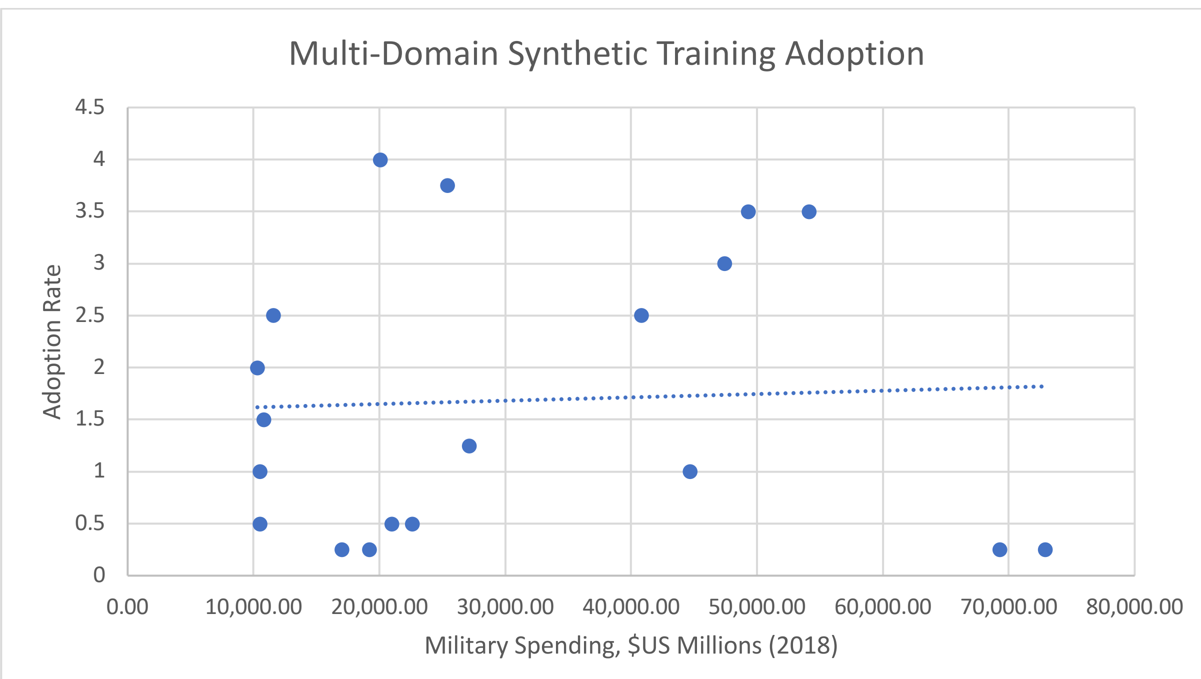

Figure 18: Mapping Multi-Domain Synthetic Training Adoption Against Military Spending

Causes of Diffusion

Attempts to better understand the process of diffusion are closely tied to another variant of diffusion scholarship—the investigation of the causes of diffusion.[18] Literature that explores the causes of diffusion operate on the assumption that some sort of technological demonstration has already taken place. From the demonstration point, various causative factors, both external and internal, drive adoption.[19]

External Causes of Diffusion

Scholars that explore external causes of diffusion tend to fall within the neo-realist school of thought. Simply put, they view competition within the international system as a powerful driver of the diffusion of military innovations leading to the emulation of first-movers and early adopters. As Kenneth Waltz noted, "the possibility that conflict will be conducted by force leads to competition in the arts and instruments of force. Competition produces a tendency towards the sameness of competitors."[20] In short, competition drives emulation.[21] Waltz argues that states will emulate the successful practices of competitors, in particular, they will seek to mimic the weapons and strategies developed by those states with the greatest demonstrated capabilities.[22] However, Waltz fails to account for the organizational implications of his predictions, nor does his theory predict the temporal circumstances of state-based emulation.

Perhaps the most developed argument within this school of thought is Joâo Resende-Santos' text on cross-national emulation of the modern mass Army within South America.[23] Resende-Santos builds on Waltz argument, however, he also draws on the structural elements of Stephen Walt's balance of threat theory and offense-defense theory to form the basis of his theory of cross-national diffusion.[24] Like Waltz, Resende-Santos shows that cross-national emulation is a function of the anarchic nature of the international system and not a result of the peculiar characteristics of states. Yet, his theory goes one step further. He demonstrates that the timing, pace, and scale of emulation will correspond to the timing and degree of the perceived external threats.

Other scholars within the neo-realist camp have explored the "contagiousness" of coercive practices—how the initiation of international disputes increase the likelihood that conflict may

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[18] Many of the "factors" of diffusion could also be considered "causes" of diffusion. As a result, overlap exists between the two fields.

[19] This dissertation operates on the assumption that SIMNET acted as a "demonstration point" for synthetic training.

[20] Waltz, *Theory of International Politics,* 128.

[21] Such arguments on competition and the drive towards homogeneity have also been espoused at the firm level. Paul J Dimaggio and Walter W Powell, "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields," *American Sociological Review* 48.2 (1983): 147-160 and John W. Meyer and Brian Rowan, "Institutionalized Organizations: Formal Structure as Myth and Ceremony," *American Journal of Sociology* 83.2 (1977): 340-363.

[22] Waltz theory is grounded in the global distribution of capabilities, or the overall balance of power, as a predictor of emulation. Waltz, *Theory of International Politics.*

[23] Resende-Santos, *Neorealism, States, and the Modern Mass Army* and Resende-Santos, "Anarchy and Emulation of Military Systems: Military Technology in South America, 1870-1930."

[24] Both theories emphasize the importance of changes in a state's immediate security environment. See, for instance: Stephen Walt, *The Origins of Alliances* (Cornell, NY: Cornell University Press, 1987) and Charles Glaser and Chaim Kaufmann, "What is the offense-defense balance and how can we measure it?," *International Security* 22.4 (Spring 1998): 1-23.

occur elsewhere.[25] Neo-realists have also highlighted how international challenges can drive state domestic policy, influencing more localized adoption decisions—particularly with regard to domestic political innovations and reform. Scholars have highlighted international competition as explanatory factors for the sustainability—and diffusion—of democracy in Latin America.[26] Others, have shown how cross-national decision-making have influenced the spread of regulatory policymaking in Europe.[27] This parallels the literature on state-level innovation. Indeed, countries whose external concerns overshadow perceived domestic insecurities tend to have higher national innovation rates than those countries that focus more narrowly on internal security issues.[28] Political and security elites can empower or reject a technical or organizational innovation in their country—or institution—based on threat perceptions. Typically, political or security elites that focus overwhelmingly on domestic threats, or represent status quo interests, will show little support for change.[29] Conversely, external threats tend to generate political pressure for reform among elites, forcing them to support organizational or institutional reform.[30]

Drawing on external threat perceptions, along with domestic variables of adoption, Mary Kaldor explores the concept of "baroque armaments."[31] Baroque armaments are the result of the interconnected nature of private enterprise and the state, what Kaldor characterizes as "a marriage…between the capitalist dynamic of the arms manufacturers and the conservativism that tends to characterize armed forces and defence departments in peacetime."[32] During peacetime, it is unclear how much technical change is needed, and as a result, baroque military technology expands industries that should contract. Kaldor argues that such a situation favors "elaborate custom-built product improvements that are typical of industries in decline" over mass-market solutions. The rise of multinationalism when combined with the posture of potential adversaries spreads these incremental bespoke advancements.[33]

Based on this literature, one would expect the following hypothesis to be true with regards to *adoption decisions*:

Hypothesis One: States that live in regions of intense geo-strategic competition will adopt synthetic training at a higher rate.

Drawing on the literature and this hypothesis, I ask the following qualitative indicator questions:

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[25] Stuart Bremmer, "The Contagiousness of Coercion: The Spread of Serious International Disputes, 1900-1976," *International Interactions* 9.1 (1982): 29-55.
[26] Kurt Weyland, "Critical Debates: Neorealism and Democracy in Latin America: A Mixed Record," *Latin American Politics and Society* 46.1 (Spring 2004): 134-157.
[27] Giandomenico Majone, "Cross National Sources of Regulatory Policymaking in Europe and the US," *Journal of Public Policy* 11.1 (1991): 79-106.
[28] Taylor, "Toward an International Relations Theory of National Innovation Rates,"114.
[29] *Ibid* 117.
[30] Emily O Goldman, "International Competition and Military Effectiveness: Naval Air Power, 1919-1945," in Risa A. Brooks et al., *Creating Military Power: Sources of Military Effectiveness* (Stanford, CA: Stanford University Press, 2007): loc. 2259- 2646 and Murray and Millet, *Military Innovation in the Interwar Period.*
[31] Mary Kaldor, *The Baroque Arsenal* (New York, NY: Hill and Wang, 1981).
[32] *Ibid,* 4.
[33] Given Kaldor's emphasis on multinational corporations, arguably her argument could also fit within the "patterns of diffusion" literature. However, given her text explores how the international environment can impact domestic decision and vice versa, for the purposes of this dissertation, I have elected to place it here.

- Does the state face an enduring competitor or potential adversary?
- Has that competitor or adversary made belligerent statements or taken provocative action that could be perceived by the bureaucratic elites as an attempt to change the political status quo within the state or its perceived sphere of influence?
- If the above is true, to what extent has geo-strategic competition been highlighted as a determining factor when making synthetic training adoption or emulation decisions?
- Is a baroque armament, the unique relationship between the defense industry and the state, driving the expansion of synthetic training?

Internal Causes of Diffusion

Studies that explore internal causes of diffusion identify key adoption drivers within an organization or a geographic location, like a state or country. Formalized adoption decisions undertaken by organizations tend to be complex, as unique bureaucratic structures or institutional cultures tend to favor the status quo, often running counter to innovation.[34] Indeed, Joseph Schumpeter, the godfather of economic innovation studies, described innovation as an almost cyclical phenomenon of "creative destruction,"—the replacement of the status quo with the new.[35] This type of change within an organization is no easy process. As the famed German sociologist Max Weber once noted, "the essence of bureaucracy [is] routine, repetitive, orderly action."[36] Security studies scholars such as Barry Posen, Stephen Rosen, Raphael Marcus, Harvey Sapolsky, and Nina Kollars have long sought to shed light on the many challenges linked to organizational change within defense organizations.[37] Defense bureaucracies, by nature, are often ponderous, slow-moving beasts. Diffusion scholars in the course of their research have highlighted organizational characteristics that act as "innovation accelerants", like interconnectedness, size, organizational flexibility, decentralized decision-making, and well-organized learning processes or learning mechanisms.[38] Typically, organizations—to include corporations—that succeed in fending off inertia by a certain degree of operational elasticity, perpetually adapting and adjusting to their competitive environment, are the most likely to achieve military or economic advantage.[39]

[34] *Ibid,* 173.

[35] Joseph A. Schumpeter, *Capitalism, Socialism, and Democracy* (New York, NY: Harper & Row Publishers, 1975): 81-86.

[36] As paraphrased by Rosen, *Winning the Next War: Innovation and the Modern Military,* 2.

[37] Barry Posen, *The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars* (Ithaca, NY: Cornell University Press, 2014); Rosen, *Winning the Next War: Innovation and the Modern Military;* Raphael Marcus, "Military Innovation and Tactical Adoption in the Israel-Hizballah Conflict: the Institutionalization of Lesson Learning in the IDF," *Journal of Strategic Studies* 38.4 (2015): 500-528; Harry Sapolsky, "On the Theory of Military Innovation" *Breakthroughs* 9.1 (Spring 2000): 35-39, Harvey Sapolsky, "The Interservice Competition Solution," *Joint Forces Quarterly* (Spring 1996); and Nina Kollars, "Genius and Mastery in Military Innovation," *Survival* 59 (2017): 125-138.

[38] Subhasish Dasgupta, "The Role of Culture in Information Technology Diffusion in Organizations," *Innovation in Technology Management: The Key to Global Leadership* (1997): 353-356. For more on the relationship between formalized learning processes and adaptation, innovation, and emulation, see: Tom Dyson, "The military as a learning organization: establishing the fundamentals of best-practice in lessons-learned," *Defence Studies* 19.2 (2019): 107-129 and Tom Dyson, *Organisation Learning and the Modern Army* (Abingdon, UK: Routledge, 2020).

[39] It is not just firms or government agencies that benefit from organizational innovation. Aaron Brantly documented how jihadist groups have innovated to circumvent government surveillance. Aaron Brantly, "Innovation and Adaption in Jihadist Digital Security," *Survival* 59.2 (2017): 79-102.

Within the security studies literature, four models of causal change have been used to better understand the circumstances under which organizations may reform, innovate, or choose to adopt change—the interservice model, intraservice model, organizational culture, and the civil-military model (the latter will be covered under "champions" in hypothesis three). Additionally, scholarship has explored the role of mimetic isomorphism on adoption decisions.

The interservice model within the innovation literature highlights the role of "resource scarcity" as one of the primary factors driving change, which could include adoption decisions.[40] The interservice politics model hypothesizes that military services innovate and change out of fear that they will lose their budget share. This change could take numerous forms, to include embracing new missions or operational concepts that no service presently executes, if they believe that adoption will ensure that the additional resources will accrue to their own service.[41] Owen Cote's scholarship supports the impact of this model on innovation by showing how interservice competition between the US Air Force and US Navy on the *Polaris* missile program enhanced innovation, as each service sought to out-perform the other.[42] Andrew Bacevich, likewise, in his study of US Army innovation in the 1950s found that the Army embraced tactical nuclear weapons out of a belief that if it did not, Congress would allocate what it believed was its funding to new Air Force nuclear weapons programs.[43]

The intraservice model, most closely associated with Stephen Rosen, hypothesizes that intraservice competition drives military reform, to include adoption. Unlike the interservice model, the intraservice model looks beyond services as unitary actors and instead focuses on how competing interests within a given service is a force for innovation. Rosen contends that a successful innovation occurs when military leadership imagines "a new theory of victory, an explanation of what the next war will look like and how officers must fight if it is to be won."[44] From that point on an "ideological struggle" will occur within the service, as advocates work to find allies and resources that can make that theory of victory a reality. For reform to occur, Rosen argues that an alignment of service-leaders, mid-level officers, and institutional arrangements must occur through the creation of new critical tasks and promotion pathways. Building on this work, Susan Marquis demonstrated that the US DoD developed new special operations capabilities in the 1980s by managing intraservice politics.[45] Vincent Davis, likewise, has shown that the development of nuclear gravity bombs, nuclear propulsion for fast ships, and fleet ballistic missiles in the US Navy can be attributed to intraservice dynamics.[46]

Theorists have also explored the role of organizational culture on military strategic behavior—to include decision and adoption. As Theo Farrell and Terry Terriff have noted, "intersubjective

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[40] Sapolsky, "On the Theory of Military Innovation."
[41] Grisson, "The Future of Military Innovation Studies," 910-911.
[42] Owen Cote, *The Politics of Innovative Military Doctrine: The US Navy and Fleet Ballistic Missiles* (Cambridge, MA: Massachusetts Institute of Technology PhD Dissertation, 1996).
[43] Andrew Bacevich, *The Pentomic Era: The US Army Between Korea and Vietnam* (Washington, DC: National Defense University Press, 1986).
[44] Rosen, *Winning the Next War: Innovation and the Modern Military,* 20.
[45] Susan Marquis, *Unconventional Warfare: Rebuilding US Special Operations Forces* (Washington DC: Brookings Institute, 1997).
[46] Vincent Davis, *The Politics of Innovation: Patterns in Navy Cases* (Denver, CO: University of Denver Press, 1967).

beliefs about the social and natural world that define actor, their situations, and the possibilities of action" is a critical factor in any military reform.[47] Indeed, Elizabeth Kier demonstrated that during the interwar years, the British and French Armies resisted mechanized warfare due to cultural factors within the officer corps and a commitment to colonial missions.[48] Nina Tannenbaum has shown how organizational standards of appropriateness can dictate what practices, concepts, and technologies tied to warfare are acceptable, and therefore adopted, and what may be deemed "taboo," which can have knock on effects when exploring diffusion.[49] Social theorists have likewise noted that emulation occurs according to a logic of appropriateness, which is grounded in shared meaning and interpretation.[50] Jeffrey Legro has shown how organizational culture can drive state security behavior—to include employing unrestricted warfare and strategic bombings despite a "firebreak" on their use.[51]

Mimetic isomorphism—the imitation or emulation of others—has also been explored as a key driving factor in adoption decisions within the security studies literature.[52] Chris Demchak in her assessment of "precision armies" or the "networked battlespace" has explored how organizations will seek to adopt the organizational practices of other "high-reliability organizations" (or services) to meet the demands of a digitally enabled battlespace—in which sensors, command, and shooters are interlinked in a joint battlespace. She argues that "information age" warfare should drive a form of "mimetic isomorphism" in organizational practices, for instance, she highlights the emergent structural similarity between ground forces and Air Force units. However, much like the organizational innovation literature that acknowledge the challenges associated with reform, she acknowledges that "rather than the emergence of a more effective and reliable organization, the more likely outcomes are avoidance of risky operations and an ineffective mimetic isomorphism." Such an outcome would undermine the digitally enabled joint operations that the emulation sought to originally address.[53]

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[47] Theo Farrell and Terry Terriff, *The Sources of Military Change: Culture, Politics, and Technology* (London, UK: Lynne Rienner Publishers, 2002).
[48] Elizabeth Kier, *Imaging War: French and British Military Doctrine between the Wars* (Princeton, NJ: Princeton University Press, 2017), Elizabeth Kier, "Culture and Military Doctrine: France between the Wars," *International Security* 19.4 (Spring 1995): 65-93.
[49] Nina Tannenwald, "The Nuclear Taboo: The United States and the Normative Basis of Nuclear Non-Use," *International Organization* 53.3 (Summer 1999): 433-469. This is somewhat tied to Theo Farell's work on transnational norms or "acceptableness" and adoption. Farrell has shown how the Irish military's transformation form a primarily unregulated guerilla organization to a conventional military was influenced by transnational norms. Theo Farrell, "Global Norms and Military Effectiveness: The Army in Early Twentieth-Century Ireland," in Risa Brooks and Elizabeth Stanley, *Creating Military Power: The Sources of Military Effectiveness* (Stanford, CA: Stanford University Press, 2007): 136-157.
[50] James March, *A Primer on Decision Making: How Decisions Happen* (New York: Free Press, 1994).
[51] See, for instance, Jeffrey Legro, *Cooperation Under Fire: Anglo-German Restraint During World War II* (Ithaca: Cornell University Press, 1995); Jeffrey Legro, "Military Culture and Inadvertent Escalation in World War II," *International Security* 18.4 (Spring 1998): 108-142
[52] The business community identifies coercive, normative, and mimetic isomorphism as a key determining factor in adoption decisions Jennifer Martinez-Ferrero and Isabel-Maria Garcia-Sanchez, "Coercive, normative, and mimetic isomorphism as determinants of the voluntary assurance of sustainability reports," *International Business Review* 26 (2017): 102-118.
[53] Chris Demchak, "Tailored Precision Armies in Fully Networked Battlespace: High Reliability Organizational Dilemmas in the 'Information Age,'" *Journal of Contingencies and Crisis Management* 4.2 (June 1996): 93-103.

Based on this literature, the following hypothesis should prove true with regard to *adoption decisions:*

Hypothesis Two: States that have a propensity for organizational reform within their defense bureaucracy will have higher synthetic training adoption rates.

- Is interservice rivalry present across the country's military services, and if so, to what extent does it impact synthetic training adoption?
- Is intraservice rivalry present within the country's various military services, and if so, to what extent does it impact synthetic training adoption? Have key promotion pathways or a critical task focus been created within a service that are linked to synthetic training?
- Has a service identified their select culture—i.e., a preference for live training or another unique attribute—as a barrier or a driver of synthetic training adoption?
- Have services mimicked the adoption plans of their sister services—either in strategy, acquisition decisions, or critical task focus—when adopting synthetic training?

The role of internal champions or opinion leadership has also been highlighted as a key contributing factor for adoption. If an internal advocate lobbies on behalf of an innovation, influencing and changing others' opinions in favor of adopting that new idea, it is more likely to be adopted. In short, as Donald Schön notes, "the new idea either finds a champion or dies."[54] Within the security studies literature, this school of though is mostly closely associated with Barry Posen's model of civil-military relations.[55] Within this model, "innovation will occur if statesmen intervene in military service doctrinal development, preferably with assistance of maverick officers from within the service."[56] Scholars have applied Posen's model to both conventional and counterinsurgency conflicts demonstrating how civilian champions have intervened to press forward changes to the US Air Force's strategic bombing capabilities, Soviet Cold War planning, and American and British counterinsurgency campaigns.[57] Intimately tied to internal champions, is the mechanism by which adoption decisions are taken. When one individual (or a few) is involved with the adoption decision, adoption (if it is in the adopter's interest) tends to occur quickly. However, scholars have also found that when an adoption decision is made by a select few possessing power, status, or technical experience, those decisions can, at times, be circumvented in the *implementation phase*, as organizations often favor stability and continuity.[58]

Based on this literature, one would expect the following hypothesis to be true with regards to *adoption decisions*:

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[54] Donald Schön, "Champions for Radical New Inventions," *Harvard Business Review* 41.2 (1963): 84.

[55] See also, David A. Armstrong, *Bullets and Bureaucrats: The Machinegun and the United States Army: 1861-1916* (Westport, CT: Greenwood Press, 1982).

[56] Grisson, "The Future of Military Innovation Studies," 908 and Posen, *The Sources of Military Doctrine,*174, 220-224.

[57] Edmund Beard, *Developing the ICBM: A Study of Bureaucratic Politics* (New York, NY: Columbia University Press, 1976), Kimberly Marten Zisk, *Engaging the Enemy: Organizational Theory and Soviet Military Innovation, 1955-1991* (Princeton, NJ: Princeton University Press, 1993), and Deborah D. Avant, *Political Institutions and Military Change: Lessons from Peripheral Wars* (Ithaca, NY: Cornell University Press, 1994).

[58] Rogers, *The Diffusion of Innovations,* 29.

Hypothesis Three: States that have high-level "champions" for synthetic training either at the Chief of Service level or at the upper tiers of the defense bureaucracy will choose to adopt synthetic training at a higher level.

Regarding the presence of a high-level "champion" for synthetic training at either the Chief of Service level or the upper tiers of the defense bureaucracy, I ask:

- Has a Chief of Service, or a joint commander (or equivalent) within the last ten years advocated for the adoption of synthetic training via the creation of a new service strategy, personnel billets, procurement programs, or service level activities?
- Has a high-level civilian official within the defense bureaucracy, over the course of the last ten years, advocated for the adoption of synthetic training via the creation or incorporation of synthetic training in a defense strategy, personnel billets, procurement programs, or defense-wide activities?

Patterns of Diffusion

A third variant of diffusion scholarship studies the pattern by which innovations spread within a system. Some of the earliest studies within this typological approach explores spatial or geographic patterns of diffusion—how "diffusion [occurs] along lines of spatial proximity or, alternatively, along major lines of communication."[59] Studies that adopt this approach seek to demonstrate that geographically proximate firms or states (or firms or states with strong "regional" identities) will adopt innovations rather quickly.[60] Indeed, political scientists conducting empirical research within this approach have shown that proximity impacts the adoption of new ideas among manufacturing firms[61] and American states.[62] Likewise, similar studies have shown regional explanations for the spread of decolonization of French and British colonies,[63] the spread of conflict[64] within the African subcontinent[65] and in central and South-east Europe;[66] and the

[59] David Collier and Richard Messick, "Prerequisites versus Diffusion: Testing Alternative Explanations of Social Security Adoption," *The American Political Science Review* 69.4 (December 1975): 1306.
[60] See, for instance: John L. Foster, "Regionalism and Innovation in the American States," *Journal of Politics* 40.1 (February 1978): 181.
[61] Jane Sneddon Little and Robert K Triest, "Technology Diffusion in US Manufacturing: the Geographic Dimension," (Proceedings of Technology and Growth Conference, Boston Federal Reserve Bank, Boston, 1996): 215-268.
[62] Foster, "Regionalism and Innovation in the American States," 179-187; John Walker, "The Diffusion of Innovations Among American States," *The American Political Science Review* 63.3 (September 1969): 880-899; John Walker, "Comment: Problems in Research on the Diffusion of Policy Innovations," *The American Political Science Review* 67.4 (December 1973): 1186-1191; Francis Stokes Berry and William D Berry, "State Lottery Adoptions as Policy Innovations: An Event Historical Analysis, *The American Political Science Review* 84.2 (1990): 395-415; and Yvonne Zylan and Sarah Soule, "Ending Welfare as We Know It (Again) Welfare State Retrenchment, 1989-1995," *Social Forces* 79.2 (2000): 623-652.
[63] David Strang, "Adding Social Structure to Diffusion Models: An Event History Framework," *Sociological Methods and Research* 19.3 (February 1991): 324-353.
[64] Kristian Gleiditsch and Michael Ward, "War and Peace in Space and Time: the Role of Democratization," *International Studies Quarterly* 44 (2000): 1-29.
[65] Harvey Starr and Benjamin Most, "Contagion and Border Effects on Contemporary African Conflict," *Comparative Political Studies* 16.1 (April 1983): 92-117.
[66] Mats Hammarstrom, "The Diffusion of Military Conflict: Central and South-East Europe in 1919-20 and 1991-92," *Journal of Peace Research* 31.3 (1994): 263-280.

development of political democracies and market economies in the post-communist era.[67] Other spatial theories of adoption have assessed communication channels between foreign policymakers when selecting to adopt various political programs.[68] Additional work has attributed innovation learning patterns to proximity, the presence of interconnected epistemic communities, and functional interdependence between government and inter-governmental institutions.[69] Despite the rich literature on the impact of geography and/or proximity on adoption decisions, in some cases spatial factors have been found to only have limited influence. For instance, Bradley Canon and Lawrence Baum found that regionalism played a weak role in tort innovations across state judicial systems—the patterns of adoption were found to be largely idiosyncratic.[70]

Literature that expands on studies of communication patterns of diffusion also explore the role of "networks" on diffusion. In essence, communication is most likely to occur among more communities or networks of peers or colleagues. People depend on the subjective evaluation of a new idea that is communicated to them by their peers. As a result, those within a like-minded community—to include attributes like beliefs, education, social status, etc.—are more likely to adopt similar innovations.[71] This overlaps with Ryan Grauer's findings that military-to-military contact is a powerful means by which new ideas are communicated between militaries. [72] Military-to-military contact can take a range of forms, from the use of military attaches and foreign military officers, to the placement of military officers in foreign military universities, and the direct observation of combat, through joint-training, exercises or even the provisioning of training instructors and advisors in foreign countries.

Based on this literature, one would expect the following hypothesis to be true with regards to *adoption decisions*:

Hypothesis Four: States that have frequent military-to-military contact will have progressively convergent synthetic adoption rates and strategies.[73]

- Does the state have military officers permanently attached to allied and partner militaries? If so, does their synthetic training adoption mirror those states?
- Does the state annually send their military officers to foreign military universities? If so, does their synthetic training adoption mirror those states?

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[67] Jeffrey Kopstein and David Reilly, "Geographic Diffusion and the Transformation of the Postcommunist World," *World Politics* 53.1 (2000): 1-37.
[68]Colin J Bennett, "How States Utilize Foreign Evidence," *Journal of Public Policy* 11.1 (1991): 31-54.
[69] Richard Rose, "What is Lesson Drawing," *Journal of Public Policy* 11.1 (1991): I 3-30 and Tom Dyson, "The Challenge of Creating an Adaptive Bundeswehr," *German Politics* (2019): 1-18.
[70] Bradley Cannon and Lawrence Baum, "Patterns of Adoption of Tort Law Innovations: An Application of Diffusion Theory to Judicial Doctrines," *The American Political Science Review* 75.4 (December 1981): 975-987.
[71] This phenomenon was labeled as homophily. Homophily and its opposite, heterophily, were first examined by Paul F. Lazarsfeld and Robert K. Merton. See: Paul F. Lazarsfeld and Robert K. Merton, "Friendship as a Social Process: A Substantive and Methodological Analysis," in Morroe Bergers et. al, *Freedom and Control in Modern Society* (New York, NY: Octagon Books, 1964): 18-54.
[72] Ryan Grauer, "Moderating Diffusion: Military Bureaucratic Politics and the Implementation of German Doctrine in South America, 1885-1914," *World Politics* 67.2 (April 2015): 268-312.
[73] This is also based off theories that assess benign external inducements. See: G. John Ikenberry, "The International Spread of Privatization Policies: Inducements, Learning, and Policy Bandwagoning," in Ezra Suleiman and John Waterbury, *The Political Economy of Public Sector Reform and Privatization* (Boulder, CO: Westview, 1990): 99-101.

- Does the state participate in annual or bi-annual military exercises? If so, does their synthetic training adoption mirror those states?

Finally, scholars have found that normative and cross-cultural factors can act as a determining factor for the diffusion of innovations—either as a barrier or a driver.[74] James Blaut, in his review of the diffusion literature, observed that existing Hägerstrandian views of diffusion were too narrow, and that a broader view was required—one that also incorporated findings from cultural geographers.[75] Blaut argued that "technological innovations tend to be rejected, not through ignorance, but through incompatibility with the existing cultural system as a whole."[76] Conversely, other scholars have noted how in some cases cultural or institutional attributes can serve as key enablers for diffusion and adoption. John Hall and G. John Ikenberry have ventured that a common cultural heritage among European states may provide explanatory power when assessing the diffusion of policy innovations among them.[77] Similarly, Jeffrey Checkel found that emulation only occurs when global norms—in the form of certain practices and organizations—are compatible with the state's culture.[78] Likewise, in his assessment of defense cooperation and military cooperation among Five Eye member states—the US, UK, Canada, Australia, and New Zealand—Thomas-Durell Young demonstrates that cultural affinity and common cultural values were key contributors for the sharing of military organizational concepts and technologies. Young argues that common cultural values played a critical role in buttressing military cooperation amongst countries of the "anglosphere", overshadowing the formal security arrangements nested within larger alliances such as the North Atlantic Treaty Organization (NATO).[79]

Cross-cultural similarity is inherently difficult to measure, as the precise definition of what constitutes culture is deeply contested. Across multiple disciplines, from anthropology to the business literature, and even security studies, differing—and at times contradictory—definitions of culture exist, with each attempting to identify different dimensions or attributes of "culture."[80] In 1980, Geert Hofstede attempted to tackle this challenge by assigning culture-values to groups of people. In his study of 150,000 individuals, Hofstede measured culture across four different dimensions: individualism/ collectivism, power distance, uncertainty avoidance, and masculinity/ femininity.[81] Hofstede's assertion was that by drawing on the different dimensions and scores

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[74] Of note, this differs from the strategic culture literature in that it explores patterns of cross-cultural diffusion. The diffusion literature has primarily focused on cross-cultural theories of diffusion or organizational culture rather than strategic culture as an attribute in adoption choices. However, for an overview of strategic culture, see Lawrence Sondhaus, *Strategic Culture and Ways of War* (New York, NY: Routledge, 2006) and Alastair Johnston, "Thinking About Strategic Culture," *International Security* 19.4 (1995): 32-64.
[75] Hägerstrandian views of diffusions see diffusion as a function of information flows. James Blaut, "Two Views of Diffusion," *Annals of the Association of American Geographers* 67.3 (1977): 343-349.
[76] *Ibid,* 343.
[77] John A. Hall and G. John Ikenberry, *The State* (Milton Keynes, UK: Open University Press, 1989).
[78] Jeffrey Checkel, "Norms, Institutions, and Cultural Identity in Contemporary Europe," *International Studies Quarterly* 43 (1999): 83-114 and Jeffrey Checkel, "The Constructivist Turn in International Relations Theory," *World Politics* 50 (January 1998): 324-348.
[79] Thomas-Durell Young, "Cooperative Diffusion through Cultural Similarity: The Postwar Anglo-Saxon Experience," in Goldman and Eliason, *The Diffusion of Military Technology and Ideas*, 93- 113.
[80] Detmar Straub et. al., "Toward a Theory-Based Measurement of Culture," *Journal of Global Information Management* (January 2002).
[81] According to Hofstede's study, individualism represents the extent to which an individual emphasizes their own needs over those of a group. Power distance is the degree to which power differentials (or inequality) is accepted within a given culture. Uncertainty avoidance is meant to represent the degree of risk acceptance within a given

between groups, one could begin to develop an understanding of the cultural differences (and similarities) across states. Later, Hofstede built on his study and included a fifth dimension, which included long-term orientation.[82] Hofstede's study has been subject to criticism, most notably, the problem of assigning a single culture to a state.[83] Others have questioned the usefulness of reducing culture to numerically measured dimensions, which may be better served through qualitative analysis.[84] Yet, despite the criticisms (and limitations), Hofstede's study is considered the preeminent empirical study of cross-cultural comparison to date. Indeed, it has been the primary source used within the diffusion literature to better understand the cross-cultural diffusion process.[85]

In the mid-1990s, in an attempt to replicate Hofstede's work, a GLOBE study was released that involved 17,000 respondents spread across 62 countries or regions. The GLOBE study measured culture across nine different attributes: performance orientation, future orientation, gender egalitarianism, assertiveness, institutional collectivism, in-group collectivism, power distance, human orientation, and uncertainty avoidance.[86] Like Hofstede's study, the GLOBE study has also suffered from criticism, most notably from Hofstede himself, arguing that the GLOBE study was too US-centric and lacked parsimony.[87] Despite the limitations of both data sets, both studies do act as a baseline to empirically assess culture similarities across states and are extensively used within the diffusion literature.

As a result, based on this literature, one would expect the following hypothesis to be true:

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culture. Finally, masculinity/ femininity is meant to represent goals within a work culture. For instance, according to Hofstede, "masculine" cultures emphasize work goals, such as assertiveness, advancement, and earnings. Whereas, "feminine" cultures place an emphasis on a friendly and comfortable work environment. Geert Hofstede, *Culture Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations* (Thousand Oaks, CA: Sage Publications, Inc., 2001).

[82] Long-term orientation is meant to represent the time typical time horizon of group decision-making. According to this analysis, East Asian cultures tend to have much longer time horizons in decision-making then those of Western cultures. Geert Hofstede and Michael Harris Bond, "The Confucius Connections: From Cultural Roots to Economic Growth," *Organizational Dynamics* 16.4 (1988): 5-21.

[83] As Straub et. al. note, subcultures exist that span national geographic boundaries (like, for instance Arab cultures); some nations have substantial internal cultural differences (like, India); and others, have inter-regional differences (like the United States). Straub et. al., "Toward a Theory-Based Measurement of Culture," 16.

[84] Brendan MacSweeney, "Hofstede's model of national cultural differences and their consequences: a triumph of faith; a failure of analysis," *Human Relations* 55.1 (2002): 89-118.

[85] Sean Dwyer et al., "An exploratory examination of the influence of national culture on cross-national product diffusion," *Journal of International Marketing* 13.2 (2005): 1-27, Abduel Azeez Erumban, "Cross-country differences in ICT adoption: A consequence of Culture?," *Journal of World Business* 41 (2006): 302-314, Idil Sayrac Yaveroglu and Naveen Donthu, "Cultural Influences on the Diffusion of New Products," *Journal of International Consumer Marketing* 14.4 (2002): 49-63, Samer Takieddine, "Internet banking diffusion: A country level analysis," *Electronic Commerce Research and Applications* 14.5 (September-October 2015): 361-371, and Henrik Vejlgaard, "Culture as a Determinant in Innovation Diffusion," in Ioannis Deliyannis, *The Future of Television- Convergence of Content and Technology* (Intech Open Book Series, 2019): 1-23.

[86] Robert J. House et. al, *Culture, Leadership, and Organizations: The GLOBE Study of 62 Societies* (Thousand Oaks, CA: Sage Publications, 2004).

[87] Sunil Venaik and Paul Brewer, "Contradictions in national culture: Hofstede vs GlOBE," (Academy of International Business Conference, Track 8: International Human Resource Management, Cross-cultural Management, and Qualitative Research Methods, July 2008, Milan, Italy): 7.

Hypothesis Five: States will select synthetic training adoptions that mirror the adoption strategies of states they feel culturally aligned with (for instance, the Five Eye countries).

Based on this literature, I ask the following qualitative indicator questions:

- Does the state make synthetic training adoption decisions like those identified by Hofstede and the GLOBE studies as culturally similar?
- Is the state part of an intelligence and/or alliance grouping that is based on shared values or ideals? If so, has the state made similar synthetic training adoption decisions to those within that groping?

Overview of the Five Alternative Hypotheses and Qualitative Indicator Questions

For ease of reference an overview of the five previously highlighted (not mutually exclusive) alternative hypotheses and their qualitative indicator questions are found below:

Alternative Hypotheses	Qualitative Indicator Questions
Hypothesis One: States that live in regions of intense geo-strategic competition will adopt synthetic training at a higher rate.	• Does the state face an enduring competitor or potential adversary? • Has that competitor or adversary made belligerent statements or taken provocative action that could be perceived by the bureaucratic elites as an attempt to change the political status quo within the state or its perceived sphere of influence? • If the above is true, to what extent has geo-strategic competition been highlighted as a determining factor when making synthetic training adoption or emulation decisions? • Is a baroque armament, the unique relationship between the defense industry and the state, driving the expansion of synthetic training?
Hypothesis Two: States that have a propensity for organizational reform within their defense bureaucracy will have higher synthetic training adoption rates.	• Is interservice rivalry present across the country's military services, and if so, to what extent does it impact synthetic training adoption? • Is intraservice rivalry present within the country's various military services, and if so, to what extent does it impact synthetic training adoption? Have key promotion pathways or a critical task focus been created within a service that are linked to synthetic training? • Has a service identified their select culture—i.e., a preference for live training or another unique attribute—as a barrier or a driver of synthetic training adoption? • Have services mimicked the adoption plans of their sister services—either in strategy, acquisition decisions, or critical task focus—when adopting synthetic training?
Hypothesis Three: States that have high-level "champions" for synthetic training either at the Chief of	• Has a Chief of Service, or a joint commander (or equivalent) within the last ten years

Service level or at the upper tiers of the defense bureaucracy will choose to adopt synthetic training at a higher level.	advocated for the adoption of synthetic training via the creation of a new service strategy, personnel billets, procurement programs, or service level activities? • Has a high-level civilian official within the defense bureaucracy, over the course of the last ten years, advocated for the adoption of synthetic training via the creation or incorporation of synthetic training in a defense strategy, personnel billets, procurement programs, or defense-wide activities?
Hypothesis Four: States that have frequent military-to-military contact will have progressively convergent synthetic adoption rates and strategies	• Does the state have military officers permanently attached to allied and partner militaries? If so, does their synthetic training adoption mirror those states? • Does the state annually send their military officers to foreign military universities? If so, does their synthetic training adoption mirror those states? • Does the state participate in annual or bi-annual military exercises? If so, does their synthetic training adoption mirror those states?
Hypothesis Five: States will select synthetic training adoptions that mirror the adoption strategies of states they feel culturally aligned with (for instance, the Five Eye countries).	• Does the state make synthetic training adoption decisions like those identified by Hofstede and the GLOBE studies as culturally similar? • Is the state part of an intelligence and/or alliance grouping that is based on shared values or ideals? If so, has the state made similar synthetic training adoption decisions to those within that groping?

Table 3: Overview of Five Alternative Hypotheses and Qualitative Indicator Questions

Diffusion Decisions

The oldest concept in innovation research, next to innovation itself, is adoption. Indeed, adoption has been considered the "original dependent variable in innovation research."[88] The original definition of adoption was first succinctly articulated by Everett Rogers and F. Floyd Shoemaker as "making full use of a new idea as the best course of action available."[89] In essence, it is some act of decision (conscious or subconscious) on an individual's part. Since that time, nearly all innovation researchers have explicitly or implicitly employed that definition.

Within the classic security studies literature, those that study the diffusion of military technology or ideas usually view adoption decisions by states as a yes or no question—a state chooses to adopt an innovation or they do not. As a result, there is a tendency to view innovators as adopters and non-innovators as non-adopters. However, in reality, adoption decisions are far more complex and can result in a much broader array of outcomes. Indeed, scholars of diffusion have long recognized that adoption decisions are not instantaneous yes/ no acts. Instead, adoption decisions take place in a process and involve multiple decisions and actions; from first accruing knowledge that an innovation exists, to then being persuaded to adopt the innovation, deciding on the best course of

[88] Eveland, "Issues in Using the Concept of 'Adoption of Innovations,'" 1.
[89] As quoted in Rogers, *Diffusion of Innovations*, 171.

action, to finally implementing that decision, and confirming that it was the proper choice.[90] As Emily Goldman notes, states may adopt an aspect of a new idea that meet their needs, but not necessarily the whole thing. This may occur because a state deems that the innovation does not meet their needs—not because they are a laggard or because barriers to adoption exist.[91]

One adoption option for a state is to attempt to adopt the new idea in its current form—the innovation diffuses from state A to state B. For instance, in early modern Europe, the creation of drill by Maurice of Orange to school troops in high-level linear tactics arguably ushered in a "Military Revolution."[92] Military officers lured by the promise of tactical effectiveness in combat traveled to the Netherlands and northern Germany in what acted as a training ground for the latest tactical warfighting techniques and formations. Drill later fully diffused to England in the seventeenth century via the experience of British mercenaries with the Continental service.[93]

However, in other cases a state may choose to adopt part of a new idea. Indeed, in the early and mid-twentieth century, lacking the capacity to fully adopt developing naval innovations, Brazil and Argentina chose to adopt only some of the technological components.[94] As Michael Horowitz notes, "partial adaption generally involves adopting technological or operational but not organizational aspects of an innovation, since it is generally much less disruptive to adopt technologies that can change the way and organization thinks about employing military force."[95] Likewise, a state could choose to adopt a new idea, but reinvent it—changing or modifying the innovation as it goes through the adoption and implementation process. Reinvention is a relatively new field of research in the diffusion scholarship, only emerging in the 1970s.[96] Diffusion scholars recognize that not every innovation is perfect for an adopting state—it may not meet the adopting state's needs or fix their problems. As a result, a state may choose to re-invent the innovation to better fit their requirements. In the second half of the eighteenth century, the British introduced regimental culture into South Asia. However, British sensitivity to South Asian religious values and norms caused only specific structural regimental advantages to be imported, allowing the sepoys to create a distinctively Indian institution.[97]

Alternatively, a state may choose not to adopt at all. Decisions to not adopt a new idea can occur for a multiplicity of reasons, out of concern that adoption could trigger domestic unrest or a lack

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[90] Rogers, *Diffusion of Innovations*, 162.
[91] Goldman and Eliason, *The Diffusion of Military Technology and Ideas*.
[92] Michael Roberts, *The Military Revolution, 1560-1660* (Belfast: Queen's University, 1956) and Parker, "The 'Military Revolution' 1560-1660- a Myth?," 195-214.
[93] Manning, "Styles of Command in Seventeenth Century English Armies," 671-699.
[94] Joâo Resende-Santos' study on the diffusion of military technology to South America. Resende-Santos, "Anarchy and Emulation of Military Systems: Military Technology in South America, 1870-1930," 193-260.
[95] Michael Horowitz, "The Diffusion of Military Power: Causes and Consequences for International Politics," (Dissertation submitted to the faculty of the Graduate School of Arts and Sciences of Harvard University in partial satisfaction of the requirements for the degree of Doctor of Philosophy, Harvard University, 2006): 42.
[96] Up until the 1970s, re-invention was considered an unusual behavior and largely disregarded from empirical data sets. Diffusion scholars treated respondent data on reinvention as "noise" within research. See: Rogers, *Diffusion of Innovations*, 174.
[97] John Lynn, "Heart of the Sepoy: The Adoption and Adaptation of European Military Practice in South Asia, 1740-1805," in Goldman and Eliason, *The Diffusion of Military Technology and Ideas,* 33- 62.

of financial or organizational capital to adopt the innovation.[98] Finally, a state could also choose to counter or offset an innovation through alternative technological or organizational means. For instance, during the Hundred Years war, the English temporarily sought to offset the conventional superiority of French cavalry through the innovative use of the long-bow and a tactical system that integrated archers with dismounted men-at-arms.[99]

A decision to not adopt an innovation could also trigger a state to respond externally. For instance, a state could attempt to mitigate the costs of non-adoption by allying with a likely adopter.[100] Such a strategy could manifest as either balancing or bandwagoning.[101] Likewise, a state could also decide that the implications of a military innovation makes its former strategic interests no longer tenable. As a result, a state may choose to shift towards neutrality, adopt a less aggressive foreign policy posture, or act within international institutions as a means to better protect itself.[102]

Diffusion decisions are fundamentally context-dependent. As noted, decisions to adopt, reject, or re-invent an innovation may be a function of an individual states' perception of their domestic or external security environment.[103] Context, however, may not just be state dependent. It may also be linked to a discrete technology. Indeed, technology is inherently political—its design and implementation implicitly encourage and discourages certain types of tactical and/or operational innovations.[104] As a result, throughout the case selection, efforts will be made to identify alternative explanations, to include technological explanations, if they exist, for a state's adoption decisions.

Limitations of Current Diffusion Scholarship: Understanding Why Adoption Occurs and In-Process Diffusion

Despite the proliferation of diffusion scholarship across a variety of disciplines, significant limitations exist. Perhaps the most serious shortcoming is the existence of a "pro-innovation" bias within the literature—innovations (and the diffusion of innovations) are systematically assumed to be wholly beneficial. This embedded bias is a function of Bryce Ryan and Neal Gross' groundbreaking study of hybrid corn in two rural Iowan communities. The effects of hybrid corn's diffusion among rural farmers were shown to be so beneficial that it was assumed that all

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[98] See the British Army's decision to not adopt mass mobilization for fear of domestic unrest in the post-Napoleonic era. Geoffrey L Herrera and Thomas G. Mahnken, "Military Diffusion in Nineteenth-Century Europe: The Napoleonic and Prussian Military Systems," in Goldman and Eliason, *The Diffusion of Military Technology and Ideas*, 205-242.

[99] Andrew Krepinevich, "Cavalry to Computer: The Pattern of Military Revolutions," *The National Interest* (September 1994), retrievable at: https://nationalinterest.org/article/cavalry-to-computer-the-pattern-of-military-revolutions-848?page=0%2C1.

[100] Paul Schroeder, "Historic Reality vs. Neorealist Theory," *International Security* 19.1 (1994): 117.

[101] Balancing is defined as allying with others against the prevailing threat, in this case, a hostile state in possession of the innovation. Bandwagoning refers to alignment with the source of danger, which would involve allying with a hostile state in possession of the innovation. Walt, *The Origins of Alliances*, 17.

[102] Such a shift is characterized by Schroeder as "hiding" in international politics. Schroeder, "Historic Reality vs. Neorealist Theory," 114.

[103] See Michael Raska's argument on how an individual state's security dilemma may influence military innovation. Michael Raska, *Military Innovation in Small States: Creating a Reverse Asymmetry* (London, UK: Routledge, 2016) and Rob Sinterniklass, "Military Innovation: Cutting the Gordian Knot," *Netherlands Defence Academy* (October 2018): 15.

[104] Langdon Winner, "Do Artifacts Have Politics?" *Daedalus* 109.1 (1980): 121-136.

innovations, and their subsequent diffusion, also generated positive outcomes. As George Downs Jr. and Lawrence Mohr noted when commenting on this trend in the 1970s,

> *The act of innovating is still heavily laden with positive value. Innovativeness, like efficiency, is a characteristic we want organisms to possess. Unlike the ideas of progress and growth, which have long since been causalities of a new consciousness, innovation, especially, when seen as more than purely technological change, is still associated with improvement.*[105]

Such a bias is prevalent in the security studies literature today. Indeed, Adam Grissom in his review of the military innovation literature, has noted that military innovation studies tend to be consequentialist—military practitioners and scholars only study changes to military practices that result in positive outcomes.[106] This bias is clearly present in definitions of military innovation. Most definitions equate military innovations as contributors to increased battlefield effectiveness.[107] Military modernization involves a series of trial and errors, and not all new ideas are positive, as the French cruelly learned in 1940 when the German circumvented the state-of-the-art Maginot Line and thrust through the Ardennes, subsequently leading to fall of France during WWII.[108]

Furthermore, "bad" innovations also diffuse. It would be difficult to find someone that characterizes the spread of crack cocaine across American cities as a positive outcome.[109] Yet, the invention of crack cocaine was a new idea, just a highly problematic one. An inability to shed a "pro-innovation" bias in the literature, has led scholars to fail to study *anti-diffusion* programs designed to prevent the spread of "bad" innovations, like crack cocaine, or even cigarettes.

Moreover, due to the positive value-laden aspects of studies of innovation, scholars often select rapidly diffusing innovations for study, thereby implicitly assuming that adopters are, by nature, more creative or agile. However, some actors may not benefit from diffusion and some new ideas may not necessarily yield improvements. Indeed, as Rogers highlights, due to this pro-innovation bias in the literature, we know far more about the diffusion of rapidly diffusing innovations than those that diffuse slowly, about choices of adoption versus rejection, and about the continued use of an innovation versus the discontinuance of an innovation.[110] As a result, somewhat understandably, diffusion literature tends to be historic, charting the S-curve of innovations that have moved throughout the entirety of the diffusion process. Indeed, no study to date in the security studies literature, perhaps except for Horowitz's recent examination of AI, explores the diffusion of a military innovation in-process.[111]

However, by studying diffusion while it is in-process, one can better shed such a pro-innovation bias in a study. Indeed, in-process diffusion research allows scholars to investigate less successful,

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[105] Downs Jr and Mohr, "Conceptual Issues in the Study of Innovations," 350.
[106] Grissom, "The Future of Military Innovation Studies," 907.
[107] *Ibid.*
[108] J.E. Kaufmann and H.W. Kaufmann, *The Maginot Line: None Shall Pass* (Westport, CT: Praeger Publishers, 1997).
[109] Roland G. Fryer et al., "Measuring Crack Cocaine and Its Impact," *Harvard University* (2006).
[110] Rogers, *The Diffusion of Innovations,* 105.
[111] Horowitz, "Artificial Intelligence, International Competition, and the Balance of Power."

as well as more successful, cases of diffusion. By studying diffusion while it is in-process, one can better acknowledge an adopter's perception of a new idea and how that drives decisions to reject, discontinue, or re-invent that innovation. Such studies allow investigators to get to the heart of "why" adoption occurs. *Why* questions are infrequently studied by diffusion researchers, as the precise motivations undergirding adoption are inherently tricky to investigate. For instance, respondents may be unable to tell a researcher why they decided to adopt or re-invent an idea. Others may be unwilling to share that information. Moreover, usual methods of diffusion research, like surveys, may be unable to identify the multiplicity and complexity of factors that influence adoption, rejection, or re-invention decisions.[112] As a result, researchers must study the broader context in which adoption decisions occur, something that a comparative case study approach and process-tracing are uniquely suited to provide.

In-process studies of diffusion, however, are not without risks and pitfalls. Indeed, by studying diffusion in-process, scholars are less able to account for behavioral or geopolitical change over time. As Rogers notes,

> *The focus of diffusion research on tracing an innovation through a system over time and/or across space has the unique quality of giving "life" to a behavioral change process. Conceptual and analytical strength is gained by incorporating time as an essential element in the analysis of human behavior change.*[113]

Time is particularly difficult to include in in-process studies of diffusion. The time horizons of an innovation's spread throughout a system may be beyond the scope of an academic study, occurring over the course of years, or even decades. As a result, studies of in-process diffusion may solely capture an individual or state's perception of an innovation at one or two moments in time, missing the entirety of the diffusion S-curve. Temporal perceptions of a new idea may be subject to change, and therefore, potential exists that some findings from in-process diffusion studies may become dated or irrelevant.

Despite this limitation, studying in-process diffusion is worthwhile, and worthy of deeper examination, particularly as it applies to the study of military innovations. In-process studies of the diffusion of military innovations may shed better light on why some new ideas are rejected, re-invented, or adopted at far slower rates. Indeed, the study of in-process diffusion should expand the academic literature on diffusion, leading to deeper understanding of the complex and idiosyncratic nature of adoption decisions.

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[112] Rogers, *The Diffusion of Innovations,* 109-110.
[113] *Ibid,* 103.

CHAPTER THREE: METHODS AND CASE SELECTION

Tracking the Variable of Interest—Adoption

This dissertation seeks to track variation in diffusion and state-level adoption decisions across two types of synthetic training: LVC and a multi-domain synthetic training environment.[1] As mentioned in the introduction, these two synthetic training applications were selected because they represent two technically complex collective training regimes that are presently in the diffusion process. Selecting synthetic training applications that are currently in the diffusion process will protect this dissertation against a "pro-innovation" bias. Indeed, as highlighted in the earlier overview of the diffusion literature, more research must assess the broader context within which adoption decisions occur. Even when a new idea or application may outwardly seem beneficial—like LVC or a multi-domain synthetic training environment—individuals or states may perceive that idea through a different lens. To best assess (and understand) adoption decisions, researchers must be capable of understanding the unicity of the decision makers' perspectives. Indeed, as Rogers notes, "simply to regard adoption of the innovation as rational…and to classify rejection as wrong or stupid is to fail to understand that innovation decisions are idiosyncratic and particularistic."[2]

Exploring why a state chooses to adopt each type of synthetic training requires the consistent and coherent measurement of the variable of interest—adoption. I do this by tracking state level variation across five of the six alternative hypotheses identified within the literature review. As will be discussed, the hypothesis on state level defense budgets was cut as it does not sufficiently explain country level-adoption decisions. As a result, this dissertation elected to use the defense budget as a control to select countries for comparative purposes.[3] By tracking adoption across five hypotheses, this dissertation falls into what Stephen Van Evera describes as a "theory testing" dissertation. It uses empirical evidence to evaluate existing theories via case studies and therefore, according to Van Evera, is a valid exercise.[4] Indeed, by testing alternatives theories of diffusion across five hypotheses, this dissertation extends and adds important nuance to the diffusion literature, particularly as it applies to the relevance of perceived geostrategic competition in adoption decisions.

The Use and Selection of Country Case Studies

To test each qualitative indicator question identified in the previous chapter, and therefore validate or falsify the alternative hypotheses, I rely on a series of case studies. Case studies provide the

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[1] This dissertation charts adoption decisions not implementation. This is important as some countries have decided to adopt a synthetic training innovation, yet they are still in the implementation process. A distinction is drawn in the innovation literature between the decision to adopt an innovation and its subsequent implementation. Gerald Zaltman, Robert Duncan, and Jonny Holbeck, *Innovations and Organizations* (Hoboken, NJ: John Wily & Sons, 1973).

[2] Rogers, *The Diffusion of Innovations,* 111.

[3] As will be discussed on page 78-79, while six alternative hypotheses are identified in the literature review, only five alternative hypotheses are used to track state level adoption decisions. When selecting country comparisons, the defense budget was employed as a control.

[4] See, Van Evera, *Guide to Methods for Students of Political Science,* 90. For examples of work that focus on theory testing, see, Steven Chan, "Mirror, Mirror on the Wall…Are the Freer Countries More Pacific?" *Journal of Conflict Resolution* 28 (December 1984): 617-648 and Zeev Maoz and Bruce Russett, "Normative and Structural Causes of Democratic Peace, 1946-1986," *American Political Science Review* 87 (September 1993): 624-638.

most viable means of empirically assessing each of the alternative hypotheses. A "case" for the purposes of my dissertation is a state that is a partner or ally of the US that has adopted, or is adopting, synthetic training applications. While my case selection is limited to US partners and allies, the case selection process should not limit the generalizability of my findings. Indeed, as will be demonstrated, even among US partners and allies, synthetic training adoption decisions were complex and idiosyncratic processes with high levels of discrepancy in adoption rates. It is likely that this trend would also be reflected elsewhere—to include states with more adversarial or conflictual relations with the US. My research focuses on cases that enable both cross-case and within-case tests of the alternative hypotheses.

To maximize validity, this dissertation selects country case studies that represent what Dan Slater and Daniel Ziblatt call "typological representativeness"—cases that represent the full range of variation across the dependent variable.[5] Therefore, in each section, country case studies are selected that represent the full spectrum of diffusion. In each case, one country demonstrates a "high-level" of adoption and the other represents a "low-level" of adoption. Employing such an approach to case selection is important because it protects it against many of the adverse consequences that occur when simply selecting cases based on the dependent variable. As Barbara Geddes notes,

> *The adverse effects of selecting cases for study on the dependent variable stem from the logic of inference. When one sets out to explain why countries A and B have, say, developed more rapidly than countries C through I, one is implicitly looking for antecedent factors X through Z that countries A and B possess in greater degree than do countries C through I. The crux of the difficult that arises when cases are selected on the dependent variable is that if one studies only countries A and B, one can collect only part of the information needed, namely the extent of factors X through Z in countries A and B. Unless one also studies countries C through I (or a sample of them) to make sure they have less of X through Z, one cannot know whether the factors identified really vary with the outcome under investigation.*[6]

To control for rival hypotheses, the dissertation also applied what political scientists call a "folk Bayesian" approach to case study selection.[7] Cases were selected that are the most puzzling based on existing explanations of diffusion. Finally, cases were chosen with an eye towards data richness, the appropriateness for controlled comparison with other cases based on military spending, and the importance of the state for coalition interoperability.

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[5] Slater and Ziblatt, "The Enduring Indispensability of the Controlled Comparison." This also follows what John Stuart Mill calls the "method of difference," meaning countries are selected with similar general characteristics but have variation in the dependent variable. See: John Stuart Mill, *A System of Logic* e.d. J.M. Robson (Toronto, Canada: University of Toronto Press, 1973).

[6] Barbara Geddes, *Paradigms and Sand Castles* (Ann Arbor, MI: University of Michigan Press, 2003): 91. See also, Shively, *The Craft of Political Research,* 109.

[7] For instance, it selected a "low adopter" that is part of the "Five Eye" alliance grouping and a "high adopter" that is also part of that grouping. Timothy K McKeown, "Case Studies and the Limits of the Quantitative World View," in Henry Brady and David Collier, *Rethinking Social Inquiry: Diverse Tools, Shared Standards* (New York, NY: Rowman & Littlefield, 2004): 158-167.

This dissertation limited case selection to US allies and partners for two main reasons—data richness and the policy relevance of the dissertation's theoretical findings. In the first instance, finding data associated with "why" states make adoption decisions about synthetic training is challenging. Even among US partners and allies, a reticence can exist to share information due to classification concerns or more general sensitives associated with the information. I often had to rely on the willingness of military officers or contractors to share information or to point me in the right direction to uncover information related to adoption. It is unlikely that military personnel or contractors within states like Russia or China would have been willing to do the same. Additionally, some of the most revealing information was not shared with me—but shown through synthetic training demonstrations. I doubt I would have received access to training facilities among non-US partners and allies, partially due to the sensitivities associated with the information, but also because the US participates in few, if any, training events with non-partners and allies.[8]

The second reason for the case selection was to ensure the policy relevance of this dissertation's theoretical findings. Indeed, as academic research has shown, great powers, like the US, are more likely to fight as a coalition.[9] As a result, the diffusion of synthetic training technologies to partners and allies is important, as it can help to facilitate future coalition interoperability and battlefield effectiveness. It is for this reason that offices within the Pentagon, like the Joint Force Development (J7) follow not just the US advances in LVC, but also efforts on the part of US partners and allies.

Country Case Study Selection

To select country case studies, this dissertation built a data set based on primary and secondary source documents and preliminary interviews with serving military officials (self-reporting on their own military) and defense industrial base employees (see appendix one).[10] Interviewees were selected that possess inside knowledge of a state's synthetic training adoption rate through their present or former job responsibilities. For each type of synthetic training, a series of questions were asked that served as a baseline to objectively measure (and compare) country adoption decisions. These questions were assessed across all US partners and allies that have procured or plan to procure fourth or fifth generation platforms and have a defense budget of over $10 billion. These two metrics were used for two reasons. First, fourth and fifth generation fighters are commonly identified as a driver for LVC adoption due to range space restrictions (see pages 44-45). By only including countries that have procured (or plan to procure) these systems, I ensure that all assessed countries have similar fighter procurement plans and to the extent it does factor into adoption rates, it is not the primary causative factor given the extreme variation in adoption results. Secondly, a defense budget of over $10 billion was selected because not all coalition countries have the financial assets to support acquiring very complex synthetic training

[8] According to the Center for Naval Analysis, the US and China only engaged in activities that met the threshold of security cooperation in the 1980s. For more information, see: David Finkelstein, "The Military Dimensions of US-China Security Cooperation: Retrospective and Future Prospects," *Center for Naval Analysis* (September 2010).
[9] Corbetta and Dixon, "Multilateralism, Major Powers, and Militarized Disputes."
[10] For each country an initial set of interviews, where possible, was conducted. It is likely that synthetic training adoption decisions in each country is far more complex than this data set demonstrates. However, due to time limitations (and budgetary restrictions), I could not travel to every country to conduct in-depth interviews with multiple respondents.

applications, as a result a number was selected to ensure that all assessed countries could theoretically afford synthetic training modernization. [11]

Country Case Data Set Selection Criteria

1. US partner or ally,
2. Possessing a defense budget over $10 billion, and
3. Planning to procure or have already procured fourth or fifth generation aircraft.

While these three metrics were used to down-select countries for case study selection, they do not artificially truncate my sample. Indeed, a wide variety of countries—approximately 46% of the globe—have developed or procured (or plan to develop or procure) fourth and fifth generation fighters (see appendix three). Additionally, while a far smaller number of states meet the budget threshold, approximately 12%, the countries are wide ranging in terms of location, geographic size, the size of their military, and their relationship with the US (see appendix one). For these reasons, it seems likely that the findings of this dissertation are generalizable beyond the case studies examined. Indeed, states that are not US partners or allies, but have similar miliary modernization plans, likely have similar causal factors that influence adoption decisions. Together, after selecting for the three criteria outlined above, nineteen states were left for synthetic training rate adoption assessment.

The questions developed were originally very narrow, with the intention of developing numerical comparisons across each training application and country. For instance, for LVC, one question asked interviewees the percent of tactical training exercises that employed LVC assets versus just live assets in 2018. However, many country respondents asked that I move over to a classified network for them to provide a response. As a result, due to classification challenges, my original question set was broadened to ensure as many country-level results as possible for comparative purposes.

The question set is as follows:

Innovation One: Live, Virtual, and Constructive Training

- Does your country prioritize, in doctrine or other strategy documents, the employment of LVC?
- Does your country have high-level training (within service or across services) that employ live, virtual, and constructive assets for tactical and/or operational training?

Innovation Two: Multi-Domain Training

[11] A defense budget of over $10 billion was selected because not all coalition countries have the financial assets to support acquiring very complex synthetic training applications like LVC or a multi-domain synthetic training environment. For those that don't have the budget, the interoperability of methods, systems, and procedures frequently falls on the US. In 1997, the US National Defense Panel argued that significant investment is required by the US to pursue a military transformation strategy. The estimated budget "wedge" for this strategy was calculated at $5 to $10 billion dollars. As a result, a $10 billion yearly defense budget seems reasonable for a country to attempt to achieve transformation over time. United States National Defense Panel, *Transforming Defense: National Security in the 21st Century*.

- Is your country prioritizing training (in doctrine or high-level statements) for multi-domain operations (i.e. space and cyber) alongside other traditional domains, like air, sea, and land?
- Does your country have plans to conduct multi-domain training exercises for command and control (C2) operators, conventional warfighters, and cyber/ space warfighters?

The country level results can be found in appendix one. Other indicators of strength, such as the size of the military and the defense budget, are also provided for comparative purposes. Given that this dissertation examines the diffusion and adoption of synthetic training that are currently in the diffusion process, the country selection data set is time bound for selection purposes and examines adoption decisions through April 2019.

For assessment purposes, the following assessment rubric was employed below. Countries are then averaged across the two indicators for an overall score.

Synthetic Training One Likert Scale: Live, Virtual, and Constructive Training

LVC Prioritization
0: Not prioritizing LVC or simulation in doctrine/strategy documents
1: Not prioritizing LVC, but simulation is mentioned in limited capacity in doctrine/ strategy
2: Not prioritizing LVC, but simulation frequently mentioned as priority
3: LVC is mentioned in doctrine/ strategy documents, but limited (i.e. one service)
4: LVC is mentioned in multiple doctrine/ strategy documents and across different services

LVC Training and Exercises
0: Not using LVC or simulation in training
1: Use of simulation in training, but platform based, and limited
2: Use of simulation across services, not integrated
3: Use of virtual and constructive training in joint exercises
4: LVC employed for exercises

Synthetic Training Two Likert Scale: Multi-Domain Training

Multi-Domain Operations Prioritization
0: Not prioritizing multi-domain operations in high-level statements or doctrine/ strategy
1: Not prioritizing multi-domain operations, however, integration with cyber and/or space is mentioned in some capacity.
2: Multi-domain operations is mentioned in high-level statements or doctrine/ strategy, but in limited capacity
3: Multi-domain operations is mentioned in multiple high-level statements or doctrine/ strategy
4: Multi-domain operations mentioned in multiple documents and is driving force development
5: Multi-domain operations implemented

Multi-Domain Operations Training and Exercises
0: Multi-Domain exercises are not mentioned and does not appear to be aspirational
1: Multi-Domain exercises are an aspiration, but no organizational steps towards achievement
2: Multi-Domain exercises are an aspiration, initial steps taken towards achievement
3: Multi-Domain exercises are an aspiration, mass organizational change towards achievement
4: Initial multi-domain exercises
5: Multi-Domain exercises occurring

The Likert scores per country can be found in appendix two. The results of the country level adoption findings (time bound through April 2019) for LVC and multi-domain training are found graphically below.

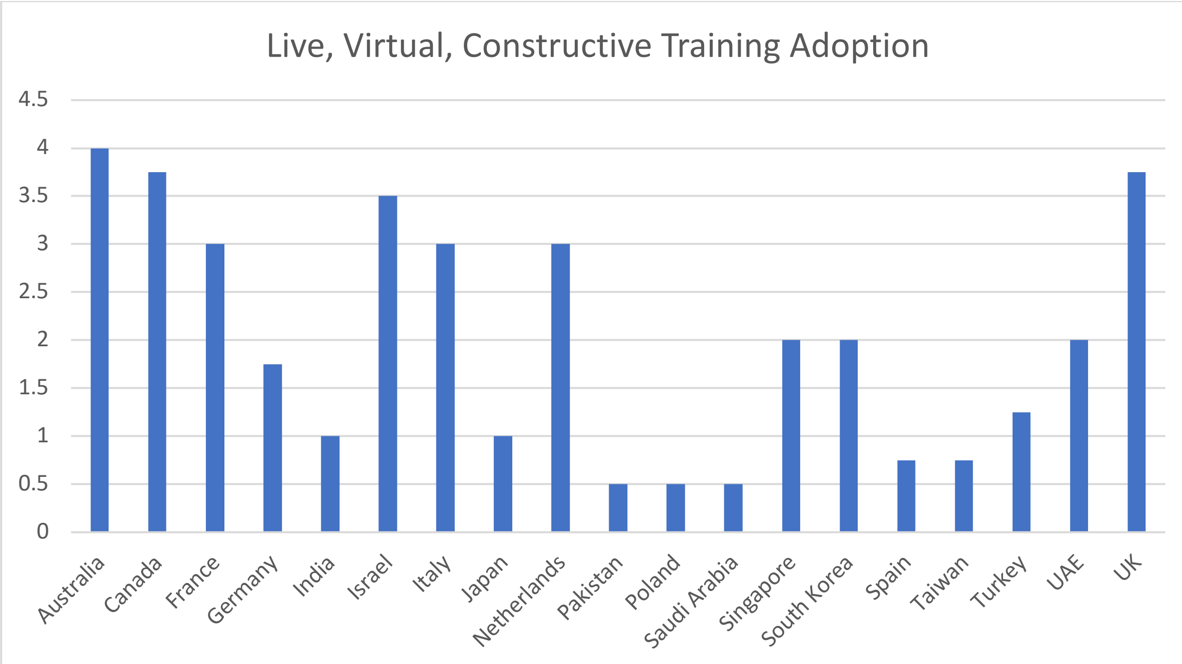

Figure 19: Initial Adoption Rates of LVC Training by Country Through April 2019

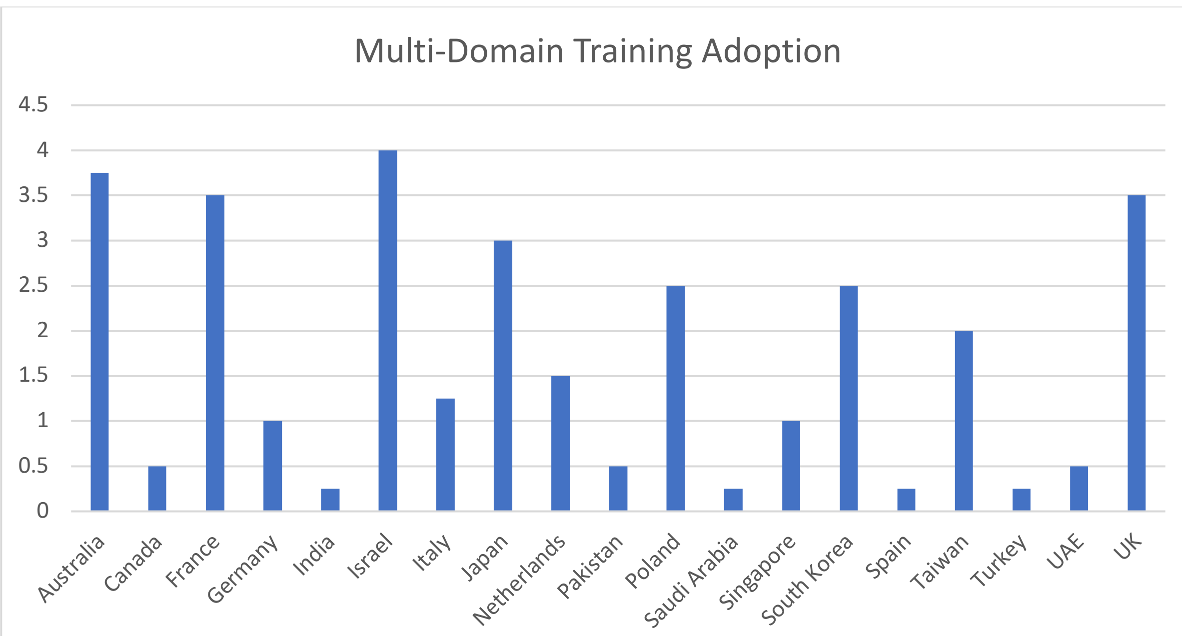

Figure 20: Initial Adoption Rates of Multi-Domain Training by Country Through April 2019

Using the Defense Budget as the Control in Country Case Selection

Adoption capacity theory hypothesizes that all other things being equal, financial and organizational capital will determine a technology's diffusion[267] As a result, it seems reasonable to assume that states with a larger defense budget will have a higher synthetic training adoption rate across both LVC and a multi-domain synthetic training environment. Given the number of

[267] Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics.*

alternative hypotheses this dissertation is testing and the ease at which one can assess defense budgets against adoption rates, it seemed reasonable to use the defense budget as a control in the dissertation. Indeed, if two countries with slightly similar defense budgets have wildly different synthetic training adoption rates than the defense budget is not a key determining factor in the diffusion of LVC or a multi-domain synthetic training environment. Some other contributing factors, or a combination of factors, must instead be driving diffusion.

As a result, when selecting case study pairs, this dissertation first identified the high and low adopters of each type of synthetic training and then selected the pairs based on the size of the defense budget.

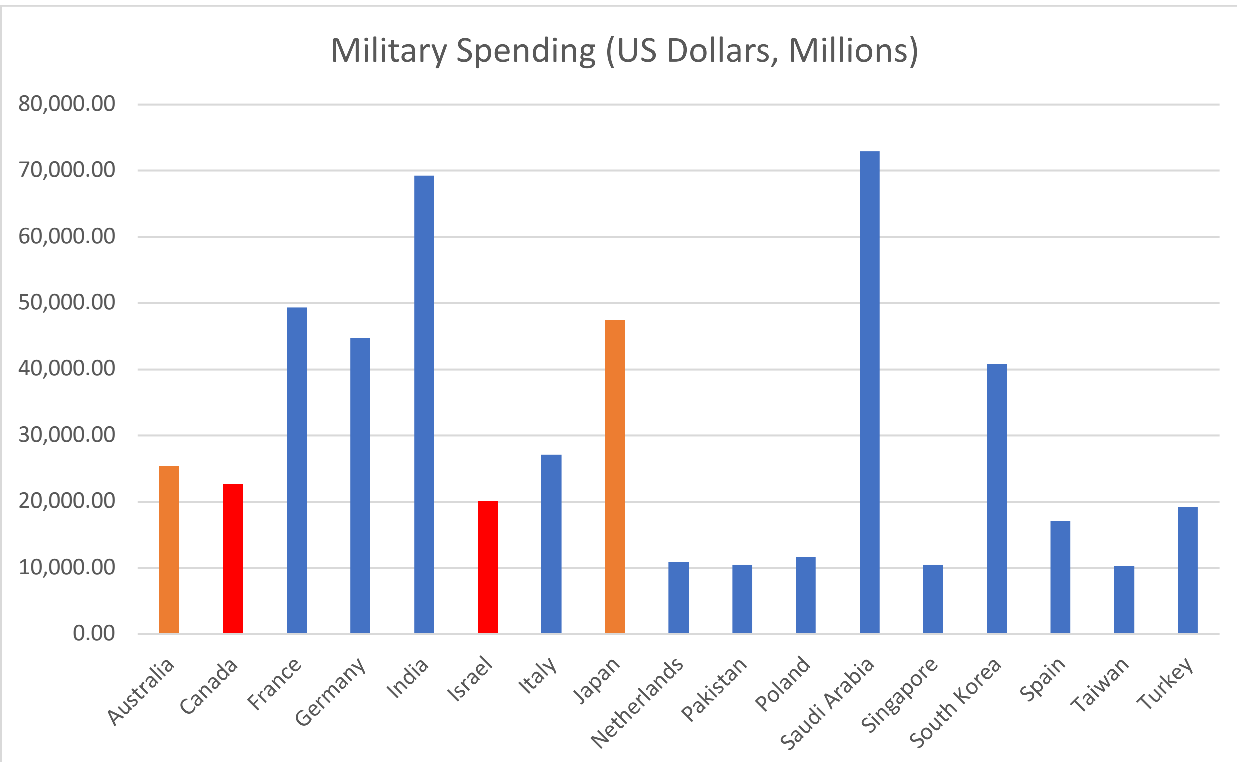

Figure 21: Military Spending (US Dollars, Millions), IHS Janes, "Total Defence Budget Activity by Country" accessed 9 June 2019

When examining LVC, Australia emerged as the highest adopter of the technology. Low adopters include India, Saudi Arabia, Taiwan, and Japan. From a budgetary perspective, India and Saudi Arabia's defense budget were far higher at $69,285 million and $72,918 million respectively to Australia's $25,391 million. Taiwan's defense budget was about 50% the size of Australia's while Japan's was conversely about 50% higher. Given the diffusion literature highlights financial capital as a driver of diffusion, it seemed wise to choose the state with the higher defense budget for comparative purposes. If Japan has a lower LVC adoption rate than Australia, but a higher defense budget than the budget is clearly not the determining factor from an adoption standpoint and some other causative factors are driving adoption decisions.

Israel emerged as the highest adopter of a multi-domain synthetic training environment. From a comparative standpoint both Canada and Spain are low adopters of a multi-domain synthetic training environment with somewhat similar defense budgets at $22,632 million and $17,307 million respectively to Israel's $20,074. As Canada's defense budget was slightly closer to Israel's and Canada has historically consistently fought as a coalition partner alongside the US, Canada was selected for comparative purposes.

Based on the data set results, the following countries were selected for assessment:

Synthetic Training Innovation One: LVC Training Country Case Study Selection: Australia and Japan Synthetic Training Innovation Two: Multi-Domain Training Country Case Study Selection: Israel and Canada

Each pair of states were selected for comparative purposes because each duo exhibited little variation in defense spending (and ran counter to diffusion theory on military spending and adoption) but showed immense variation across the variable of interest—adoption. Accordingly, these cases are worth examining in more depth to uncover possible alternative explanations.

Validating and Falsifying the Alternative Hypotheses

Through the selected country case studies, this dissertation tests each of the qualitative indicator questions and therefore, attempts to verify or falsify each of the alternative hypotheses. It then relies on process-tracing to identify *why* countries made their synthetic training innovation adoption decisions. This methodology runs counter to many studies that assess the diffusion of new ideas. Indeed, adoption decisions in the innovation literature are frequently examined via survey methods. Yet, survey methods are inherently problematic when seeking to better understand "why" questions around diffusion. Indeed, as Allen H. Barton notes:

> *…the survey is a sociological meat-grinder, tearing the individual from his social context and guaranteeing that nobody in the study interacts with anyone else in it. It is a little like a biologist putting his experimental animals through a hamburger machine and looking at every hundredth cell through a microscope; anatomy and physiology gets lost; structure and function disappear, and one is left with cell biology.*[268]

Surveys do very little when trying to identify broader issues of causality, something that qualitative methods, like process-tracing, are uniquely qualified to address. Indeed, process-tracing methods attempt to identify the intervening causal process between the independent variables, in this case the previously identified hypotheses and the dependent variable, adoption.[269] In brief, process tracing helps to identify the complex and (at times multiple) reasons why states choose to adopt, reject, or re-invent an innovation.[270] From a comparative country case study standpoint, process-

[268] Allen H. Barton, "Bringing Society Back In: Survey Research and Macro Methodology," *American Behavioral Scientist* (November/ December 1968): 1.
[269] See for instance, Alexander George and Andrew Bennett, *Case Study and Theory Development in the Social Sciences* (Cambridge, MA: MIT Press, 2005): 205-232.
[270] For this reason, process-tracing is suited to testing theories and alternative hypotheses. As Peter Hall notes, *"process-tracing is a methodology well suited to testing theories in a world marked by multiple interaction effects,*

tracing also provides advantages over other qualitative social science approaches, like controlled comparisons. While attempts were made with each pair of countries to control for the size of the defense budget, pairing based on the size of the military or the size of the country in addition to the budget was not possible. Process-tracing helps to make for up for this limitation—when it is not possible to find cases that are similar in every respect but one. Finally, process tracing allows this dissertation to identify possible alternative explanations for synthetic training diffusion outside the identified hypotheses, should an omitted variable better explain country-level adoption.[271] Data employed in each of the case studies are from a range of source material, to include primary and secondary sources, technical texts, and in-field interviews with military and industry officials.

Within the process tracing literature, four tests can be used to affirm causal inference—the "doubly decisive test," "smoking gun test," "hoop test," and the "straw-in-the-wind test" (see figure twenty-two).[272]

		Sufficient for Affirming Causal Inference	
		No	**Yes**
Necessary for Affirming Causal Inference	**No**	**1. Straw in the Wind Test**	**3. Smoking Gun Test**
		Passing: Affirms the relevance of hypothesis but does not confirm it.	**Passing**: Confirms hypothesis.
		Failing: Hypothesis is not eliminated but is slightly weakened.	**Failing**: Hypothesis is not eliminated but is somewhat weakened.
		Implications for alternative hypotheses: Passing: Slightly weakens them Failing: Slightly strengthens them	**Implications for alternative hypotheses**: Passing: Substantially weakens them. Failing: Somewhat strengthens them.
	Yes	**2. Hoop Test**	**4. Doubly Decisive Test**
		Passing: Affirms the relevance of hypothesis but does not confirm it.	**Passing**: Confirms hypothesis and eliminates others.
		Failing: Eliminates hypothesis.	**Failing**: Eliminates hypothesis.
		Implications for alternative hypotheses: Passing: Somewhat weakens them. Failing: Somewhat strengthens them	**Implications for alternative hypotheses**: Passing: Eliminates them. Failing: Substantially strengthens them.

Figure 22: Process Tracing Tests for Causal Inference. Adapted from David Collier, "Understanding Process Tracing," Political Science and Politics 44.4 (2011): 825.

Given this dissertation assesses two training capabilities that are in the diffusion process, it is challenging for the hypotheses to meet or pass the criteria outlined by the "doubly decisive" or

where it is difficult to explain outcomes in terms of two or three independent variables—precisely the world that more and more political scientists believe we confront." Peter A Hall, "Aligning Ontology and Methodology in Comparative Politics," (paper presented at the Annual Meeting of the American Political Scientists Association, Washington DC, September 2000): 18. Christine Trampusch and Bruno Palier, "Between X and Y: how process tracing contributes to opening the black box of causality," *New Political Economy* 21.5 (2016): 437-454 and Derek Beach, "Process-Tracing Methods in Social Science," *Oxford Research Encyclopedias Politics* (25 January 2017).

[271] This help protect against an omitted variable bias. Jessica Blankshain and Andrew Stigler, "Applying Method to Madness: A User's Guide to Causal Inference in Policy Analysis," *Texas National Security Review* 3.3 (Autumn 2020).

[272] David Collier, "Understanding Process Tracing," *Political Science and Politics* 44.4 (2011): 823-830.

"smoking gun" test. Much of the evidence that are tied to adoption decisions associated with LVC or multi-domain synthetic training environments are classified; recorded in government requests for information or proposals that do not elucidate "why" decisions; remain only in the minds of government contractors or training personnel that are tasked with their development, procurement, or implementation; or their procurement has not been unequivocally decided yet. As a result, few hypotheses can decisively pass one of those two tests, eliminating or substantially weakening alternative hypotheses. Yet, even without decisive evidence, one can begin to add weight to various hypotheses, helping to uncover evidence about why synthetic training adoption occurs. Engaging in prospecting with regards to these technologies is valuable because even within the US, the causal processes that leads to training adoption—beyond limited explanations like financial capital—are poorly understood. For this reason, when studying in-process theories of diffusion, employing tests, like "straw in the wind" or "hoop tests" can start to uncover adoption trends that can provide powerful future explanatory evidence.

As a result, this dissertation employs a mix of "straw in the wind" tests and "hoop tests" to demonstrate that the case studies meet the evidentiary threshold required to test and assess the alternative hypotheses outlined in the diffusion literature.[273] Straw in the wind tests affirm the relevance of a hypothesis but does not confirm it. Likewise, it does not eliminate a hypothesis, but it does weaken them. While in a single case, a straw in the wind test is not compelling, when a hypothesis passes multiple straw in the wind tests across a series of case studies (like in this dissertation), it does add up to important affirmative evidence. Hoop tests set a more demanding threshold than straw in the wind tests, the hypothesis must "jump through the hoop" to remain under consideration, therefore the hypothesis, while not sufficient, becomes a necessary factor when exploring causality. When an alternative hypothesis passes a hoop test, it weakens the plausibility of other alternative hypotheses, while not discounting the possibility that they may be relevant. From an evidentiary standpoint, this dissertation aims to subject every hypothesis to a "hoop test," but is aware some may not meet that threshold, and if so, it will explore whether an alternative hypothesis is valid or not based on a series of straw-in-the-wind tests. By testing the various alternative—but not mutually exclusive hypotheses—across four case studies, together enough evidence should be generated to make some claims about synthetic training adoption, even via "hoop" or "straw in the wind" tests.

As previously mentioned, the main limitation associated with process-tracing for this dissertation is the ability to get a full and complete picture of the causative events, or casual chains, that led to an adoption decision. Each selected type of synthetic training skirts, or involves, information that is classified (on a country-by-country basis). For instance, topics, like offensive cyber operations (under the multi-domain synthetic training environment), are highly sensitive and incentives exist for countries to classify, and even, at times, mislead others on the nature and size of their "cyber capabilities"—to include zero-day stockpiles, personnel, or other indicators of strength. As a result, information may be lacking and, at times, information in the public-domain may be incorrect and incomplete. When data is unavailable, or even slightly questionable, process-tracing can only reach provisional conclusions on the validity of the various alternative hypotheses. To compensate for this limitation, I take pains throughout the dissertation to highlight whenever

[273] By employing this rubric, this dissertation should meet the "completeness standard" as outlined by David Waldner. Waldner, "What makes process tracing good? Causal mechanisms, causal inference, and the completeness standard in comparative politics," 128.

classification challenges arise as well as when incentives may exist for states to publish misleading information or figures. In the latter case, these incentives are often state and regime specific. Indeed, the publication of disinformation is a part of some states' current and historic strategies for long-term competition and combat.[274]

Interviews and Ethics

Interviews are used as *one aspect* of this dissertation's multi-method line of inquiry. They are used to *supplement* other primary and secondary data sources because interviews have strengths that other sources of information may lack. Indeed, interviews—particularly elite interviews, like in the case of this dissertation—serve a range of additive functions, allowing me to better gauge elite perceptions of synthetic training, glean first-hand accounts of decisions or actions that may be behind various synthetic training adoption strategies, or even shed light on aspects of the adoption process that are not captured in other forms of documentation. Indeed, interviews can account for a lack of documentary evidence, something that can be a persistent problem when conducting "in process" diffusion research on a subject that is not closely followed or documented, within or outside most governments.[275] For a full list of interviewees and other associated details see appendix four.

To select interviewees for this dissertation, I used a combination of purposive (sometimes called judgmental) sampling and snowball sampling. In the former case, interviewees were selected based on either positional criteria or reputational criteria. I sought out individuals that had key roles related to synthetic training adoption or who had overseen various service or defense specific branches that included training. Reputational criteria can be useful when assessing retired military officers. Indeed, when servicemembers retire, companies will often jockey for individuals that they deem as someone with "market making" potential. These individuals may not be high ranking, but they often known the "ins and outs" of the training establishment, to include technical and organizational roadblocks to reform. Interviewing these former mid-level officers was often far more revealing than higher-ranking officials. Snowball sampling was cautiously employed in select instances to increase the pool of interviewees.[276] In the case of Japan, where it proved challenging to interview government or military officials because of sensitivities on the part of those serving officials, I opted to interview Americans who were charged with developing and delivering synthetic training for the JSDF.[277] All interviews involved written notes during the

[274] See Russia's penchant for "reflexive control" and their use of cyber for information and psychological operations. Timothy Thomas, "National State Cyber Strategies: Examples from China and Russia," in Franklin D Kramer and Stuart H Starr, *Cyber Power and National Security* (Washington, DC: Potomac Books, Inc., 2009): 10-11.

[275] On the strengths of using interviews alongside other methods when conducting process tracing research, see Julia Lynch, "Aligning Sampling Strategies with Analytic Goals," in Layna Mosley, *Interview Research in Political Science* (Cornell, NY: Cornell University Press, 2013): 37 and Oisin Tansey, "Process Tracing and Elite Interviewing: A Case for Non-Probability Sampling," *Political Science and Politics* 40.4 (October 2007): 766-767.

[276] Snowball sampling was occasionally used to recruit a larger pool of interviewees—for instance, in the case of Japan. This technique is not without risks, as it is possible to become trapped in a network of like-minded respondents. However, as will be described later in this section, I triangulated interview data against other primary and secondary source information to mitigate against potential bias. Erik Bleich and Robert Pekkanen, "How to Report Interview Data," in Layna Mosley, *Interview Research in Political Science* (Ithaca, NY: Cornell University Press, 2013): 87.

[277] In several instances, even with introductions from former American government officials, the Japanese officials chose not to respond to me after I sent over high-level interview questions. Given the JSDF is unique in that a lot of

interview process. They were supplemented by follow on notes immediately following the interview. Quotations are only used in select instances when I was able to quickly capture verbatim the interviewees statement, or, in instances, where they sent me written responses via email.

Ensuring the Ethical Treatment of Research Subjects

Ensuring the ethical treatment of all interviewees was an important component of my research.[278] All interviews were obtained voluntarily, and I received written consent via email to participate in an interview from nearly all participants. When agreement to participate in an interview was not possible via email, I received verbal consent from interviewees.[279]

All interviewees were notified that the research would be used to support my dissertation for King's College London and that the dissertation, like all dissertations, would be available, once complete, through the university. In cases where dissertation information arose serendipitously through interviews from my various employments—like interviews pre-2019 in Australia—those conversations received ethical approval and were cleared for publication by other institutions and are clearly referenced in appendix four.

To protect the privacy of my interviewees, each interviewee was asked whether they would like the conversation to be on-the-record, not-for-attribution, or off-the-record and background only. Additionally, for those conversations that were not-for-attribution or off-the-record, I asked them to explicitly state how they would like to be labeled within my dissertation. All my interview notes are stored in encrypted files on my laptop.[280] Off-the-record conversations are coded so that interviewee names are not associated with the notes. Due to the nature of my research topic, this research was deemed of "minimal risk" and therefore only required self-registration, which was confirmed with the King's College London, Research Ethics Office.

Trustworthiness of Interview Data

I also sought to ensure the reliability and trustworthiness of interview data throughout the interview process. Hesitation can exist utilizing interviews in scholarship because interviews may not produce accurate information—interviewees may inadvertently (or advertently) convey imprecise information. In the case of this dissertation, this problem was mitigated against through

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its training is provided by, and conducted with, Americans, it seemed reasonable to interview American training providers that worked with the JSDF instead. This obviously does not provide a complete picture, so in this case, extra efforts were made to triangulate the data against other sources as much as possible.

[278] The ethical treatment of my interviewees was important for two reasons. First, as a human and a researcher, it is important to me that people are treated with respect, that my account of our conversation is honest, and that I do not put them at risk. Second, I work in the synthetic training field and run a research program. My access, credibility, and ability to do my job, now and in the future—and therefore my livelihood—would also be put at risk if I did not take my promise or privacy and confidentiality to my interviewees seriously.

[279] Verbal consent on the sideline of events was preferable for interviews than written statements. Some conversations took place on the sidelines of a simulation conference with high-level elites. It is unlikely anyone would have spoken to me and answered questions on my dissertation if I approached them asking them to sign documentation. It would have made something that felt fundamentally informal and risk-free to participants seem far more formal and laden with risk. Often, in these instances, I opted to just use conversations as background information.

[280] Notes that were used for other publications based on my previous employment have been destroyed, as the analysis from the interviews have been published elsewhere and is publicly available. Handwritten notes, similarly, after transcription, were destroyed.

triangulation. Employing process tracing ensured this dissertation drew on a multiplicity of source material—not just interviews. By triangulating interview data against data from other sources to answer the same "why" questions about the occurrence of diffusion, one can better establish the credibility of data and ensure that the overall findings are not entirely weighted by interview findings.[281] In instances where just interview data is available on a certain subject, I sought to establish their "closeness" to the event on which they were speaking (i.e., is this first-hand knowledge) and I do my best to highlight that in the text.[282]

Finally, the potential always existed that I could bias my interview subjects. I fully acknowledge as someone that has studied and followed the synthetic training for over seven years, and now works in the industry, that I have a bias towards synthetic training technologies. I view them as inherently useful military training tools. However, my dissertation is not focused on the benefits, or drawbacks, of synthetic training. Instead, it is focused on *why adoption occurs among US partners and allies,* something that I have no personal or professional stake in. Potential also existed that I could bias my research subjects simply by asking certain direct question or framing questions in certain ways. For that reason, I opted to conduct my interviews in a non-structured way, asking very open-ended questions of my interviewees. I did not tell my interviewees why their country was selected from a case study standpoint (i.e., that their country represented a high or low adopter). Nor did I tell my interviewees the various hypotheses that were under examination. I simply asked them to provide a high-level overview of how their country was approaching LVC or a multi-domain synthetic training environment (once it was clear we had converged on a common definition of LVC or a multi-domain synthetic training environment) and to provide their perspectives on why adoption was or was not occurring. Depending on where the interviewee took the conversation, I would ask clarifying or follow-up questions to better understand the events under discussion. By conducting interviews in such an open-ended way, I ensured that I was not inadvertently pigeon-holing countries into my previous assumptions on adoption rates, nor that I was favoring one causative explanation on diffusion over others. This also allowed interviewees to identify other alternative explanations for adoption that may not have been captured in the review of the diffusion literature.

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[281] J Erik Bleich and Robert Pekkanen, "How to Report Interview Data," 84 and Julia Lynch, "Aligning Sampling Strategies with Analytic Goals," 37.
[282] See, for example, the discussion of synthetic training adoption among the Canadian Navy on page 195.

SECTION TWO: THE DIFFUSION AND ADOPTION OF LVC AMONG US PARTNERS AND ALLIES

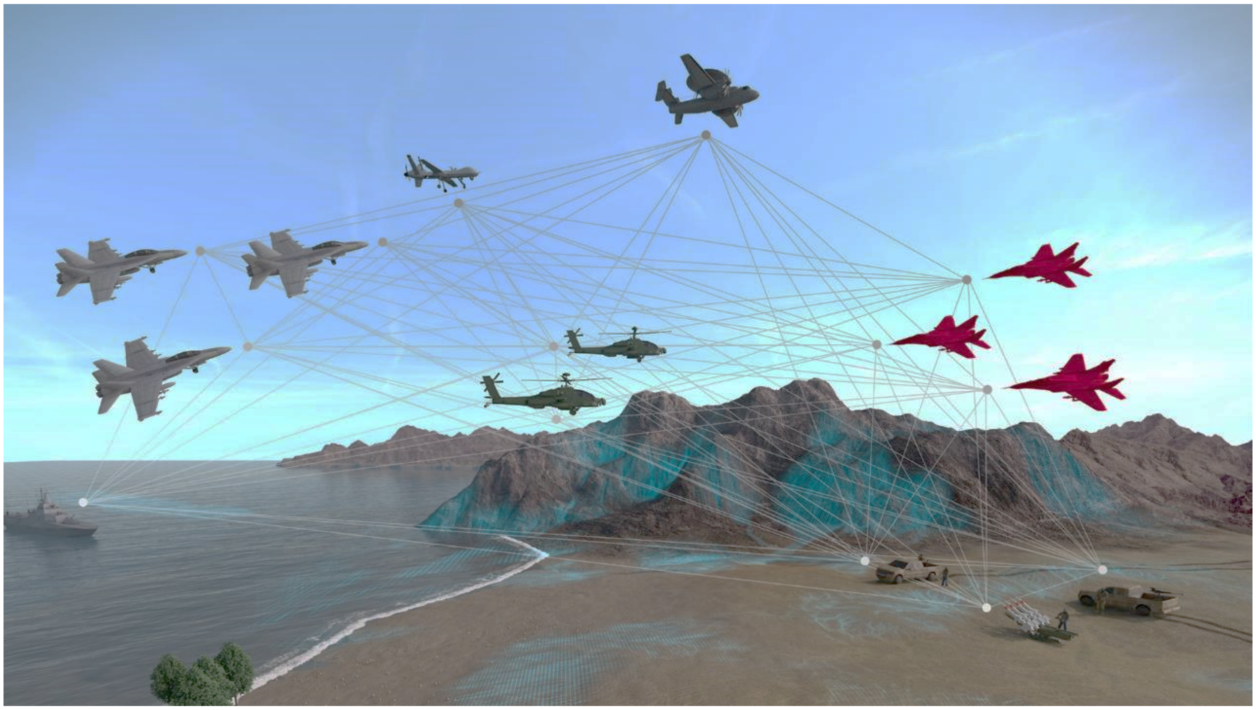

Figure 23: Depiction of Military Assets Integrated into an LVC Scenario, Author's Own

CHAPTER FOUR: EXPLAINING THE ADOPTION OF LVC BY THE AUSTRALIAN DEFENCE FORCE

On Friday, 19 July 2019, just as twilight crept over the Strait of Hormuz, masked Iranian gunmen rappelled from a helicopter onto the British-flagged tanker, the *Stena Impero* ending the tanker's attempts to evade seizure by a series of small Iranian fast-attack crafts. After forcing the tanker into Iranian waters, the Iranian Revolutionary Guards Corps alleged the crew had violated international law, exacerbating already spiraling tensions within the region.[1]

The specter of routinized ship seizures in the Strait roiled international markets and heightened local threat perceptions leading the US Navy to attempt to piece together a coalition to counter the maritime threat—but with little success.[2] Australia, however, answered the US' call. The ADF would provide planning and operations staff to the coalition, a P-8 Poseidon surveillance aircraft, and divert a naval frigate that had previously been tasked with counter-piracy and terrorism operations.[3]

Australian Prime Minister, Scott Morrison's announcement that the ADF would assist Australia's long-time ally, and great power patron, the US, was not without controversy. Australian policy strategists criticized the decision, noting that the country should instead be allocating those resources closer to home in the Indo-Pacific.[4] The rift between Morrison and members of Australia's strategic community highlights a long-running debate in Canberra. Should Australia remain a mid-sized power with a thin global presence that acts as a contributor to US and allied global operations? Or should Australia pivot and focus on its own backyard with a more localized concentration of force?

Indeed, as a sparsely populated island-continent located at the cross-roads of the Indo-Pacific, Australia has been molded by what could be perceived as a Janus-faced dilemma. Western in character and history, but Asian in geography, Australia has been forced to adopt a multi-faceted, and at times uncomfortably ambidextrous approach to its security. Since Federation, Australia has looked to culturally-similar great powers—first the British Empire and later post WWII, the US—to help guarantee its security. At the same time, however, this has been accompanied by a historic wariness of the risks posed by an overreliance on great power security guarantees, and this residual concern has long permeated Australia's national security community. As Australia knows all too well, great powers can be fickle and self-interested patrons.[5] Consequently, Canberra has also

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[1] Benoit Faucon, "World News: 'No Niceties' in Iran's Ship Seizure—Tehran's confiscation of a UK-flagged oil ship shows how easily it can disrupt global trade," *The Wall Street Journal,* 23 July 2019, https://www.wsj.com/articles/no-niceties-for-seized-oil-tanker-crew-from-iranian-commandos-11563823772.

[2] Germany resisted calls to join the US/UK coalition, while New Zealand stated that it lacked the assets and capabilities necessary to contribute. Jon Gambrell, "New US-led patrols in Persian Gulf raise stakes with Iran," *Associated Press,* 3 September 2019, https://apnews.com/5dbb964d081b4aa28b3d30d63d131ef7.

[3] Primrose Riordan, "Australia to join US-led naval coalition in the Gulf," *Financial Times,* 20 August 2019, https://www.ft.com/content/5ba72c32-c3b8-11e9-a8e9-296ca66511c9.

[4] *Ibid* and Ashley Townshend and Brendan Thomas-Noone, "Australia Must Refocus Foreign Policy On Its Own Indo-Pacific Region," *United States Studies Centre,* 23 July 2018, https://www.ussc.edu.au/analysis/australia-must-refocus-foreign-policy-on-its-own-indo-pacific-region.

[5] From the Japanese "island hopping" threat in WWII to the US' unwillingness to contribute troops in the INTERFET peacekeeping operation in East Timor in 1999, Australia has come to recognize that there are inherent

advocated for increased self-reliance. This strategic duality has been characterized by some as a tension between "alliance maximalists" and "alliance minimalists" or as a debate between the exigencies of continental defense and expeditionary strategies. [6]

As will be shown, it is with these seeming contradictions in mind that one is best positioned to understand the drivers behind Australia's growing pursuit of LVC. The continuous tension between a desire for deeper interoperability with US forces, and the ambition to develop a more self-reliant ADF has significant implications for the trajectories of ADF's force posture, procurements, and training—all of which, shapes, in turn the ADF's LVC adoption choices. Drawing on field research in Canberra, Sydney, and DC and previously unpublished correspondence, this chapter proceeds in three parts. It first provides an overview of the ADF's current and planned adoption of LVC across the services and their joint force. It then scrutinizes the diffusion literature to identify the causal pathways by which the ADF may—or may not—have made adoption decisions. Indeed, as will be shown in the final section's assessment, the ADF's geopolitical threat perceptions, when coupled with their exceeding close relationship with the US and their laser focus on jointness are best poised to explain the ADF's adoption, to date, of LVC.

The ADF's LVC Training

The ADF and the Department of Defence have been particularly forward-leaning with the employment of simulation, integrating simulation technologies across the defense enterprise for the purposes of test, concept validation, and training, among other areas. While LVC is a newer construct, the foundation for an LVC environment can be traced back to 2006 when the ADF commenced the Joint and Combined Training Capability, or JP-2098 (Joint Project 2098). Since then, LVC capabilities have diffused across the services and the ADF's joint enterprise manifesting in the most recent joint LVC program, JP-9711 (Joint Project 9711). Indeed, today, in some respects, the ADF's current and planned use of LVC transcends US capabilities. LVC procurements have a distinctly joint flavor due to continued organizational and procurement changes within the ADF and Department of Defence. This ensure that cross-service interoperability is prioritized from the start, instead of being a longer-term aspiration, like current US Army and Air Force LVC acquisition programs.[7]

The Employment of Synthetic Training Across the Services

The Royal Australia Air Force (RAAF) is considered by many within the ADF to be the service that has the most heavily invested in simulation, and LVC. In 2012, The RAAF released a roadmap

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limitations to great power dependency. Stephen Fruhling, "The Defence of Australia: From lucky country to uncomfortable normality," in Dean et. al., *After American Primacy,* loc. 436.

[6] Zack Cooper and Iskander Rehman, "Gateway to the Indo-Pacific: Australian Defense Strategy and the Future of the Australia-US Alliance," *Center for Strategic and Budgetary Assessments* (2013): 2-8 and Hugh White, "Beyond the Defence of Australia: Finding a New Balance in Australian Strategic Policy," *Lowy Institute Paper* 16 (2006): 3.

[7] US Army's Synthetic Training Environment program and the US Air Force's Common Synthetic Training Environment: US Army, "Synthetic Training Environment (STE)," accessed 17 April 2022, https://asc.army.mil/web/portfolio-item/synthetic-training-environment-ste/ and Meredith Roaten, "Air Force Looking to Boost Connectivity for Simulators," *National Defense,* 22 July 2021, https://www.nationaldefensemagazine.org/articles/2021/7/22/air-force-looking-to-boost-connectivity-for-simulators.

for their future "information age" force—Plan Jericho.[8] Plan Jericho sought to capitalize on the RAAF's acquisition of fifth generation platforms—the E7-A Wedgetail, the P8-A Poseidon, EA-18G Growler, and the F-35A Lightning—to drive change across their service. A key facet of Plan Jericho is the use of information technology to boost LVC training opportunities across the service. Indeed, Jericho strives to develop new operational concepts, while deepening integration across platforms. [9] Given the live training limitations associated with fifth generation platforms, like the F-35, Jericho pushed the RAAF to lean heavily into simulation, while boosting LVC training opportunities across the service.

Since the 2012 release of Plan Jericho, the RAAF has made some strides achieving an LVC training capable force. In 2015, the RAAF networked, for the first time, its C-130J Full Flight Mission Simulator at the RAAF Base Richmond to Coalition Virtual Flag, allowing those in their virtual simulators to fly in the virtual Nevada Test and Training Range, with other LVC "co-located" assets.[10] Similarly, exercises like Talisman Sabre include a moderate level of LVC integration through the incorporation of a constructive battleground.[11] In 2016, the RAAF inaugurated their Air Warfare Centre, designed to improve the operational effectiveness of fifth generation platforms, partially through networked connectivity across the ADF and with allies. [12]

In 2019, the RAAF stood up their Advanced Test and Training Environment program, which seeks to provide warfighters with a realistic test and training environment.[13] As the program notes,

> *A fifth-generation force demands new methods for training, experimenting, and conducting test and evaluation. LVC capabilities combined with advanced test and training ranges offer an opportunity to conduct these activities in a more effective and efficient way. This [program] will ensure that LVC capabilities and ranges are managed to effectively facilitate force generation and sustainment. The [program] will also identify and progress LVC and range capability gaps that need to be remediated in order to realize a robust and enduring capability*.[14]

To meet these needs, RAAF training ranges, such as the Woomera Range Complex and the Delamere Air Weapons Range are being updated to better facilitate networking via Link16, while also supporting more complex operations than could include electronic injects among other activities. The RAAF expects to deliver the programs goals within the coming two years. Given program aims, one would expect the RAAF to conduct tethered LVC upon completion.[15]

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[8] Royal Australian Air Force, "Media Release: Air Force goes online for Coalition Virtual Flag," *Royal Australian Air Force*, 28 August 2015, https://news.defence.gov.au/media/media-releases/air-force-goes-online-coalition-virtual-flag.
[9] Royal Australian Air Force. "Plan Jericho," *Air Power Development Center* (2015): 4.
[10] RAAF participation in Virtual Flag has been ongoing every year for about the last decade. Royal Australian Air Force, "Media Release: Air Force goes online for Coalition Virtual Flag."
[11] Conversation with Wing Commander Steve Laredo, 4 March 2020.
[12] Interview with Wing Commander Mick Tully, 8 April 2020. See also: Royal Australian Air Force, "Air Warfare Centre, accessed 4 May 2020, https://www.airforce.gov.au/about-us/structure/air-command-headquarters/air-warfare-centre.
[13] Plan Jericho was subsequently absorbed within the program.
[14] Wing Command Mick Tully, "Advanced Test and Training Environment," *Royal Australian Air Force Briefing* (8 April 2020).
[15] Interview with Wing Command Mick Tully, 8 April 2020.

Like the RAAF, the Royal Australian Navy (RAN) has a strategic vision that incentivizes simulation—Plan Pelorus. Plan Pelorus, released in April 2015, outlines the RAN's vision for acquiring more capable individual platforms, while also optimizing the workforce through training and increased simulation.[16] Speaking on Plan Pelorus aims, former Director General for Navy Capability Plans and Engagement, Andy Gough observed that, "LVC is not an option to be considered when selecting simulation to enable the delivery of training, it is always the answer."[17] As a result, the RAN has made a concerted effort to increase simulation and LVC usage. In 2015, the RAN undertook its first solely Australian-run distributed synthetic exercise, entitled "Triton Simulation." Through the Australian Defence Simulation and Training Centre, Triton allowed the crews of the HMAS Sydney, Perth, and Melbourne to exercise warfare skills in a multi-ship environment using simulated systems ashore in HMAS Watson and Stirling.[18] In 2017, the RAN established the Navy Synthetic Warfighting Centre at the HMAS Watson Naval Base in Sydney Harbor—its premier training center— deepening the RAN's capacity for LVC through land and ship-based local and distributed mission training activities.[19] Shortly thereafter, the RAN inked a $9 million deal with Cubic for a wide range of simulation capabilities to support LVC across the service—at both the individual and collective level.[20] Synthetic exercises, like those provided through the US-Australian Naval Viking Series, provide regular opportunities for both navies to deepen interoperability in planning, command and control, surface to air coordination, anti-submarine warfare and maritime strike and interdiction, among other proficiency sets.[21]

In contrast to its sister services, the Australian Army has been slower to adopt simulated, and more specifically LVC, solutions, but that trend is changing. Indeed, in 2016, the Australian Army released their "Army Simulation Concept," which outlined a 2026 vision for the employment of simulation across the service, to include force generation and training. The concept called for an approximate investment of AUS $4 Billion (~US $3.6 Billion), to reconcile key shortfalls, such as a lack of an Army simulation policy and governance system.[22] Building on this, in 2018, the Army released an Army Simulation Manual, which sought to place Army level responsibility for LVC within a single point of responsibility in the Land Simulation Core.[23]

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[16] Jane's Defence Weekly, "Beyond Plan Pelorus," *IHS* (2015), http://www.janes360.com/images/assets/422/54422/Beyond_Plan_Pelorus__2.pdf and Royal Australian Navy, *Plan Pelorus: Navy Strategy 2022,* retrievable at: https://www.navy.gov.au/stategy/plan-pelorus-2022.
[17] Andy Gough, "Combining LVC Capabilities- the RAN Perspective," *Williams Foundation Seminar* (June 3, 2015): 1.
[18] *Ibid,* 10.
[19] Vivienne Machi, "Australian Navy Boosting Simulation and Training," *National Defense,* 18 October 2017, https://www.nationaldefensemagazine.org/articles/2017/10/18/australian-navy-boosting-simulation-and-training. For more on HMS Watson, see, "HMAS Watson History," *Royal Australian Navy,* accessed 28 March 2022, https://www.navy.gov.au/history/base-histories/hmas-watson-history.
[20] "Cubic to Provide Navy LVC Training," *Australian Defence Magazine* (8 August 2017).
[21] Anthony Martin, "Synthetic training simulates real world experience," *Navy Daily,* 9 September 2019, https://news.navy.gov.au/en/Sep2019/Fleet/5438/Synthetic-training-simulates-real-world-experience.htm#.XmFf6C2ZOu4.
[22] Given the amount awarded in the JP-9711 tender, it seems unlikely that the Australian Army will secure $4 billion for simulation capabilities. Australian Army, "Army Simulation Concept- Silicon Warfighting: A Strategic Narrative for Army's Simulation Capability," *Australian Army* (August 2016): 5, 10.
[23] "Australian Army licenses Titan Vanguard," *Military Simulation and Training Magazine,* 15 May 2018, https://militarysimulation.training/technology/australian-army-licenses-titan-vanguard/.

To date, it seems that the Australian Army is gradually making some progress towards LVC. The Australian Army has seven different battle simulation sites and, at present, any two can be networked to enhance and scale the size of a given exercise. Moreover, the Army's live exercises have the potential to impact an ongoing virtual exercise (and vice versa). For instance, a live training exercise ongoing at the Army's Puckapunyal training facility can feed into the Army's constructive simulation package, changing how computer-generated forces operate in an ongoing virtual battle. Likewise, those soldiers can receive input from those same computer-generated entities, generating a true LVC scenario.[24] Most recently, in late 2021, the Morrison government inked a $319.8 million dollar contract with Cubic to continue its delivery of training support to the Australian Army's Combat Training Centre's Live Instrumentation System for up to a fourteen-year period. This contract allows for the live environment to be integrated with a virtual and constructive environment through range instrumentation and information systems.[25]

However, limitations still persist. Many of the Army's LVC simulation systems are neither networked or interoperable, which creates challenges when attempting to create a coherent complex training environment across the service—let alone across the joint force. One such limitation is the issue of conflicting levels of classification—the Army's simulated systems operate at the restricted level, while its sister services' simulation systems often operate at the secret level. Classification challenges present networking issues, often leading to ad-hoc solution sets. [26]

The Development of Joint Live, Virtual, and Constructive Training: JP97-11

While discrete instances of LVC are apparent across each of the services, in many ways, they are still limited. Many synthetic training solutions, to include LVC, are bespoke solutions that provide a temporary capability for a given exercise, but lack permanence.[27] Furthermore, the capability to link distributed simulations together across the ADF still falls short of needs, with no more than ten joint simulation exercises taking place each year.[28] A new joint program (JP-9711), or "the Core Simulation Capability Project" is designed to fundamentally change that. JP-9711, which was released as a three-phase tender, is meant to make LVC—to include tethered and untethered operations—a reality, while also providing the ADF with an enhanced persistent distributed synthetic environment.[29]

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[24] Myles Peterson, "Army displays simulation technology," *Shepparton News,* 23 February 2019, https://www.sheppnews.com.au/news/2019/02/23/457923/news-community1111-army-displays-simulation-technology.
[25] Department of Defence Press Release, "$319 million contract for North Queensland Army Training Centre," *Mirage,* 15 December 2021, https://www.miragenews.com/319-million-contract-for-north-queensland-army-694298/.
[26] Conversation with Wing Commander Steve Laredo, 4 March 2020.
[27] Mick Ryan, "The Ryan Review: A study of Army's education, training, and doctrine needs for the future," *The Royal Australian Army* (April 2016): 42.
[28] Max Blenkin, "Lockheed Martin & Commonwealth sign JP 9711 Phase 1 contract," *ADBR,* 27 March 2019, https://adbr.com.au/lockheed-martin-commonwealth-sign-jp-9711-phase-1-contract/ and "Australia JP9711-1 Core Simulation Capability (CSimC) Australia," accessed 3 March 2020, https://gateway.icn.org.au/project/4460/australia-jp9711-1-core-simulation-capability-csimc-australia?st=projects&psid=1578522900.
[29] Kym Bergmann, "Simulation a vital ADF capability," *Asia Defence Reporter* 47.6 (September 2021): 31.

Phase One (JP-9711-1): Develop a Core Simulation Capability to support multiple joint training events at the protected and secret levels. Update and improve some of the simulation training offerings across each of the services.

Phase Two (JP-9711-2): Improve integration of simulation across the services for enhanced distributed collective and joint training. Deepen simulation use within the services to areas of logistics, health, among other areas. Provide and support whole-of-ADF training, to include fifth generation training above the secret level.

Phase Three (JP-9711-3): Promote the use of simulation across the entire Defence enterprise, from force design, through decision-making, capability development, and capability delivery.[30]

In 2019, the ADF awarded phase one of the JP-9711 contract—valued at the AUS $897 million (US $639 million)—to a Lockheed Martin-led consortium. The award's announcement on the ADF's future LVC training capability is particularly noteworthy, as according to Lockheed, it will represent the "first services-based distributed missions simulation environment to support joint coalition and allied training in the Asia Pacific."[31] JP-9711 represents the first time a LVC environment is being developed to handle joint training, to include coalition training, at scale. All previous LVC environments that have been developed are single service, causing defense commentators to note that "JP-9711 looks to be a world first."[32] Such a capability would theoretically transcend US simulation capabilities, as ongoing American synthetic environment procurements—like the US Army's Synthetic Training Environment—are entirely single service with joint connectivity somewhat of an after-thought. Indeed, in a particularly revealing internal email after the award's announcement, one US Air Force officer made the following observation to his team, "Being first is not important. However, it may be worthwhile to take a hard look at what Australia is doing. If it fills a need for us, it may be something we can replicate."[33]

JP-9711 is meant to fundamentally transform synthetic training across the ADF in the short and long term. Minister for Defence Industry Linda Reynolds predicts that under the program, the ADF will host fifty simulated events by the end of 2020 and over 200 by the program's completion in 2025.[34] This is a significant increase in throughput, with a 500% increase in simulated events in the program's first year, and a 2000% increase by completion.

Identifying the "Why" Between the ADF's LVC Training Adoption

The drivers behind the ADF's adoption of LVC are complex and multi-faceted. This section delves into the diffusion literature to identify the causal pathways by which the ADF may have made its

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[30] Department of Defence, Associate Secretary, "Australia-Singapore Military Training Initiative: Defence Industry Future Training Briefing," *Government of Australia* (2 November 2018).
[31] Stew Magnuson, "Australia- Not US- to Take the Lead on Joint, Multi-Domain Aircraft Simulations," *National Defense Magazine* (16 May 2019).
[32] Kym Bergmann, "One System to Bind them All," *Asia Pacific Defence Reporter* 47.6 (September 2021): 30-31.
[33] Forwarded internal US Air Force correspondence, 16 May 2019.
[34] Katherine Ziesing, "Defence and Lockheed Martin sign JP9711 simulation capability," *Australian Defence Magazine,* 27 March 2019, https://www.australiandefence.com.au/defence/simulation/defence-and-lockheed-martin-sign-jp9711-simulation-capability.

adoption decisions, thus subjecting each hypothesis to "straw-in-the-wind" or "hoop tests" (see table five for a summary of findings).

Alternative Hypotheses	Evidentiary Threshold: Process Tracing Test
One: Presence of Geo-Strategic Competition	Hoop Test
Two: Organizational Propensity for Reform	Straw-in-the-Wind
Three: Presence of High-Level Champions	Hoop Test (initial investments); Straw-in-the-Wind (later investments)
Four: Military-to-Military Contact	Hoop Test
Five: Cultural Similarity	Straw-in-the-Wind (normative alliance groupings)

Table 4: Explanatory Value of Alternative Hypotheses to the ADF

Hypothesis One: States that live in regions of intense geo-strategic competition will adopt synthetic training at a higher rate.

Since federation, and arguably before, Australia has been secure in its existence. Blessed by its geography, the island-continent has rarely feared invasion by an enduring competitor or potential adversary. Far from the great power conflicts that convulsed the world in the twentieth century, Australians have instead fought—and died—far from its Indo-Pacific shores. [35] Yet, the "free security" afforded by Australia's geographical position is at odds with its leadership's fixation on the democracy's defense. For much of Australia's history, a deep-seated sense of vulnerability has permeated its consciousness. Canberra's sense of vulnerability stems from an acute belief that the island-continent is difficult for Australians alone to shield from great power predation. Indeed, a sparsely populated, resource rich island-continent located at the far reaches of the Indian and Pacific Oceans, the Australian strategic mindset has, for much of its history, been suffused with a certain sense of vulnerability. Located at a distant remove from its great power patrons—first the UK and later the US—and surrounded by more populous northern Asian neighbors, Australia has long suffered from fears of invasion, trade disruption, or great power coercion. These anxieties—and the desire for stronger collective defense in the face of alleged Russian, Chinese, and French activities in its environs—was one of the defining factors that drove six separate British self-governing colonies towards Federation in 1901.[36] Since that time, the fear of being absorbed or strong-armed by a regional hegemon has continued to permeate the Australian psyche.[37]

In the early 1900s this fear was largely predicated on Japanese industrialization and military modernization.[38] Japan's string of military successes against Korea and China, coupled with their

[35] Michael Wesley, "Defending Australia," *Australian Foreign Affairs* 4 (October 2018): 18 and Hugh White, *How to Defend Australia* (Carlton, Australia: La Trobe University Press, 2019): loc. 430.
[36] David Horner, "Security Objectives" in FA Mediansky, *Australian Foreign Policy* (Melbourne, Australia: Macmillan, 1997): 74-77 and Trood, "Politics and the Defence Debate," loc 445.
[37] Indeed, Australian literature and film reflects this fear. Starting in 1908 when William Lane penned "White or Yellow: A Story of Race War of AD 1908" and continuing through the 1990s, a familiar theme within Australian popular culture is that of an Asian invasion of the island-continent. Catriona Ross, "Paranoid Projections: Australian Novels of Asian Invasion," *Antipodes* 23.1 (June 2009): 11-26.
[38] Immigration has also fueled fears of an "Asian invasion." This can be traced to Chinese immigration during the gold rush in the 1850s, but is also present today, particularly in discussions related to the effects of climate change. Khalid Koser, "Environmental Change and Migration: Implications for Australia," *Lowy Institute for International Policy* (December 2012).

earlier, landmark victory in the Russo-Japanese war was a source of consternation for Australian policymakers. Public figures expressed doubt that the British, bound by their many European commitments, could come to Australia's aid in the event of an invasion.[39] Imperial Japan's territorial expansion during WWII seemed to vindicate those that viewed Japanese military modernization throughout the interwar years with trepidation. Japan's southward thrust through Southeast Asia and the Philippines, followed by the cataclysmic fall of Singapore in 1942, and the bombing of Darwin, reinforced Australian invasion fears.[40] As one of Australia's foremost strategists, TB Millar noted in 1965,

> *From that time…we have been conscious of a direct or indirect threat from Asia. It came first from the Japanese, and the image of a potential threat from Japan lingered long after the collapse of Japan's fighting strength in August 1945. The 'Japanese menace' was replaced, after the victory of the Communist forces in China in late 1949 and following the state of the Korean War in June 1950, by a 'Communist menace,' not easily defined but apparently a single threat, subtle and powerful*.[41]

During the Cold War, a newly independent Indonesia became one of the main pacing threats for the ADF, and the archipelagic state's demographic heft and relative proximity heightened Australian force planners' threat perceptions.[42] Most famously, during the 1980s, the ADF conducted a series of exercises against a fictitious enemy entitled "Kamaria," whose order of battle was strikingly similar to that of the Indonesian National Armed Forces.[43] The fear of a potential Indonesian menace, coincided with intensified Australian military activity within its near-abroad. The specter of an "arc of instability" stretching from the Coco Islands in the Indian Ocean to New Zealand and the islands of the Southwest Pacific in the East, led Australia to intervene throughout the southern Indo-Pacific theater in the 1990s, most notably in East Timor and Bourgainville. Today, those fears have evolved, and Australian strategists are no longer as concerned by Southeast Asian state armies, but rather over concerns that regional instability may lead to a surge in transnational crime or Islamic terrorism.[44]

Since the end of the Cold War, the rise of China has become an ever-growing source of concern for the Australian government. Indeed, the Chinese military has now undergone two decades of sustained modernization and reform efforts. It has acquired increasingly sophisticated weapon

[39] Neville Meaney, "Fears and Phobias: E.L. Piesse and the Problem of Japan, 1909-39," *National Library of Australia, Occasional Paper Series* 1 (1996).
[40] Japan's WWII proposal to invade Australia was not based on Australian resources. Tokyo saw Australia as a strategic liability—its northern settlements were hosting enemy forces. Gary Brown and David Anderson, "Invasion 1942?: Australian and the The Japanese Threat," *Parliamentary Research Service Background Paper* 6 (1992).
[41] TB Millar, *Australia's Defence* (Carlton, Australia: Melbourne University Press, 1965): 1-2.
[42] In WWII, the Japanese seized Indonesia from the Dutch and used the archipelagic state as a launchpad to conduct attacks. John Blaxland, "Australia, Indonesia and Southeast Asia," in Peter Jean et. al., *Australia's Defence Towards a New Era?* (Melbourne, Australia: Melbourne University Publishing, 2014): loc 2211- 2813.
[43] Paul Dibb and Richard Brabin-Smith, "Indonesia in Australia's Defence Planning," *Security Challenges* 3.4 (2007): 82.
[44] Graeme Dobell, "The 'Arc of Instability': The History of an Idea," and Greg Fealy, "Jihadism and 'the Battle of Ideas' in Indonesia: Critiquing Australian Counterterrorism," in Ron Huisken and Meredith Thatcher, *History as Policy: Framing the Debate on the Future of Australia's Defence Policy* (Canberra, Australia: Australian National University Press, 2007): 85-104 and 105-116.

systems, procured a greater number of military platforms, and invested heavily in training and exercises.[45] China's military power has coincided with it adopting a progressively more aggressive and irredentist policy within the region—violating the territorial boundaries of its neighbors on land, air, and sea, while building artificial landmasses over disputed islets in the South China Sea. To some Australians, these actions have together amounted to a de facto Chinese military annexation of the South China Sea.[46] However, it is not just China's conventional military build-up that is cause for concern within Canberra, but its targeted use of what has been labeled "grey zone" measures, to include more insidious economic tools, lawfare, information operations, and cyber. Indeed, Australia has emerged as the proverbial canary in the coal mine when it comes to being on the receiving end of Chinese economic coercion, political interference, and general assertiveness.[47]

Despite these mounting concerns over an increasingly redoubtable threat to the north, there is also a belief among some that Australia's geostrategic situation continues to afford the country a strong degree of security. As the Department of Defence noted in 1947, "[Australia's] geographic position is such that no hostile power, without possessing command of the sea and local air superiority could successfully invade Australia."[48] Indeed, what has been labeled Australia's "air sea gap" to its north has been likened to a protective moat, shielding the country from a large-scale amphibious invasion.[49] Coupled with the security provided by Australia's northern approaches is the country's strategic depth. Its major population centers, economic hubs, and government infrastructure are located at the continent's south-eastern corner, forcing a would-be invader to project power across considerable distances to decisively threaten the nation's economic and political centers of gravity. This had led some to argue that a truly existential military threat to the island-continent's sovereignty seems improbable.[50]

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[45] Oriana Skyler Mastro, "China's Military Modernization Program: Trends and Implications," *American Enterprise Institute* (4 September 2019).

[46] Marcus Hellyer, "The Cost of Defence: ASPI Defence Budget Brief 2019-2020," *Australian Strategic Policy Institute* (2019): 17.

[47] Rob Schmitz, "Australia and New Zealand Are Ground Zero for Chinese Influence," *NPR,* 2 October 2018, https://www.npr.org/2018/10/02/627249909/australia-and-new-zealand-are-ground-zero-for-chinese-influence, Colin Packham, "Exclusive: Australia concluded China was behind hack on parliament, political parties – sources," *Reuters,* 15 September 2019, https://www.reuters.com/article/us-australia-china-cyber-exclusive/exclusive-australia-concluded-china-was-behind-hack-on-parliament-political-parties-sources-idUSKBN1W00VF,m "Sam Dastyari: Australian senator to quit after China scrutiny," *BBC News,* 12 December 2017, https://www.bbc.com/news/world-australia-42318774.amp, and Evelyn Douek, "What's in Australia's New Laws on Foreign Interference in Domestic Politics," *Lawfare,* 11 July 2018, https://www.lawfareblog.com/whats-australias-new-laws-foreign-interference-domestic-politics.

[48] Department of Defence, "Key Elements in the Triennial Reviews of Strategic Guidance since 1945: Submission to the Parliamentary Joint Committee on Foreign Affairs and Defence," *Inquiry into the Management of Australia's Defence and National Security: Official Hansard Report, Submissions and Incorporated Documents* Vol. 3 (17 February 1945): 3-4.

[49] The 1986 Dibb Report and the subsequent 1987 and 1994 Defence White Papers established the concept of an "air sea gap." See: Stephen Kuper, "Understanding Australia's strategic moat in the 'air sea gap,'" *Defence Connect,* 18 June 2019, https://www.defenceconnect.com.au/key-enablers/4249-understanding-australia-s-strategic-moat-in-the-sea-air-gap.

[50] Ron Huisken and Meredith Thatcher, *History as Policy: Framing the Debate of Australia's Defence Policy* (Canberra, Australia: Australian National University Press, 2007): 7.

These contradictory sentiments—in-between an acute sense of vulnerability and isolation in the face of regional great power threats along with a perception of geographically-conditioned “free security” has given rise to different strains of thought with regards to Australia’s geostrategic threat environment, which has downstream effects on the adoption of LVC.[51] Indeed, as security scholars have shown a state’s assessment of its security environment is more indicative of adoption practices than the actual presence—or lack thereof—of competition. A state’s perception of its security environment influences its strategic goals, the structure of its armed forces, and conception of future operations, which has implications for training, and more specifically synthetic training.[52]

In this case of Australian adoption of LVC, Australia’s perception of its geostrategic threat environments seems to pass the “hoop test”—it is a necessary factor impacting Australia’s adoption decisions. While Australia has been investing in various LVC capabilities since 2006, the mass uptick in adoption is relatively recent, with JP-9711 being fully funded in 2019 and LVC service strategies emerging in 2012 (Air Force), 2015 (Navy), and 2016 (Army). This uptick corresponds with heightened perceptions among Australian’s elite and the general populace that their security environment is deteriorating spurring the defense establishment to modernize their force, to include their training infrastructure.

Indeed, Australia’s *2016 Defence White Paper*, while not explicit about geostrategic threats to the island-continent, does note increased “security uncertainty and complexity” as a key reason behind modernization and professionalization.[53] The document, in many ways, has acted as a catalyst for greater synthetic training adoption. While past documents have focused heavily on investments for large-scale military platforms, such as ships, aircrafts, and vehicles, the 2016 document reversed that trend, instead emphasizing the importance of a balanced investment portfolio that includes both platforms and force enablers, live LVC (see figure twenty-three).[54]

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[51] On the notion of geographically determined “free security” as it applies to insular states such as Great Britain, Australia, and to a certain extent the US, see Gregory D. Cleva, *Henry Kissinger and the American Approach to Foreign Policy* (Lewisburg, PA: Bucknell University Press, 1989): 87-90.
[52] Fravel, *Active Defense: China’s Military Strategy since 1949.*
[53] Department of Defence, “2016 Defence White Paper,” *Australian Government* (2016): 9.
[54] *Ibid,* 86.

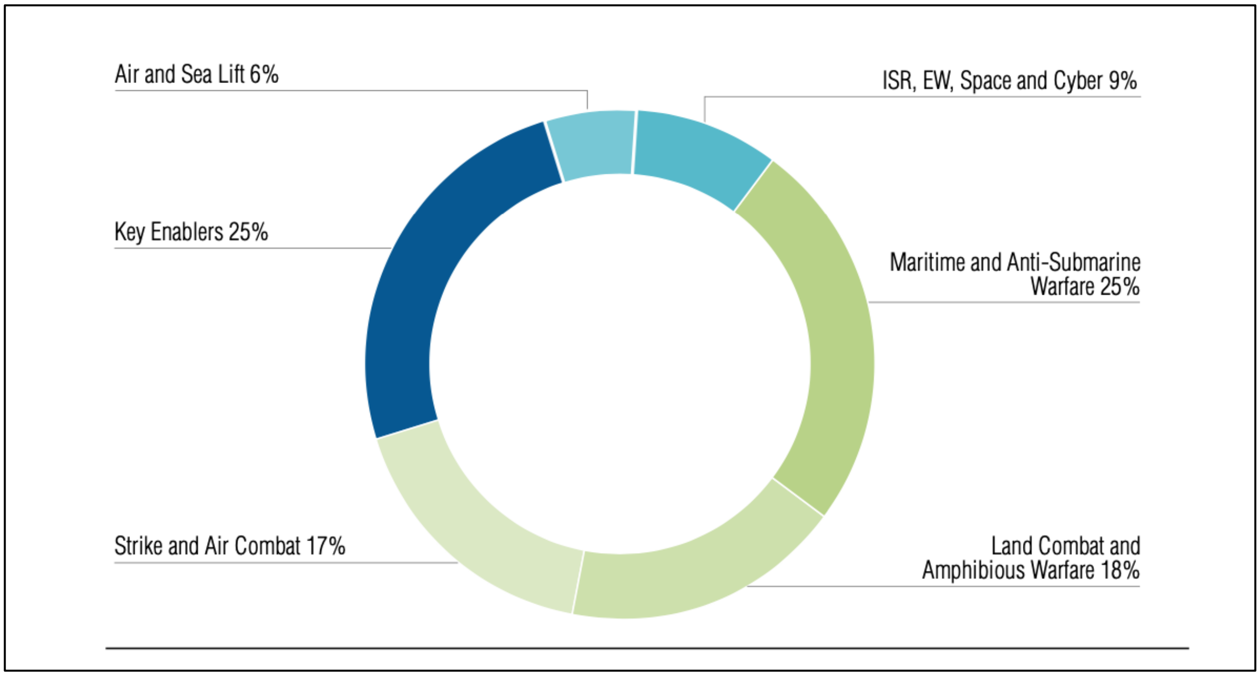

Figure 24: Ten Year Division of Investment by Capability Stream to FY 2025-26. Image from Department of Defence, "2016 Defence White Paper," (2016): 85

More recent documentation, like the *2020 Defence Strategic Update* has been far more explicit about Australia's changing geostrategic environment, in particular the threats posed by China.[55] Complimented by the *2020 Force Structure Plan,* both documents highlight the need for increased investment and modernization to shape, deter, and respond to geopolitical changes within their region. As part of this ongoing investment, defense training and simulation remain a priority, particularly at the enterprise level (see figure twenty-four).[56]

[55] Department of Defence, "2020 Defence Strategic Update," *Australian Government* (2020).
[56] Department of Defence "2020 Force Structure Plan," *Australian Government* (2020): 18 and 83.

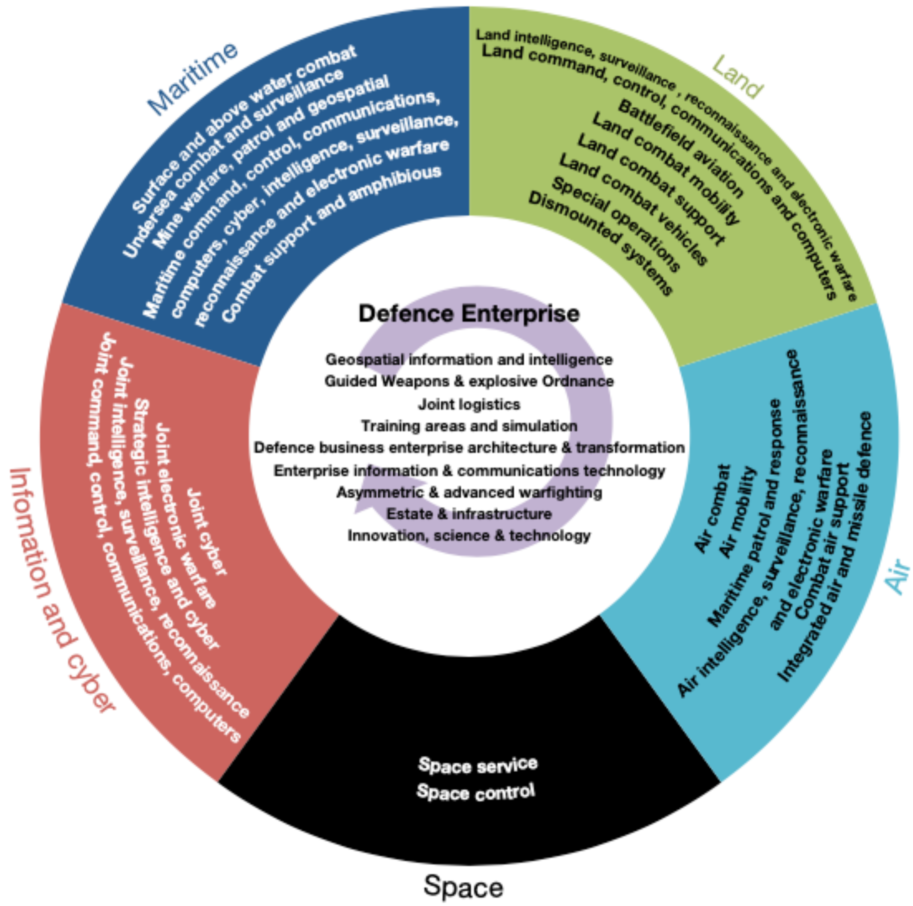

Figure 25: Australia's "Defence Capability Program Architecture." Image from Department of Defence "2020 Force Structure Plan," (2020): 83

Hypothesis Two: States that have a propensity for organizational reform within their defense bureaucracies will have higher synthetic training adoption rates.

Scholars that study organizational innovation point to four models that typically guide organizational reform—the interservice model, instraservice model, organizational culture model, and civil-military model (the last of which will be covered in the alternative hypothesis on champions).[57] Mimetic isomorphism—mimicking the adoption strategies of sister services—has also been shown as a causative factor in diffusion decisions.[58]

The first two theories of innovation do not seem valid in the case of the ADF, not because Australia lacks organizational agility, but because adoption—or acquisition—decisions for LVC are inherently joint. The large acquisition programs are not occurring at the service level, but within a joint organizational framework. Indeed, as previously mentioned, Australia's large scale LVC

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[57] Sapolsky, "On the Theory of Military Innovation," 35-39, Rosen, *Winning the Next War: Innovation and the Modern Military,* Farrel and Terriff, *The Sources of Military Change: Culture, Politics, and Technology,* and Posen, *The Sources of Military Doctrine.*
[58] Martinez-Ferrero and Garcia-Sanchez, "Coercive, normative, and mimetic isomorphism as determinants of voluntary assurance of sustainability reports."

program, JP-9711, is occurring at the joint level, representing a first-of-its kind acquisition globally that differs from other LVC programs that are occurring at the service level, like the US Air Force's Common Synthetic Training Environment. To create the foundation to support LVC, and simulation adoption more generally at the joint level, the ADF has undergone a significant period of structural reform, particularly since 2000.

A 1998 report by the Australian National Audit Office noted that despite significant investments in simulation were being made by the ADF (approximately $1 billion since 1960 with another $2-3 billion expected to be invested from 1998 to 2008), no governance structure for simulation existed within the ADF. In response to the report's findings, the Australian Defence Simulation Office (ADSO) was stood up in 2000 to address critical shortfalls in simulation governance and coordination. ADSO was a branch within the Australian Defence Headquarters with responsibility for policy direction and coordination activities.[59] Shortly thereafter, in 2004, the Australian Minister for Defence announced the creation of the Joint Combined Training Capability (JCTC) for bilateral activities with the US and that the initial JCTC would be demonstrated at Exercise Talisman Sabre in June 2007 with a focus on the Shoalwater Bay Training Area (see figure twenty-five).[60]

Figure 26: Shoalwater Bay Training Area. Image from T. Wickham and D. McFarlane, "The Australian Joint Combined Training Capability- Reality or Fiction"[61]

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[59] D. McFarlane, "Australian Defence Simulation – Status," in *Transforming Training and Experimentation through Modeling and Simulation Meeting Proceedings* RTO-MP-MSG-045 Paper 2 (2006): 2-2.
[60] JCTC and the 2007 Talisman Sabre exercise will be covered in more depth in the section on adoption decisions and champions.
[61] T. Wickham and D. McFarlane, "The Australian Joint Combined Training Capability- Reality or Fiction," in *Improving M&S Interoperability, Reuse and Efficiency in Support of Current and Future Forces Meeting Proceedings* RTO-MP-MSG-056 Paper 2 (2007): 2-1

A significant component of the JCTC vision was tied to synthetic training as the four core pillars that undergirded the initiative included realistic combat training, common ground truth (an ability to understand what is occurring within the synthetic environment), adaptative and credible opposition force, and high-quality feedback or after action reviews.[62] As will be discussed in the following section, JCTC did achieve its objectives, partially because there was high-level oversight and champions for the program. However, to support the delivery of the simulation and support system for JCTC a unique management structure had to be created. The Australian Defence Management Organisation that was charged with delivering the program lacked the requisite experience in simulation integration that was necessary for program completion. As a result, ADSO stepped in and acted as the prime integration agent on behalf of the Defence Material Organisation and a unique governance structure was created across Defence to ensure the participation of all major stakeholders, to include contractors from the US Department of Defense.[63] Several lessons learned were drawn from the JCTC experience—not least the cultural challenges of charging two separate organizations with delivering the synthetic component of JCTC. The Defense Management Organisation and AMSO were not always aligned on various corporate processes and as a result different emphases could be placed on certain system requirements, which had downstream repercussions for those charged with delivering synthetic training.[64]

Even without the presence of inter-service or intra-service rivalries, the cultural tension between different organizations, and the Australian Defence establishment's willingness to take a critical look at their governance structures for simulation—particularly in the wake of the JCTC delivery for 2007 Talisman Sabre—drove further reform. In 2011, the chief of the Defence Force released a tiger-team report on ADF simulation. The tiger-team's findings caused ongoing simulation programs to be scrapped in favor of an enhanced joint "Core Simulation Capability" under a new organization with greater authority and capacity for delivery—the Australian Defence Simulation and Training Center (ADSTC).[65] ADSTC merged ADSO, JCTC, and the J7/J8 (Joint 7 and Joint 8 Training and Exercises) under a dedicated one star command. It was mandated to develop, deliver, govern, and run the Defence synthetic environment with key input from each of the services and the Defense Science Technology Organisation (DSTO) (see figure twenty-six).[66]

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[62] *Ibid.*
[63] *Ibid,* 2-5.
[64] *Ibid,* 2-6.
[65] Charles McHardie, "The Formation of the Australian Defence Simulation and Training Center, Vision 2020," *SimTec T Brief,* 17 September 2013.
[66] *Ibid.*

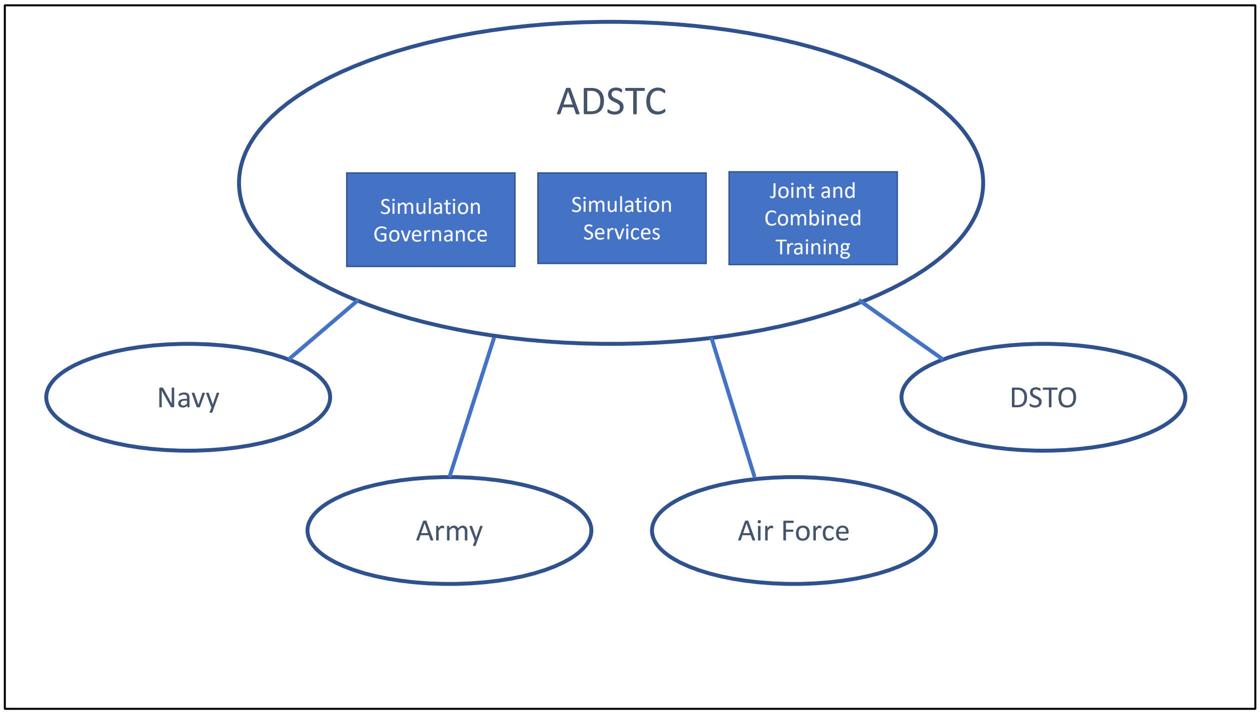

Figure 27: Organization Structure of ADSTC. Adapted from Charles McHardie, "The Formation of the Australian Defence Simulation and Training Center, Vision 2020," SimTec T Brief, 17 September 2013

According to Commodore Charles McHardie, the first commander of ADSTC, the organization's vision was to create "a mature systems center capable of providing effective governance, training simulation and exercise support workforce, applications and services that underpin a synthetic environment that supports the delivery of a challenging and complex training environment. These services are delivered in a repeatable, persistent, and agile manner to the complete spectrum of Defence synthetic environment users."[67] To achieve this vision, three directorates were created under ADSTC: Simulation Governance, Simulation Services, and Joint and Combined Training. The organizational structure of the ADSTC has largely remained the same, but it has since been renamed as the Joint Collective Training branch - J7 (Joint Force Development) Joint Operations Command Headquarters.[68]

What can explain the ADF's ongoing organizational change when it comes to the employment of synthetics and simulation? Certainly, one explanation is that the ADF was simply responding to organizational needs. Deploying an enterprise synthetic environment solution is challenging—both technically and in terms of overall procurement processes (as Defence recognized with the deployment of JCTC). However, organizational change may also have been in response to two other trends: cultural resistance in some quarters of the ADF and personnel issues.

Indeed, when commenting on cultural barriers to adaptation within the defence enterprise, Australia scholars have noted two key trends that tend to handicap reformist efforts—a culture that

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[67] Katherine Ziesing, "Defence Business: SimTect 2013: ADSO to become ADSTC ADM November 2013," *Australian Defence Magazine,* 13 December 2013, retrievable at: https://www.australiandefence.com.au/news/defence-business-simtect2013-adso-to-become-adstc-adm-november-2013.

[68] Calytrix, "Calytrix and the J7," accessed 6 August 2022, https://www.calytrix.com/casestudies/jctb.html.

dismisses critical and creative thinking within the ADF and a workforce program that fails to identify and retain the talented officers that are most likely to carry out innovative reforms.[69] This maps back to organizational culture theories of reform that note the culture can act as a key barrier to innovation or adoption.[70] As Albert Palazzo notes when discussing Australian cultural challenges,

> *Australians tend to favor the 'happy larrikin' over the deep thinker. Within the defence realm, this takes the form of a preference for 'doers' over 'thinkers' or as one officer observed, the Army has a cultural fixation on delivering outputs rather than achieving outcomes.*[71]

Palazzo went on to opine that this characteristic was not solely a function of the Army, but a broader anti-intellectualist tradition that permeates the ADF and even broader Australian society.[72] The military struggles to identify talent and when it does, few programs exist to support and promote those thought leaders. Moreover, when individuals operate "outside the box" of typical military careers, they are often marginalized, as the promotion system has little tolerance for those that deviate from the norms of service. While working in LVC does not constitute a highly unorthodox career trajectory, the implementation of such a complex suite of technologies does require the involvement of critical thinkers with a diverse range of expertise—from engineering to human performance, training, and operational experience. Perhaps because of the heterogeneous quality of this required talent set, a bias still exists in some quarters of the military against LVC.[73] To overcome cultural resistance to synthetic training, LVC must be demonstrated in a way that clearly demonstrates its training effectiveness. This can be challenging, as one failure in demonstration can overturn years of built up good-will towards a training system.[74] Reorganizing the Defence approach to simulation better ensured the successful demonstration of technologies by combining the governance under one organization charged with development and delivery. It also allowed the ADF to better identify those individuals that could make up the LVC workforce. Indeed, studies have shown the challenges associated with identifying the right talent to make up an LVC workforce—a challenge that has been historically plagued by a lack of standardized job descriptions, competency frameworks, education and training pathways, and career progression options.[75] While reform efforts did not entirely solve this issue, it did help to mitigate against some of these systematic problems.

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[69] James Brown, "The Challenge of Innovation in the Australian Army," *Security Challenges* 7.2 (Winter 2011): 13.
[70] Kier, *Imagining War: French and British Military Doctrine between the Wars.*
[71] Albert Palazzo, "The Future of War Debate in Australia. Why has there not been one? Has the need for one now arrived?," *Australian Defence Force Journal* 201 (2017): 62.
[72] *Ibid.*
[73] After speaking on LVC at the 2018 Royal Australian Air Force Air Power Conference, several mid-ranking officers reached out to me after my presentation, mentioning how difficult it can be to get the senior leadership to recognize the value of these technologies. See, also, Patrick Durrant, "Some Home Truths about LVC," *Australian Defence Magazine* (31 August 2017).
[74] Conversation with Wing Commander Steve Laredo, 4 March 2020.
[75] Karen Louise Blackmore and Evan William Henry Allitt, "Building and Sustaining the Simulation Training Workforce," *Journal of Defence Modeling and Simulation: Applications, Methodology, Technology* 18.2 (2021): 157-170.

According to this line of inquiry, Australia has been incredibly organizationally agile—overcoming cultural and bureaucratic pressure to reform. It is worth highlighting a second line of thought, however. Australian Defence has been notorious for its overzealous approach to change, at times driving a level of organizational "fatigue" within Defence that has proven counterproductive. Since the 1973 *Tange Review*, which created the Department of Defence, there have been over thirty-five significant reviews of the department.[76] These external reviews account for only a sliver of the audits that Defence has been subjected to, from parliamentary reviews, ADF boards of enquiry, and Commonwealth audits. Together, these reviews have led to an "audit fatigue" within the department. Their sheer frequency—particularly over the past decade as Australia has cycled through prime ministerial administrations—has caused many reviews to be short-lived, with recommendations being overtaken by the release of a new review or audit.[77] In other instances, recommendations have been implemented in "process only" rather than with an eye to "outcomes," thus leaving the underlying problems unaddressed.[78] This inability to adopt reforms is problematic. Indeed, the most recent defense-wide review, entitled the *First Principles Review* noted:

> *[Defence's] current organizational model and processes are complicated, slow and inefficient in an environment which requires simplicity, greater agility and timely delivery…Defence is suffering from a proliferation of structures, processes, and systems with unclear accountabilities. These in turn cause institutional waste, delayed decisions, flawed execution, duplication, and change-resistant bureaucracy, over-escalation of issues for decision and low engagement levels amongst employees*.[79]

However, unlike previous reviews, the *First Principles Review* has spurred reform. The current Secretary of Defence, Greg Moriarty noted that Defence had implemented all but two of the review's seventy-five recommendations, representing "the most far reaching reform program in [the department's] history."[80] This has significant implications for how the department may approach LVC, as the Vice Chief of the Defence Force (synthetic training's champion within the ADF) has been allocated increased authority and now has greater power within the Department's Defence Committee.

Yet, despite this spate of reforms, there are certain lingering challenges. The *First Principles Review* identified three root causes that have hindered organizational change—the ADF's high operational tempo, the constant leadership churn within the department, and a lack of consistency in funding. These issues are not going away, and concerns over the financial sustainability of some

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[76] Australian Government, *Australian Defence Reorganisation Report* (Canberra, Australia: Austalian Government Publishing Service, 1974).
[77] Department of Defence, "First Principles Review: Creating One Defence," 13 and Russel Trood, "Politics and the Defence Debate," in Peter Dean et. al., *Australia's Defence Towards a New Era?* (Melbourne, Australia: Melbourne University Press, 2014): loc 564.
[78] Australian National Audit Office, "Performance Audit Report No. 6 2013-2014," *Capability Development Reform* (October 2013): 273-287.
[79] Department of Defence, "First Principles Review: Creating One Defence," 13.
[80] Stephen Easton, "Greg Moriarty: Collaboration is the key to reform a "change resistant bureaucracy," *The Mandarin,* 10 April 2019, https://www.themandarin.com.au/107021-greg-moriarty-collaboration-is-the-key-to-reform-a-change-resistant-bureaucracy/.

of these efforts will likely be exacerbated following COVID-19. High rates of leadership turnover may continue to jeopardize long-term planning so long as Australian parliamentary politics continue to remain fluid and unpredictable in nature. And, finally, while the government has affirmed a commitment to spending two percent of GDP on defense, it is unclear whether it can—and will—maintain the *2016 Defence White Paper* and the *2020 Defence Strategic Update* funding line. Recent economic trends when combined with the costs associated with new acquisitions, may durably tighten governmental purse strings, forcing Australian security managers to make some difficult decisions.[81] Deeper LVC adoption—beyond the reforms promised by JP-9711—will require a continued prioritization of synthetic training across the ADF.

Finally, scholars of organization reform have pointed to mimetic isomorphism as a factor in organizational change decisions. While it is possible to point to the release of LVC strategy documents within the various services as a form of emulation—the RAAF released their strategy in 2012 with the Navy and Army following closely behind—since LVC adoption happens at the joint level this does not seem to be an explanatory factor. Additionally, the ADF's JP-9711 program is a world's first—nothing like it exists, to date.

It appears that organizational factors fail to pass the hoop test. Organizational agility is certainty relevant when assessing ADF LVC adoption decisions, but it does not necessarily confirm it. Organizational changes within Defence may have aided in adoption—streamlining processes, overcoming cultural resistance, and ensuring the right talent is present to aid in LVC procurement. At the same time, however, persistent change may cause many changes to be implemented in name only, to include some organizational changes related to synthetic training.

Hypothesis Three: States that have high-level "champions" for synthetic training either at the Chief of Service level or at the upper tiers of the defense bureaucracy will choose to adopt synthetic training at a higher level.

In concert with Posen's civil-military model of adoption, the adoption of LVC within the ADF can largely be traced back to high-level advocates that pushed for its early-stage procurement.[82] As previously mentioned, in 2006, the US and Australia inaugurated JP-2098—a joint initiative that demonstrated distributed connectivity through exercise Talisman Sabre 2007. The concept, first envisioned in 2004 by then US Secretary of Defense Donald Rumsfeld, and his counterpart Defence Minister Robert Hill sought to upgrade and link the Australian defense training center at Shoalwater Bay in Queensland with the Bradshaw Training Area and the Delamere Weapons Range—both located in the Northern Territory—with training centers located in the US.[83] This goal came to fruition with the JP-2098 program. When commenting on the Joint Combined Training Centre, the Australian Ministry of Defence emphasized the synthetic nature of the program, noting:

[81] Hellyer, "The Cost of Defence: ASPI Defence Budget Brief 2019-2020," 25 and Marcus Hellyer, "Funding on track but strategic circumstances worsening: the cost of Australia's defence," *The Strategist,* 26 May 2021, https://www.aspistrategist.org.au/funding-on-track-but-strategic-circumstances-worsening-the-cost-of-australias-defence/.
[82] Posen, *The Sources of Military Doctrine.*
[83] "Joint Combined Training Centre," *Nautilus Institute for Security and Sustainability,* accessed 12 April 2020, retrievable at: https://nautilus.org/publications/books/australian-forces-abroad/defence-facilities/joint-combined-training-centre-jctc/.

> *A mature JCTC [Joint Combined Training Centre] should not be seen as a test range or even a series of ranges. The JCTC should function as a training system that links training management systems, training areas, simulations, headquarters and units. It is proposed that the JCTC should be linked to the US Pacific Command's Pacific Warfighting Center and the US Joint Force Command's Joint National Training Capability as part of the US Global Joint Training Infrastructure. The JCTC concept envisages the enhancement of a number of Australia's ranges, including SWBTA, Bradshaw Field Training Area and the Delamere Range Facility. Ultimately these ranges could be networked through a series of interoperable systems and interfaces, enabled by advances in information technology*.[84]

The ministerial-level interest in the project ensured buy-in from senior leadership across the ADF, rendering it the ADF's highest profile activity in 2007—notwithstanding ongoing operations.[85] Despite challenges developing and deploying JCTC, ministerial level oversight rendered success of the program paramount. By 2007, JP-2098 had created a compelling proof-of-concept.

However, it wasn't just the deployment of JCTC that was required to ensure success at Talisman Sabre—the ADF also needed to demonstrate connectivity with the US. The ADF established a network for distributed experimentation and training, the Defence Training and Experimentation Network (DTEN) and provided connectivity to the US equivalent, the Joint Training and Experimentation Network (JTEN).[86] During Talisman Sabre, 26,000 troops spread across Australia and the US co-located (either live or virtually via the two connected networks) in a combined forces operation demonstrating the effectiveness of ADF training investments.[87]

The success of Talisman Sabre 2007 marked the end of JP-2098, and its transition to a permanent operating asset within the force. DTEN nodes were expanded within the country, allowing for enhanced distributed training across the ADF in support of ongoing operations in Afghanistan (see figure twenty-seven) and persistent connectivity between the Australian DTEN and the US JTEN was also established.[88]

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[84] Parliament of Australia, "Chapter Four: Australia's Defence Relations with the United States," *Joint Standing Committee on Foreign Affairs Defence and Trade* (2006): 42.
[85] Calytrix, "JCTC/ ADSTC," accessed 15 September 2019, https://www.calytrix.com/casestudies/adstc.html.
[86] *Ibid.*
[87] Adam R. Cole, "Australia-US Expeditionary Forces Complete Talisman Saber 2007," *Navy News Service,* 9 July 2007, https://www.navy.mil/submit/display.asp?story_id=30448.
[88] The Joint and Combined Training Activity Memorandum, updated in 2018, notes that the ADF has a persistent connection between the DTEN and the US JTEN via the Australia/ Canada/ Great Britain/ US (ACGU) gateway at the Joint Staff J7 (JSJ7) in Suffolk, VA. The gateway provides the ADF connections to the Canadian Forces Experimental Network (CFXNet) and the UK's Joint Multi-National Interoperability Assurance Network (JMINIAN). Conversation with Wing Commander Steve Laredo, 5 March 2020.

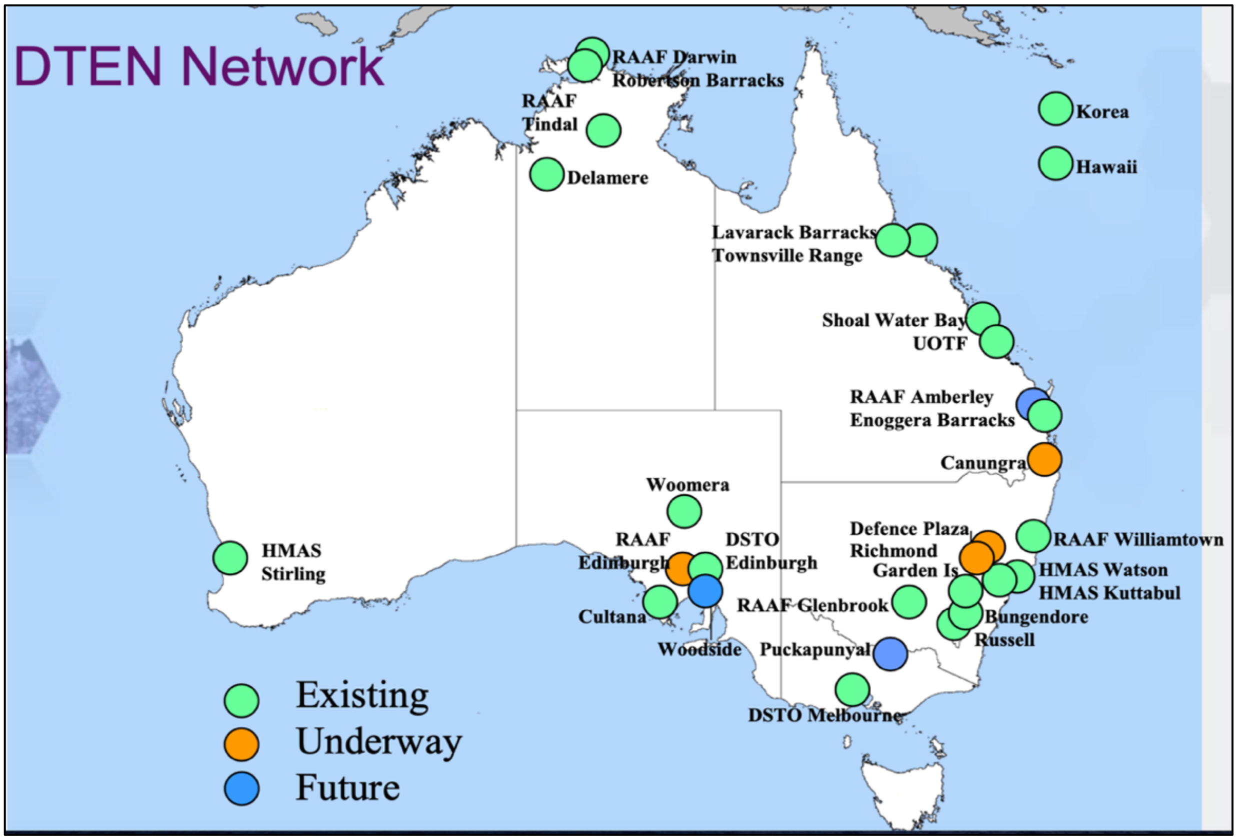

Figure 28: DTEN Nodes within ADF. Image from Phil Spedding and Bernie Grealy, "Australian Defence Simulation and Training Centre," Joint Operations Command (Presentation at the Williams Foundation Seminar, Canberra, Australia, 2015)

JP-2098 created the foundation for LVC across the ADF, or as the Department of Defence calls it, "the synthetic spine."[89] While an imperfect and bespoke solution, the Joint and Combined Training Capability laid the groundwork for the ADF's follow on service and enterprise-level LVC support programs, such as JP-9711.[90] If not for Rumsfeld and Hill's early interest in LVC, JCTC and DTEN may not have come into fruition until much later.

More recently, the ADF has sought to ensure simulation adoption by ensuring high-level service oversight at the joint level. Simulation adoption—to include LVC—across the joint force is delegated to the Vice Chief of the Defence Force Group and their associated capability managers.[91] As a three-star within the ADF (weighted equally to the service chiefs and reporting directly to the Chief of the Defence Staff), the Vice Chief of the Defence Force has the capacity to implement simulation usage at the joint level, while also, theoretically, incentivizing its use across the entire ADF.[92] However, despite identifying a focal point for simulation within the ADF, the *First*

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[89] Department of Defence, "Defence Simulation Strategy and Roadmap," *Department of Defence* (2011): 12.
[90] The limitations of JCTC included network connectivity, non-consistent standards, and the fact the solution was bespoke—it had to be built, tested, executed, and broken-down after each training activity. Conversation with Wing Commander Steve Laredo, 4 March 2020 and Lucien Zalvman and Jon Blacklock, "Synthetic Range LVC Interoperability for the Royal Australian Air Force," *Interservice/ Industry Training, Simulation, and Education Conference (I/ITSEC)* Paper No. 10033 (2010): 2, 10.
[91] Department of Defence, "Defence Simulation Strategy and Roadmap," 48.
[92] James Goldrick, "The Evolution of the ADF into a Joint Force," in Peter Dean et. al., *Australia's Defence: Towards a New Era?* (Melbourne, Australia: Melbourne University Press, 2014): loc. 4863.

Principles Review has noted that the Vice Chief's authority to implement enablers, like LVC, can be limited. Indeed, while the Vice Chief of the Defence Force is a three star and identified as the Joint Capability Authority, their power to ensure that interoperability requirements are met can at times be constrained. The Vice Chief's voice has historically been one voice among seventeen within the Department of Defence's Defence Committee.[93] Under the Defence Act of 1903, the Vice Chief lacks explicit command authority, and this limits their capacity to accomplish mission tasks (to include implementing training directives). Furthermore, the organization reporting to the Vice Chief has traditionally been a complex and challenging bureaucratic environment, which has at times marginalized joint enablers, such as synthetic training.[94] The 2014 *First Principles Review* highlighted these issues as areas needing reform and some changes have been made, most notably in organizational structure. However, while the organization reporting to the Vice Chief has been streamlined, no point-of-contact is explicitly charged with simulation.[95]

At the service level, LVC strategy adoption can primarily be attributed to champions. Indeed, Plan Jericho—the RAAF's strategy to become a fifth generation "information age" force—is largely a function of champions within the Air Force's senior leadership, most notably Air Marshal (ret.) Geoff Brown and Air Marshal (ret.) Leo Davies. Brown and Davies' recognition that the service needed to transform drove programmatic change within the Air Force, the latter's work having since been dubbed "top-down design meets bottom-up innovation."[96] Jericho's associated *Program of Work* identified over 100 capability gaps that needed to be rectified. To ensure the program's implementation, accountability was dictated at the senior level, with the Deputy Chief of Air Force and the Air Commander Australia (two star) issuing programmatic directives to program managers typically at the one-star level.[97] The Royal Australian Navy (RAN) followed closely behind the RAAF, releasing their Plan Pelorus in 2015. Like the RAAF's document, Plan Pelorus views increased use of simulation as key to future warfighting effectiveness.[98] Finally, while the Army is behind its sister services, champions are emerging. The Army's Simulation Concept, *Silicon Warfighting,* had explicit buy-in from the Chief of the Army. However, as one officer noted, despite the Chief's advocacy, "not many people [understand] LVC."[99]

To what extent does the presence of champions figure into ADF decisions to adopt LVC? It appears that the presence of champions, in particular Rumsfeld and Hill were necessary for the early adoption of LVC. Rumsfeld and Hill's interest in the program ensured that the development and delivery of JCTC and DTEN at Talisman Sabre 2007 were a success. The importance of champions for the early adoption of LVC therefore meets the hoop test. The presence of champions for later adoption decisions, like each service-chief's decision to push forward LVC strategies does show the continued relevance of champions within the adoption process. However, a strategy is not indicative of implementation and given implementation is occurring at the joint level, their

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[93] Department of Defence, "First Principles Review: Creating One Defence," 20.
[94] *Ibid,* 24.
[95] Department of Defence, "Vice Chief of the Defence Force: Organisational Chart," accessed 10 March 2020, https://www.defence.gov.au/vcdf/OrgChart.asp.
[96] Royal Australian Air Force, *Plan Jericho Program of Work* (2016): 6.
[97] *Ibid,* 2.
[98] Andrew Forbes, "The Future of Sea Power: Proceedings of the RAN Sea Power Conference of 2015," *Sea Power Centre* (2017): 73.
[99] Australian Army, "Army Simulation Concept- Silicon Warfighting: A Strategic Narrative for Army's Simulation Capability" and interview with Lieutenant Colonel Kane Mangin, Canberra, Australia, 11 August 2016.

advocacy does not necessarily confirm its importance. Later adoption decisions based on champions, therefore, pass the straw-in-the-wind test.

Hypothesis Four: States that have frequent military-to-military contact will have progressively convergent synthetic adoption rates and strategies

Ryan Grauer is his exploration of diffusion practices found that military-to-military contact can explain adoption decisions. Grauer notes that military-to-military contact can take a variety of forms, such as the presence of military attaches and foreign military officers, the placement of military officers in foreign military universities, direct observation of combat, and joint training and exercises.[100] In the case of Australia, military-to-military contact is largely a function of coalition operations, which is cemented in shared norms. Indeed, the Australian government explicitly states that "coalition operations are likely to be the norm for like-minded western forces for the foreseeable future." However, "coalitions are fragile and demand constant attention if they are to survive." As a result, the Australian government notes that coalitions based on alliance frameworks should be nurtured "through sustained cooperation on military exercises and training, the networking of information and of forces, and shared experience in joint operations."[101]

To nurture those relationships, the ADF participates in a range of annual and biennial training exercises with partners and allies and exchanges military personnel. As part of the Five Powers Defence Arrangement between Australia, Malaysia, New Zealand, Singapore, and the UK, Australia participates in Exercise Bersama Shield, Bersama Limi, Bersama Padu, and Suman Protector, which cultivates regional ties through training in combined and joint operations.[102] It also sends its personnel abroad for military education viewing it as one means, amongst many, to maintain an intellectual edge.[103] Additionally, Australia participates in the French-led Croix Du Sud and Equator exercises, each held in New Caledonia that focus on humanitarian assistance and disaster relief within the region. The ADF is also an active participant in the Canadian-led Maple Flag series of exercises.[104] Meanwhile, Australia hosts a range of exercises that work to deepen interoperability within the region. Exercise Kakadu, a maritime exercise, focuses on coordination between New Zealand, Singapore, Thailand, Japan, and Australia.[105] Likewise, exercise Black Pitch has worked to improve the planning and execution of offensive counter air and offensive air

[100] Ryan Grauer, "Moderating Diffusion: Military Bureaucratic Politics and the Implementation of German Doctrine in South America, 1885-1914."
[101] Parliament of Australia, "Chapter Four: Australia's Defence Relations with the United States," 42.
[102] Bersama Limi, Bersama Padu, and Suman Protector take place in a five-year cycle. Department of Defence, "Australian Defence Force Major Exercises," accessed 5 March 2020, https://www.defence.gov.au/Publications/Reviews/ADFPosture/docs/ex.pdf. For more on Australian exercises with Southeast Asian partners, see: Blaxland, "Australia, Indonesia, and Southeast Asia," loc 2211- 2813.
[103] Australian Government, "The Australian Joint Professional Military Education Continuum," *Australian Defence College* (2019).
[104] *Ibid* and Royal Australian Air Force, "Exercises," accessed 7 March 2020, https://www.airforce.gov.au/news-and-events/events/exercises.
[105] In 2010, Malaysia acted as a participant, but played a limited role coordinating the exercise. Other countries also participated as observers—India, Indonesia, Papua New Guinea, the Philippines, France, and the Republic of Korea. *Ibid.*

support between Australia, Canada, France (with its assets stationed in New Caledonia), Germany, Indonesia, Netherlands, New Zealand, Singapore, Thailand, Malaysia, and the US.[106]

The ADF's closest ally, however, remains the US. As the Australian Defence Association notes:

> *Given the United States is our major ally and that we operate with them quite closely within Australia, the region, and further afield, we have to exercise at every level. The current suite of exercises between the two countries is extensive and time-tested…The command post exercises and the strategic level map exercises are important because they set the broad criteria of what each country can and cannot bring to the table. The operational level exercises, particularly those involving deployment, are important because you basically need to test what you promised to bring to the table. The lower-level tactical level exercises and unit and subunit level are important because people need to get to know each other and the operational culture*.[107]

Australia's participation in US-led exercises have been ongoing for some time. For instance, Australia has been participating in the US Air Force led Red Flag Exercise since 1980. Today, Australian troops participate in a range of regular single and combined service exercises alongside the US, such as Rim of the Pacific (RIMPAC), Pacific Flag, Red Flag, Tandem Thrust, Talisman Saber, Cope North, Diamond Storm, and Crocodile.[108] The ADF has a range of simulation systems that can interconnect with the US and partners in the event of Coalition Virtual Flags.[109] ADF personnel attend US military war colleges and liaison officers are placed in key offices within the Pentagon and across the services, and vice versa.[110]

The benefits of this frequent military-to-military contact on synthetic training adoption decisions can most closely be seen in the case of the RAN and the US Navy "Cruiser in a Cornfield," which is frequently cited by Australians as a model for future synthetic training. In Southern New Jersey, the USS Rancocas, located in a field of corn, is home to a USN Combat Systems Engineering and Development Site. Despite its landlocked location, Rancocoas is a commissioned naval vessel manned by USN sailors. It allows USN and industry personnel to conduct research and development in tandem, while also providing an environment to test next-generation systems before they are put to sea. This site also allows sailors to conduct training on the same equipment

[106] Royal Australian Air Force, "Exercises," accessed 7 March 2020, https://www.airforce.gov.au/news-and-events/events/exercises.
[107] Australian Defense Association as quoted in Parliament of Australia, "Chapter Four: Australia's Defence Relations with the United States," 42.
[108] Australian Army, "Major Exercises, accessed 7 March 2020, https://www.army.gov.au/our-work/operations-and-exercises/major-exercises and Department of Defence, "Australian Defence Force Major Exercises."
[109] For instance, for 2020's Coalition Virtual Flag, the RAAF plans to include E-7 Wedgetail simulators, C-130 simulators, C-17 simulators, Joint Terminal Air Controller (JTAC) domes, distributed ground stations, space operators, and key air operations center personnel. This is a significant increase from the RAAF's 2015 participation, which only included E-7 Wedgetail and C-130 simulators. Interview with Wing Commander Mick Tully, 8 April 2020.
[110] Tatjana Christian, "TRADOC officer experiences life in Australia as liaison officer," *US Army,* 29 June 2012, https://www.army.mil/article/82473/tradoc_officer_experiences_life_in_australia_as_liaison_officer.

they will use at sea.[111] RAN officials see the benefit of employing such a model within their own service.

More than just military-to-military contact, it seems likely that the ADF's LVC adoption decisions are significantly shaped by its reliance on the US as its senior ally. As former Australian Prime Minister, Robert Menzies famously observed "no country in the world more than [Australia] needs great and powerful friends."[112] Despite sporadic calls within the ADF for greater self-reliance, the reality of the US-Australian defense relationship is one of unique, almost unparalleled cooperation, and this naturally has a profound impact on the ADF's force posture and acquisition decisions.

Australia's *2016 Defence White Paper* opens with the explicit acknowledgment that a strong Australia-US alliance is a core part of its defense strategy and that the government's actions reflect that vision.[113] Australia provides 2,500 US Marines access to the RAAF's base at Darwin on a rotational basis with plans for future US Air Force assets to also be rotationally stationed there. To support US military activities in Australia's north, the US and Australia have jointly pledged to invest $2 billion in aircraft maintenance, support facilities, fuel storage, upgrades to accommodations, and training areas and ranges.[114] Additionally, the US and Australia share exquisite intelligence, communications, and surveillance facilities at Pine Gap and Exmouth. Australia's technology choices are in some ways dictated by the US defense market. Indeed, as technology has become more complex, Australia has almost systematically privileged the US over others to meet its defense needs.[115] High-end acquisitions like the EA-18G Growler are indicative of Australia's special status, compared to other allies. Indeed, Australia is the only country, outside the US that is operating the aircraft.[116]

The close nature of the relationship has had some profound impacts on Australia's force design, with implications for LVC decisions. Indeed, three schools of thought have emerged within Australia's strategic community, which does have downstream impacts on adoption decisions.

One view, can be broadly summarized as that of the "alliance maximalists"—those that believe that Australia's geostrategic vulnerability requires a deeper cooperation with its great power patron, formerly the UK, and now, since WWII, the US.[117] As one Australian, noted, when highlighting this school of thought:

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[111] Gough, "Combining LVC Capabilities- the RAN Perspective," 16 and Lockheed Martin, "USS Rancocas: The Cornfield Cruiser," *Lockheed Martin,* http://www.lockheedmartin.com/us/100years/stories/cornfield-cruiser.html.
[112] Brandan Taylor, "Searching for a New Great and Powerful Friend?" in Dean et. al., *After American Primacy,* loc 2961.
[113] Department of Defence, "2016 Defence White Paper," 9.
[114] Seth Robson, "US military presence in northern Australia will grow, former defense officials says," *Stars and Stripes,* 21 October 2019, https://www.stripes.com/news/pacific/us-military-presence-in-northern-australia-will-grow-former-defense-official-says-1.603959 and "US-funded facility under USFPI opens at Darwin, Base Australia," *Air Force Technology,* 3 December 2019, https://www.airforce-technology.com/news/facility-usfpi-darwin-base-australia/.
[115] Kim Beazley, "America First and Australia's Strategic Futures," in Dean et. al., *After American Primacy,* 2712.
[116] "Full complement of EA-18G Growlers obtained," *Australian Defence Magazine* (7 July 2017).
[117] CSBA breaks down Australian strategic schools of thought into the alliance maximalists, alliance minimalists, and incrementalist. Cooper and Rehman, "Gateway to the Indo-Pacific: Australian Defense Strategy and the Future of the Australian-US Alliance."

> *For more than a century, Australians have fought and died abroad to help preserve a global power configuration that consigns their homeland to the status of strategic backwater…There have been two rationales for this, one prudential, one geopolitical. The logic of the prudential alliance operates on an insurance metaphor: if we consistently pay our premium by fighting alongside our larger ally, this all will help us in our times of need. The logic of the geopolitical alliance reasons that as long as our larger ally remains the most powerful maritime power in the Indian Ocean and the South Pacific, no hostile power can muster the sea control to launch an attack on Australia.*[118]

Those that espouse this school of thought see Australia developing a force posture that can work to actively complement that of the US, not only within the immediate region but also further afield. They tend to believe that Australia should adopt a policy of "deterrence by punishment," and should take the fight to the enemy in the event of conflict.[119] However, some Australians argue that there is reason to be wary of a policy that places too much emphasis on the US. Canberra has long been concerned about an "alliance abandonment dilemma." The dilemma is both a facet of its history—for instance, in 1942 Great Britain was unable to meet its obligations to Australia during WWII—but also, the fact that ANZUS lacks a formal, written security guarantee.[120] The presidency of Donald Trump heightened these abandonment concerns with some Australian commentators warning that the Trump presidency significantly eroded the credibility of the US alliance system in Asia.[121]

This gives rise to a second school of thought, those that believe Australia's force posture should be structured for greater self-reliance. Within this school of thought there are two strains of thinking, which can be broadly characterized as "Fortress Australia" and "Forward Defence."[122] "Fortress Australia" calls for the transformation of the island-continent into an impregnable fortress, taking advantage of its geographical position. This was Australia's favored policy in the colonial period and post WWI and naturally favors a more inward focused posture, centered around the Army.[123] "Forward Defence," conversely, employs a strategy of denial by defending the "air sea" gap to Australia's north and east of the continent through an identified series of layers (often represented as concentric circles radiating out from the continent). This strategy is most closely associated with the 1986 Dibb Review, which led to a substantial reallocation of resources to the Navy and Air Force and a subsequent hollowing out of Australia's Army, which proved problematic in the 1999 intervention in East Timor.[124]

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[118] Wesley, "Defending Australia," 19.

[119] Ross Babbage, "Australia's Strategic Edge in 2030," *Kokoda Foundation* (2011) and Ross Babbage, "Strategic Competition in the Western Pacific: An Australian Perspective," in Thomas Mahnken, *Competitive Strategies for the 21st Century: Theory, History and Practice* (Stanford, CA: Stanford University Press, 2012): 236-257.

[120] Peter Dean, "ANZUS: The 'Alliance' and its Future in Asia," in Peter J Dean et. al., *Australia's Defence Towards a New Era?* (Melbourne, Australia: Melbourne University Press, 2014): loc. 4063- 4635.

[121] Thomas Wilkins, "Re-assessing Australia's Intra-alliance Bargaining Power in the Age of Trump," *Security Challenges* 15.1 (2019): 10.

[122] Horner, "Security Objectives," 74-77.

[123] Dean, "ANZUS: The 'Alliance' and its Future in Asia," 4063 - 4637.

[124] Alan Dupont, "Transformation of stagnation? Rethinking Australia's Defence," *Australian Journal of International Affairs* 57.1 (2003): 56.

Each school of thought has implications for Australia's choices with regards to LVC adoption. In the former case, a force posture designed to complement the US would likely favor service specific LVC solutions with connectivity between an Australian service (i.e., the Australian Army) and its American counterpart (i.e., the US Army). In some respects, the development of Australia's DTEN and its subsequent connection to the US Joint Training and Experimentation Network JTEN can be viewed within this framework. Fortress Australia, as an Army centric policy, which doesn't place a heavy emphasis on joint operations, is not likely to favor LVC solutions. Instead, one would expect it to place a heavier emphasis on live exercises or virtual point-of-need solutions. This may explain the slightly lower adoption LVC rate within Australia's Army. Meanwhile a strategy of denial would place a premium on cross-domain joint integration, particularly across the Air Force and Navy. This would encourage cross-service LVC solutions, something that is apparent via LVC enabled exercises, like Talisman Sabre.

It appears that military-to-military contact acts as a driver of Australia's approach to LVC adoption. It therefore passes the hoop test—it is a necessary factor. Australia's past synthetic training adoption decisions have been significantly influenced by military-to-military contact, in particular its reliance on the US as its senior ally. The RAN's interest in the US "cruiser in a cornfield" approach to training is a strong example of how synthetic training ideas have diffused from the US to Australia via that ongoing contact. How Australia chooses to develop its LVC architecture reflects its relationship with the US as an ally and coalition partner.

Hypothesis Five: States will select synthetic training adoptions that mirror the adoption strategies of states they feel culturally aligned with.

The Hofstede and GLOBE studies seek to identify cross-country cultural similarities via a range of qualitative attributes that are then compiled into quantitative scores.[125] These scores serve as the basis for cross-cultural comparison, allowing analysts to identify to what extent cross-cultural similarity acts as a driver in adoption decisions. Australia's results, and those countries that were identified as "culturally similar" to Australia in select attribute areas are found below (see table four).

Study	Attribute	Score	Cultural Similarity	Findings
Hofstede	Power Distance Index	41	US and Canada	Score indicative of pluralistic countries with decently high levels of equality.[126]
Hofstede	Uncertainty Avoidance Index	51 (47 when controlling for age)	East Africa and Norway	Score indicative of older, more developed democracies.
Hofstede	Individualism Index	90	US and UK	Premium is placed on individualism

[125] Hofstede, *Culture, Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations* and House et. al., *Culture, Leadership, and Organizations: The GLOBE Study of 62 Societies.*
[126] Hofstede's study is from the 1970s. It is possible that Australia's score is different given more recent demographic change within the country, to include immigration from higher power distance index countries throughout the Asia-Pacific, thereby driving the score up.

				over collective responsibility.
Hofstede	Masculinity and Femininity	61 (59 when controlling for gender)	US and New Zealand	Work is prioritized over quality of life; starker societal views of gender differences.
Hofstede	Long Versus Short Term Orientation	31	Germany and New Zealand	Bias towards characteristics of personal stability and tradition over persistence and thrift.
GLOBE	Performance Orientation Indicator	4.36	Indonesia and Ireland	Premium is placed on encouraging and rewarding innovation.
GLOBE	Future Orientation	4.09	Nigeria and Hong Kong	Australia skews towards longer-term policymaking but can still be driven by a short-term agenda.
GLOBE	Gender Egalitarianism	3.4	Switzerland and Finland	Women hold positions of power, but skewed towards men.
GLOBE	Assertiveness	4.28	Netherlands and Israel	Society values assertiveness.
GLOBE	Individualism versus Collectivism	4.29	Austria and Kazakhstan	Greater collectivism within society, but some prioritization towards individualism.

Table 5: Australia Cultural Similarity Expectations from Hofstede and GLOBE studies[127]

Given the range of countries identified in the Hofstede and GLOBE studies that Australia is allegedly "culturally similar" to, it is difficult to identify one or two countries in which Australia may have similar synthetic training adoption strategies. However, the presence of "Anglosphere" states is particularly notable. [128] Indeed, the ADF's LVC adoption decisions, do, in some respects, mirror those of the US, UK, and perhaps to a lesser extent, New Zealand. However, it is unclear whether that alignment is a facet of being quantitatively "culturally" similar or a function of a longer shared "anglosphere" tradition that has manifested in institutions, like the Five Eye (FVEY) intelligence sharing alliance and, more broadly, recent coalition operations.

Australia is party to few formal alliance groupings, however, those in which it is an active participant are a function of shared normative values. Indeed, perhaps the most notable grouping

[127] Hofstede, *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations,* 87, 150, 215, 285, 351, 355 and House et. al., *Culture, Leadership, and Organizations: the GLOBE Study of 62 Societies,* 250, 304, 365, 410, and 468.
[128] For a defense of the symbolic significance of the anglosphere in Australia's security partnerships, see John Howard, *The Anglosphere and the Advance of Freedom* (Washington, DC: Heritage Foundation, 2011).

is ANZUS. Founded in 1951, ANZUS is a collective non-binding agreement between the three member states—Australia, New Zealand, and the US—to cooperate on issues of military importance in the Pacific Ocean (however the treaty has been broadly interpreted to have a global focus).[129] Likewise, Australia is also a member of the FVEY intelligence grouping of Anglophone states.

The ADF has adopted similar simulation systems to its New Zealand counterparts, from the use of Virtual Battlespace 3 (VBS3)—a multi-player battlefield virtual simulation system that allows users to train for individual, crew, team, platoon, and company collective warfighting tasks—to its pilot training simulation capabilities.[130] It is difficult, however, to attribute this solely to shared cultural attributes. Indeed, two factors are worth noting. First, many of these training solutions, like VBS3 have been adopted to a wide range of countries, many of which do not meet the Hodstede and GLOBE studies metrics of cultural similarity. Second, the shared nature of these systems could partially be a function of how many multi-national training companies approach the Australian and New Zealand defense market, often lumping the two countries under one umbrella for sales and business development purposes.[131] Finally, it should be noted that while there are similarities in simulation adoption choices, the New Zealand Defence Force has not adopted LVC to the same extent as Australia.[132]

The ADF's adoption of LVC is similar to the UK. However, again it is unclear whether this can be attributed to "cultural similarity," a shared history as anglophone countries, the UK's former history as Australia's former great power patron, or to other causative factors. Indeed, in conversations with ADF officials, no official mentioned the British Armed Forces adoption of LVC as a driver for their own adoption of the LVC. However, both countries have leaned heavily into LVC at the joint and enterprise level.[133]

Perhaps the best example, to date, of how alliance groupings, like the FVEY alliance, has impacted Australia's adoption decisions is via the Australian Army's choice to adopt the US Army Decisive Action Training Environment (DATE) program. DATE provided a sophisticated adversarial operational force in training and is constantly updated to reflect changes in the geopolitical environment. From 1948 forward, the Australian army developed their own adversary training

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[129] Andrew Kelly, *ANZUS and the Early Cold War: Strategy and Diplomacy between Australia, New Zealand and the United States, 1945-1956* (Cambridge, UK: Open Book Publishers, 2018).
[130] "New Zealand Defence Force acquire enterprise licence of VBS3 FiresFST," *SimCentric,* https://www.simct.com/new_zealand_defence_force_acquire_enterprise_licence_of_vbs3_firesfst/ and "Royal New Zealand Air Force T-6C GBTS," *Shepherd Media,* 2014, https://www.shephardmedia.com/search/?q=New+Zealand.
[131] See, Cubic Defence's Australia and New Zealand team. "Cubic Defence Australia & New Zealand Ranked Top Small and Medium-sized Enterprise by Australian Defene Magazine," *Cubic Global Defence,* 29 January 2019, https://www.cubic.com/news-events/news/cubic-defence-australia-new-zealand-ranked-top-small-and-medium-sized-enterprise.
[132] New Zealand's lack of LVC adoption decisions could be a function of future conflict expectations. New Zealand has deliberately adopted a strategy where it plans to rely on "physical remoteness and goodwill" to protect it. Robert Ayson, "Unarmed and Independent? The New Zealand Option" in Dean et. al., *After American Primacy,* loc. 3568-3811.
[133] For more on the British adoption of LVC, see: "The Role of Live, Virtual, and Constructive Training," 47. The UK Defence Synthetic Environment Platform (DSEP) programme is currently in development by the UK Ministry of Defence. See, Tech UK, "20220218-DSEP Early Market Engagement Event," 6 April 2022, retrievable at: https://www.techuk.org/what-we-deliver/events/20220218-dsep-early-market-engagement-event.html.

doctrine, entitled the Musorians. Yet, in 2015, the US Army offered DATE to the Australians. At that time both the Canadians and the British had adopted DATE and New Zealand was still evaluating its application to their own armed forces. The Australian Army sought input from their British and Canadian counterparts on DATE's implementation and decided not to adopt the program due its Army centric focus—concerns existed that it would not be able to simulate joint adversarial training for Exercise Hamel/ Talisman Sabre. Additionally, implementation of DATE would require significant cost and personnel investments. The following year, however, the British and Canadian Armies mandated DATE as the common operating environment for training at the division level and below, while New Zealand continued to evaluate the program. This changed the Australian Army's calculus. DATE's adoption by Australia's closest FVEY partners incentivized Australia to follow; it would enhance the Australian Army's multinational interoperability. As a result, in late 2016, the Australian Director of Training Systems at Headquarters Force Command travelled to the US for a demonstration of DATE's capabilities. He left convinced that DATE should be adopted. In 2017, Headquarters Force Command convened a DATE working group with personnel from the Australian training centers, alongside partners in the US, UK, and Canada to establish an implementation plan. While friction points did emerge—like DATE's focus on Caucus terrain for training—a path forward was established. In 2018, the Australian Army switched to DATE, and a Pacific terrain update was delivered in 2020.[134]

It appears that culture does impact Australia's synthetic training—and LVC—adoption decisions, however adoption is far more a function of normative alliance groupings, than quantitative indicators of culture. Examples like DATE point to the relevance of normative alliance groupings, like the FVEY alliance grouping, as relevant in Australia's adoption decisions, yet one example does not confirm it. As a result, culture, when assessed through the lens of normative groupings meets the threshold of a straw-in-the-wind test.

The Drivers of the Australian Defence Force's LVC Adoption

What do the five alternative hypotheses reveal when tested against the ADF's adoption of LVC? In short, it shows that rather than a grand theory, a range of factors (some more than others), have contributed to the ADF's adoption decisions to date.

The ADF's adoption of LVC can be traced back originally to the presence of champions, most notably, Donald Rumsfeld and Robert Hill's decision to upgrade and link Australia's defense training centers and weapons ranges with training centers located in the US. The willingness of these two leaders to advocate for allied training interconnectivity gave the program high-level visibility that ensured its success. In short, it was necessary for adoption. Later LVC adoption decisions can also be attributed, as a necessary factor, to ongoing military-to-military contact between the US military and the ADF. Choices to adopt synthetic training programs, like the US "Cruiser in the Cornfield" training model can be attributed to close and ongoing contact between the two militaries. One of the strongest factors when assessing recent uptick's in LVC adoption, particularly the JP-9711 program, is geostrategic threat perceptions within the Australian government. The governments focus on enablers—to include training—in the face of a rising geostrategic challenge from China is a key reason why JP-9711 was fully funded.

[134] Jim Sinclair, "The Evolution of Australian Army Training Adversaries: 1948-2018," *Australian Army Journal* (2019): 96-105.

Organizational agility does not appear to be a necessary factor in the ADF's adoption of LVC to date, but it does appear relevant. The ADF has undergone significant organizational changes as it has worked to build an organizational structure that can promote a far more streamlined training regime that can support is LVC ambitions, but in some instances, ongoing changes have been implemented in name only (for instance the name change of the ADSTC to the Joint Collective Training branch). Likewise, normative alliance groupings do appear to have some bearing on the ADF's adoption decisions. The ADF's decision to adopt DATE is perhaps the best example of how the adoption of a synthetic training tool by FVEY members influenced their decision-making.

LVC is still within the diffusion and adoption process within the ADF, and warrants continued investigation. How the ADF continues to adopt LVC, and what elements of LVC they emphasize, will likely continue to be a function of their geostrategic threat perceptions and how they choose to modernize their force to meet that threat. Indeed, a rich debate has been ongoing within Australia for some time on how best to ensure the island-continent's security. In the past, and even today, the ADF's force posture and defense decisions have been guided by so called "alliance maximalists"—those that see the Australia-US alliance as key to the country's defense. However, recent geopolitical changes have increased the salience of those that argue for a more "self-reliant" force structure. How this debate unfolds within Australia could have implications for the type of LVC environment the ADF chooses to adopt. Should the ADF's force posture continue to be guided by "alliance maximalists" it is likely that LVC emphasis will continue to be placed on networking—ensuring that a greater number and variety of ADF simulators and systems can link to the US and other coalition partners, in events like Coalition Virtual Flags. However, if those that argue for a more "self-reliant" Australia gain greater traction within the ADF and the Australian defense bureaucracy, one could envision a slightly different LVC training environment taking hold. The ADF may instead seek to prioritize networking across its own force, with emphasis placed on improving its air and naval training ranges to better showcase how the ADF may fight to preserve its "air sea gap."

Overall, it seems likely that the ADF will continue to press forward with its planned LVC training environment. However, the extent to which the ADF re-invents its planned training architecture is fundamentally contingent on how the Australian defense community arbitrates between the differing schools of thought that have shaped its thinking since federation.

CHAPTER FIVE: EXPLAINING LVC ADOPTION BY THE JAPANESE SELF DEFENSE FORCE (JSDF)

Japan has often been presented in orientalist terms as an enigma by Western observers—a country whose decision-making often seems difficult to decipher, let alone comprehend. Writing in the 13th century, Macro Polo wrote a hearsay account of a mysterious archipelagic state "Zipangu"—what he called Japan—that had so much gold, the king could pave the floor of his palace with the material, in addition to fashioning a gold roof. The irony, of course, of Marco Polo's account, was that Japan only produced about 255 tons of gold between the 8th and 16th centuries, an estimated 5 percent of global production.[135] Five centuries later, the first British Minister to Japan, Rutherford Alcock, resolved that,

> *Japan is essentially a country of paradoxes and anomalies, where all—even familiar things—put on new faces and are curiously reversed. Except that they do not walk on their head instead of their feet, there are few things in which they do not seem, by some occult law, to have been impelled by a perfectly opposite direction and a reversed order.*[136]

Prior to WWII, the US was equally at a loss understanding Japanese thinking, assessing that "no rational Japanese could believe that an attack on [the US] could result in anything but disaster for his country."[137] These views were echoed by US allied leaders, like Winston Churchill, and were revealed to be fatally flawed on 7 December 1941—the bombing of Pearl Harbor.[138] In the post war era, little changed. Henry Kissinger, who served as the Secretary of State and National Security Advisor under the Nixon and Ford administrations, "failed," in his own words, "to grasp Japan's unique character."[139] During his time in office, Kissinger struggled to hide his xenophobic disdain for the Japanese, mocking them as "little Sony salesmen," or "small and petty book keepers."[140] To Kissinger, Japan lacked strategic acumen—they could only "think in commercial terms."[141] Indeed, Kissinger's views were so reductive that even Mao Zedong felt compelled to correct him on his analytic shortcomings vis-a-vis the Japanese. It wasn't until years later, when Kissinger was no longer serving in government, that he began to recognize the degree to which he had misperceived Japanese thinking.[142] The Japanese had relentlessly pursued their economic interests, practicing in essence a form of economic realism. Somewhat ironically, Kissinger, the quintessential old-world realist, had failed to see the fundamentally "realpolitik" aspects of Japan's foreign policy. This trend seems to have continued today. A sixteen member-group comprised primarily of former government officials under the leadership of Richard Armitage released a report with the intention of reinvigorating the US-Japan alliance. While the report is fundamentally

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[135] Miyazaki Masakatsu, "The Legend of 'Zipangu,' the Land of Gold," *Nipponia* 45 (15 June 2008).
[136] Ian Nish, *Britain and Japan: Biographical Portraits* Vol. 2 (London, UK: Curzon Press, 1997): 18.
[137] US Assistant Secretary of State Dean Acheson as quoted in Kenneth Pyle, *Japan Rising: The Resurgence of Japanese Power and Purpose* (New York, NY: Public Affairs 2007): 10.
[138] Scott Sagan, "The Origins of the Pacific War," *The Journal of Interdisciplinary History* 18.4 (Spring 1988): 893.
[139] As quoted in Pyle, *Japan Rising: The Resurgence of Japanese Power and Purpose,* 13.
[140] Kissinger hated receiving invitations to the Japanese embassy in DC, complaining that they always served him wiener schnitzel. *Ibid.*
[141] William Burr (ed), *Kissinger Transcripts: The Top Secret Talks with Beijing and Moscow* (New York, NY: W.W. Norton, 1998): 246
[142] Henry Kissinger, *Years of Upheaval* (Boston, MA: Little, Brown, 1982).

prescriptive it also notes, somewhat interestingly, that "the Japanese tend to be adverse to radical change except in circumstances where no other option exists."[143] This statement is at odds with that of other former US government officials, like Zbignew Brzezinski, who bemoaned the Japanese "predilection for abrupt change."[144]

It is through this seemingly contradictory lens that one can best grasp the drivers behind Japanese adoption of synthetic training, and more particularly LVC. Japan, perhaps more so than others, would significantly benefit from the utilization of LVC, and more broadly synthetic training; yet it exhibits a nearly non-existent level of adoption.[145] Adoption capacity theory posits that a country's defense budget acts as one the key factors that will inhibit or drive adoption, but this is not the case with Japan.[146] Japan possesses the world's third largest economy. Its per capita income, relative to other states in the region, like China, leaves a lot of financial power to devote to defense should it find the political will.[147] Even so, while Japan devotes a small portion of its gross domestic product to defense—just 1 percent—1 percent of a large economy is still a sizable amount of defense spending. Indeed, for comparative purposes, Japan has a higher defense budget than Australia, and, as a result, has the financial capacity to pursue LVC, should it choose—yet it has not, unlike the Australians who are high adopters.

Japanese LVC adoption decisions may at first glance appear puzzling or paradoxical, however, Japan's adoption decisions align with other foreign policy and defense decisions that are informed by the country's unique historic legacy—a legacy shaped in many ways by geopolitical circumstances. Drawing on interviews with American contractors tasked with provisioning synthetic training for US and Japanese forces stationed in Japan alongside primary and secondary source documentation, this chapter proceeds in three parts.[148] It first provides an overview of the JSDF's adoption of synthetic training across its three services. It then evaluates the diffusion literature to identify the causal pathways by which the JSDF may—or may not—have made adoption decisions. As will be shown in the final section's assessment, Japan's LVC adoption decisions to date can primarily be explained via its past geostrategic threat perceptions and its unique relationship with the US. Cultural similarity appears to have no bearing on the JSDF's decision-making.

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[143] Richard Armitage et. a., "The United States and Japan: Advancing Toward a Mature Partnership," *Institute for National Strategic Studies* (2000): 6.
[144] Zbigniew Brzezinski, *The Fragile Blossom: Crisis and Change in Japan* (New York, NY: Harper and Row, 1972): 16.
[145] As will be discussed, the JSDF's severe lack of training range space, procurement of the F-35 joint strike fighter, close relationship with the US, and the added benefit of having an operationally secure training environment via synthetic training, particularly when exercising capabilities that may have offensive implications, would all seem to incentivize higher level of synthetic training and LVC adoption.
[146] Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics.*
[147] Jonathan Caverley and Peter Dombrowski, "Introduction: A Bumpy Road to Normalcy," *Texas National Security Review Policy Roundtable: The Future of Japanese Security and Defense* (1 October 2020).
[148] It was challenging to secure interviews with Japanese government or military officials because of sensitivities on the part of the serving officials. As a result, I was only able to secure one interviewee that worked with a team of officers to answer my questions in a not-for-attribution format. To fill gaps, I opted to interview Americans who were charged with developing and delivering synthetic training for the JSDF. In some ways American interviewees proved more advantageous for the purposes of this chapter as the LVC capabilities on Japanese soil are American LVC capabilities.

The JSDF's Adoption of LVC Training

Simulation has been employed by the JSDF for training since, at least, 1935 when the Imperial Japanese Navy first purchased Link Trainers for pilot training.[149] Since that time, synthetic training has developed, with indigenous companies, such as Mitsubishi, furnishing the services with pilot training simulators.[150] However, writ-large, the use of synthetic training has largely been considered an add-on to training, as live training and exercises tend to be prioritized across the force. Capabilities, like LVC, do not exist within the JSDF, except in a very limited capacity for discrete mission sets, like ballistic missile defense.[151]

The Employment of Synthetic Training Across the Services

The Japanese Air Self Defense Force (JASDF) possesses a sizable training organization, Koku Kyoiku Shudan Air Training Command, with five flying training schools and five aerospace technical schools. The training schools and JASDF training ranges provision the service with the primary, basic, and advanced phases of flight instructions.[152] Pilot training is mainly conducted live, with JASDF estimating that at least 90 percent of its pilot training occurring live.[153] Indeed, as one JASDF official told this author:

> *JASDF tactical fighter aircraft trainings are basically [all] live trainings. The F-15 simulator is used for limited purposes, such as practicing for emergency procedures. Almost all F-15 tactical and combat trainings are conducted live. [Mitsubishi] F-2 simulators are relatively advanced, some tactical trainings can be conducted using the simulator*.[154]

The official went on to explain that the JASDF possesses a very limited number of simulators, which reduces potential training throughput, thereby placing the weight on live training.[155] However, the JASDF is in the process of equipping its future F-35 Joint Strike Fighter squadron, which could signal a shift towards more virtual and constructive pilot training. Indeed, JASDF officers note that the training for the F-35 is currently under review by the JASDF. Military officials assume that the JASDF will likely follow the US lead and adopt a similar training ratio (i.e., 50 percent live, 50 percent synthetic) for the F-35. More virtual training via simulators is not indicative of distributed mission training or LVC, however. For the JASDF to link simulators together for collective training, they would need some sort of distributed mission operations network, which does not presently exist.[156] Additionally, they would need to invest in developing interoperability between live and synthetic assets, which is not an easy technical task.

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[149] Chinyung Jeon, "Technologies of the operator: engineering the pilot in the U.S. and Japan, 1930-1960," *Dissertation submitted to the Massachusetts Institute of Technology, Program in Science, Technology, and Society* (2010): 64.

[150] Mitsubishi created its first simulator in 1962 for the F-104J Starfighter. The company now provides the JSDF a range of full flight simulators and fixed-base flight training devices. "Mitsubishi – Flight Simulators and Flight Training Devices," *Jane's Simulation and Training Devices,* 18 March 2020.

[151] However, this does not mean that LVC does not exist on Japan's sovereign territory. As will be shown, one of the most advanced LVC ranges is in Japan under the auspices of the US Forces Japan.

[152] "Japan- Air Force," *Jane's Sentinel Security Assessment.*

[153] Interview with Japan Air Self Defense Force official, 17 February 2019.

[154] *Ibid.*

[155] *Ibid.*

[156] Potential exist for the JASDF to develop that capability in the future, particularly as the service is in the process of developing their own air operations center. Interview with Ronald (Scott) Hamman, 16 April 2020.

More recently, the JASDF has demonstrated a limited LVC training capability via its Japan Aerospace Ground Environment (JADGE)—a command and control system for ballistic missile defense. While JADGE acts as the JASDF's integrated air defense system, it also includes a simulated training function for weapons controllers and operational-level staff tasked with air defense operations planning.[157] This training function can link into a limited LVC environment for training purposes. Indeed, in broader ballistic missile defense capability tests, live targets were launched from live aircrafts, which were subsequently detected by radar and sensor systems, with JADGE simulators calculating a potential (virtual) interception plan. JADGE simulators can also link to Aegis and Patriot ballistic missile defense simulators, training need dependent.[158]

Much like the JASDF, the Japanese Ground Force (JGSDF) primarily trains in a live environment—at home in training ranges like Yausubetsu Hokkaido or via multilateral exercises within its near-abroad. However, range space limitations associated with population density and noise restrictions are increasingly pushing the JGSDF to explore synthetic training solutions, to include virtual and constructive command post exercises and training simulators.[159] Indeed, the JGSDP utilizes the US Warfighters Simulation (WARSIM) as its command post exercise driver. WARSIM can simulate friendly and adversarial forces to drive reactions among command and control operators in a large spectrum of conflict, from peacekeeping to high-intensity operations.[160] The Army additionally employs simulators to meet many of its pilot training needs, to include flight and weapons simulators for platforms like the Fuji built Bell-AH1S Huey Cobra attack helicopter.[161]

While the Japanese Maritime Self Defense Force (JMSDF) operates a robust training program—complete with four primary service training schools which teach a variety of skills, from navigation, to flight, weapons operating, among other competencies—the service struggles with provisioning sea-training. Indeed, Japan's large volume of maritime commercial trade severely constrains opportunities to train at sea, particularly in the shallow-waters that are necessary for minelaying, minesweeping, and submariner training. As a result, training days are typically scheduled during the fishing low-season, accounting for about ten training days throughout the year.[162] Despite the limited amount of training days, the JMSDF does not necessarily employ synthetic training to fill potential training gaps. While simulators are used for flight training for service platforms (i.e. air rescue simulators, etc.), interviewees mentioned that to the best of their knowledge they could not identify any virtual or constructive systems that the JMSDF may use across the service.[163] Yet, even without service specific synthetic training capabilities, the JMSDF

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[157] "Japan Aerospace Defense Ground Environment," *Jane's C4ISR & Mission Systems: Air,* 13 March 2020.
[158] Interview with Japan Air Self Defense Force official, 17 February 2019.
[159] "Japan-Army," *Jane's Sentinel Security Assessment- China and Northeast Asia.*
[160] Ronald (Scott) Hamman, 16 April 2020. Of note, the US Army is now replacing WARSIM with their Synthetic Training Environment program. Maria Gervais, "The Synthetic Training Environment Revolutionizes Sustainment Training," *US Army,* 23 August 2018, https://www.army.mil/article/210105/the_synthetic_training_environment_revolutionizes_sustainment_training.
[161] "Mitsubishi Flight Simulators and Flight Training Devices," *Jane's Simulation and Training Systems.*
[162] "Japan-Navy," *Jane's Sentinel Security Assessment- China and Northeast Asia* and interview with Pacific Air Forces training provider, 20 April 2020.
[163] "Mitsubishi Flight Simulators and Flight Training Devices," *Jane's Simulation and Training Systems*; interview with Pacific Air Forces training provider, 20 April 2020; interview with Brent Johnson, 22 April 2020; and interview with Brig Gen (ret.) Barry Barksdale, 23 April 2020.

does participate in the US Navy led Fleet Synthetic Training exercises that allows US forward deployed guided missile destroyers to train alongside JMSDF destroyers in a synthetic ballistic missile defense exercise.[164]

The Use of Synthetic Training at the Joint Level

The JSDF has historically struggled to operate as a joint force. Indeed, each service has its own entrenched service specific mindset and doctrine, which has caused disparities in terms of terminology, codes, and communication systems across the force. In 2006, the JSDF implemented a joint operational structure—to include a Joint Staff Office—to help alleviate these problems and boost interoperability across the force.[165] As a result, emphasis has since been placed on joint exercises, and documents, like the *Medium-Term Defense Program (FY 2019- FY2023)* indicate that joint training should become increasingly tailored and visible.[166] While synthetic training will not necessarily boost the visibility of joint exercises, it is no surprise given the JSDF's increased emphasis on joint training that the force recently procured the US Joint Theater Level Simulation (JTLS) system.[167] JTLS is a hex based simulation that models joint and combined forces with a focus on theater level operations. JTLS is often used in a distributed environment, where participants typically sit at workstations, where they can view the ongoing battle and enter orders into the simulation. The simulation integrates the air, land, and sea environment into a single simulation that includes logistics, intelligence, and special operations forces. Military operatives can train for a range of military operations, to include grey zone operations, a key focal area of the JSDF.[168] To better expose the JSDF to the JTLS theater level simulation suite, the US incorporated the product into the 2019 Pacific Sentry exercise with a co-chaired exercise control led by a US 0-6 (colonel) and a Japanese equivalent.[169]

The Presence of LVC Capable Training Ranges on Japan's Territory

However, this is not to say that Japan does not have LVC capabilities on its territory. Japan is host to LVC capable ranges, but those bases (and the associated range space) are owned and operated by the US. In 2015, the US Air Force linked its distributed mission operations network (DMON) to the Misawa Air Base in Japan, allowing airmen located in Japan to train in a virtual environment with pilots at Tinker and Elmendorf Air Forces Bases, located in Oklahoma and Alaska,

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[164] Commander, Destroyer Squadron, "US Forces, JMSDF Complete Synthetic Training," *US Navy Public Affairs,* 2 March 2016, https://www.public.navy.mil/surfor/cds-15/Pages/US-Forces,-JMSDF-Complete-Fleet-Synthetic-Training-.aspx.

[165] "Japan- Armed Forces," *Jane's Sentinel Security Assessment- China and Northeast Asia,* 6 March 2020.

[166] Ministry of Defense, "Medium Term Defense Program (FY 2019- FY 2023," *Japanese Government* (18 December 2018): 31.

[167] Interview with Ronald (Scott) Hamman, 16 April 2020. For more on the JTLS, see Bill Robinson, "United States Joint Forces Command Joint Warfighting Simulation Support to Homeland Security and Defense," (Briefing Document for Joint Forces Command, 3 March 2003), Robert H Bolling, "The Joint Theater Level Simulation in Military Operations Other Than War," *Proceedings of the 1995 Winter Simulation Conference* (1995): 1134-1138, and David Prochnow and Jonathan Roberts, "The Use of Joint Theater Level Simulation (JATLS) with the High Level Architecture (HLA) to Produce Distributed Training Environments," *Simulation Interoperability Standards Organization Simulation Innovation Workshop Paper* (2000).

[168] For more on Japan's approach to grey zone operations, see: Sugio Takahashi, "Development of gray zone deterrence: concept building and lessons from Japan's experience," *The Pacific Review* 31.6 (2018): 787-810.

[169] Interview with Ronald (Scott) Hamman, 16 April 2020.

respectively.[170] By 2018, these capabilities were expanded, as US Air Force crew members located at Misawa were able to remotely participate via virtual cockpits in the US Air Force's ongoing LVC Red Flag Alaska exercise at the Joint Pacific Alaska Range Complex range.[171] In 2020, Misawa became the third LVC capable US Air Force—the first located outside the US. The Draughon training range associated with Misawa Air Base has been upgraded with threat emitters that produce a realistic constructive environment by simulating surface-to-air missiles among other threats for pilots that are live flying within the range. As a result, pilots live flying in Draughon can train alongside virtual pilots located in at Tinker (or elsewhere), while additional aircraft or threats can be injected into the scenario via computer-generated means to add greater complexity. The addition of these capabilities has led some airmen to label the Draughon Range as "the premier range in the Western Pacific" and the "best thing outside of Nellis [Air Force Base] or [the Joint Pacific Alaska Range Complex]."[172] JASDF airmen are able to benefit from these capabilities, as both US and Japanese warfighters are co-located at Misawa. The base will also serve as the home of the JASDF F-35 fleet.

Identifying the "Why" Between the JSDF's (Lack of) LVC Training Adoption
The drivers behind the JSDF's lack of adoption of LVC could seem, at first glance, challenging to ascertain. Contrary to some theories of diffusion, like adoption capacity theory, Japan is a low adopter of LVC and synthetic training more generally. As will be shown, the JSDF's adoption decisions is primarily a function of the country's unique geopolitical outlook—a legacy shaped in many ways by both its geography and history—and its relationship with the US.

Alternative Hypotheses	Evidentiary Threshold: Process Tracing Test
One: Presence of Geo-Strategic Competition	Hoop (geo-strategic competition matters in the JSDF adoption decisions, but it appears to counterintuitively be driving non-adoption)
Two: Organizational Propensity for Reform	Does not pass either evidentiary threshold
Three: Presence of High-Level Champions	Hoop (Lack of champions, lack of adoption)
Four: Military-to-Military Contact	Hoop test (LVC assets in Japan are US LVC assets)
Five: Cultural Similarity	Does not pass either evidentiary threshold

Table 6: Explanatory Value of Alternative Hypotheses to the JSDF

Hypothesis One: States that live in regions of intense geo-strategic competition will adopt synthetic training at a higher rate

An archipelagic nation-state located at the eastern edge of Asia, Japan abuts Russia's sea access in the North and then stretches down past the Korean Peninsula to China's Pacific Ocean approach in the South. Composed of four main islands—Hokkaido, Honshu, Skikoku, and Kyushu—and over sixty-eight hundred smaller islands, Japan's land territory is slightly smaller than Norway.

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[170] Johan Pirot and Louis G Hodges, "Enhanced Mission Record and Review System for Distributed Mission Operations," *Interservice/ Industry Training and Education Conference* No. 9351 (2009): 1.
[171] "US Misawa Air Base Pilots in Japan join live RED FLAG Alaska Mission from virtual cockpits," *Northrop Grumman Newsroom,* 2 November 2018, https://news.northropgrumman.com/news/releases/us-misawa-air-base-pilots-in-japan-join-live-red-flag-alaska-mission-from-virtual-cockpits.
[172] Jennifer Hlad, "Range Roving," *Air Force Magazine,* 1 April 2020, https://www.airforcemag.com/article/range-roving/

However, the archipelago's exclusive economic zone covers 2.8 million square miles, making it the world's sixth largest state in terms of overall maritime territory.[173] Japan's archipelagic geography has shaped Japanese strategic thinking, decision-making, and more recently its defense force posture. Indeed, in the mid-2000s then- Japanese Ambassador to the US, Okazaki Hisahiko, when queried by an American journalist as to whether there were any foundational principles underlying Japanese foreign policy, responded in the following terms, "The histories of our two countries are different. Your country was built on principles. Japan was built on an archipelago."[174] Japan's need to secure trade and access to its constellation of islands has historically instilled its security managers with a certain sense of vulnerability. Japan, as a resource-poor country, is deeply dependent on the security of its sea lanes—from access to energy and raw materials to food sources. Indeed, Japan suffers from the infamous "Malacca dilemma," based on its vulnerability to sea routes. While some countries, post industrialization, may be able to turn inwards and adopt more autarkic or isolationist policies when it best suits them, Japan does not have that luxury.[175] Instead, Japanese leaders have developed an acute sensitivity, and an unabashed realism, when adapting to shifts in the international balance of power, particularly when applied to its near abroad.[176]

While traditionally realist policies have been equated with policies built around military power, Japan throughout the Cold War took a different tact—one based around economic realism. Throughout the Cold War, the Japanese government largely dismissed threat perceptions as the structural basis for defense planning—a direct military threat to Japan was deemed by government officials to be an unlikely danger to the archipelagic state.[177] Instead, government officials largely focused on curbing the expansion of Japanese military capabilities, while working to reduce the influence of the defense community in policymaking.[178] As a result, the Japanese political elite channeled their diplomatic ambitions in the form of an outward-looking economic strategy. They became, over the course of several decades of sterling economic growth, a great maritime trading state. The Japanese appeared to systematically subordinate their grand strategy to the advancement of their own economic interests rather than to the consolidation of hard power.[179]

However, more recently, Japan's approach to foreign policy has changed and, in the words of some academics, undergoing a "security renaissance."[180] As will be discussed, many of Japan's self-binding policies that characterized its defense posture in the post-WWII era have been loosened, reinterpreted, or revised. These shifts can be largely attributed to recent shifts in Japan's threat

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[173] Andrew Oros, *Japan's Security Renaissance: New Policies and Politics for the Twenty-First Century* (New York: NY, Colombia University Press, 2017): 11.
[174] As quoted in Pyle, *Japan Rising: The Resurgence of Japanese Power and Purpose,* 48.
[175] Caverley and Dombrowski, "Introduction: A Bumpy Road to Normalcy."
[176] For an overview of Japan's realpolitik approach to foreign policy, see: Pyle, *Japan Rising: The Resurgence of Japanese Power and Purpose*, 41.
[177] During that period, Japan did make significant investments in anti-submarine warfare, which was linked to the need to protect sea lines of communications from disruptions caused by military activities, piracy, or terrorist activities. Alessio Patalano, "Shielding the 'Hot Gates': Submarine Warfare and Japanese Naval Strategy in the Cold War and Beyond (1976-2006)" *Journal of Strategic Studies* 31.6 (2008): 859-895.
[178] Sheila Smith, *Japan Rearmed: The Politics of Military Power* (Cambridge, MA: Harvard University Press, 2019): 228.
[179] Japanese bureaucratic elites, as will be discussed, recognized that power is multi-faceted and not solely a function of the military.
[180] Oros, *Japan's Security Renaissance: New Policies and Politics for the Twenty-First Century*.

perception, due to the steady deterioration of its geostrategic environment. Indeed, as former Prime Minister Shinzo Abe has noted,

> *The security environment of Japan is becoming more severe and increasingly uncertain at a pace far faster than what was expected...We are not able to protect Japan from the range of threats if we are thinking only through the conventional lens on the ground, maritime, and air defense categories. We need to identify an ideal form of defense capabilities that is truly needed to protect Japan, rather than developing them along the current path*.[181]

Abe's characterization of Japan's security environment is no surprise. Analysts note that three of the world's "hotspots"—China, Russia, and North Korea—are in Northeast Asia, and Japanese security managers are eyeing their neighborhood with a growing degree of trepidation.[182] In the north, Russian aircraft continue to probe Japan's air defenses, testing JASDF response times (see figure twenty-eight). The Russian military has resumed exercises in Japan's disputed "Northern Territories" or "Kuril Islands" and in August 2019 then Russian Prime Minister Dmitry Medvedev reprised visits to the disputed islands, despite protests from Tokyo.[183] North Korea possesses a stockpile of several hundred ballistic missiles capable of reaching Japan, and Pyongyang has miniaturized nuclear weapons that can be mated to ballistic missile systems.[184] Japanese officials have remarked that the hermit kingdom's claims that they have successfully carried out a thermonuclear test is "difficult to deny" given the estimated yield of the weapon, which the Japanese Ministry of Defense placed at 160kt.[185] Additionally, North Korea is suspected of possessing several facilities capable of producing chemical and biological weapons alongside a stockpile of various agents.[186]

Meanwhile, Beijing's military modernization is part and parcel of what China views as a long-term zero-sum competition for power within the region—a rivalry, which is not only directed at the US, but also Japan. Indeed, in an oft quoted Chinese idiom referring to Japan's position in Northeast Asia, Chinese Communist Party officials have remarked that "two tigers cannot live on one mountain."[187] Over the past decade, the Chinese Navy and Air Force have substantially heightened their activities within Japan's surrounding seas and airspace, including and especially around the disputed Senkaku Islands. In 2018, the JASDF scrambled 638 times in response to Chinese incursions into Japan's airspace (see figure thirteen). Chinese navy vessels, likewise, have encroached into Japanese territorial waters, not only in the vicinity of the Senkaku Islands, but also

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[181] As quoted by Koichi Isobe, "Operational Aspects of Japan's 2018 NDPG," in James Schoff and Sayuri Romei, *The New National Defense Program Guidelines: Aligning the US and Japanese Defense Strategies for the Third Post Cold War Era* (Washington: DC, Sasakawa Peace Foundation, 2019): 7.
[182] *Ibid,* 8.
[183]Ministry of Defense, *2019 Defense of Japan*, 22 and 126 and Jiji Kyodo, "Russian PM Dmitry Medvedev visits disputed island off Hokkaido despite protest from Tokyo," *Japan Times,* 2 August 2019, https://www.japantimes.co.jp/news/2019/08/02/national/russian-pm-dmitry-medvedev-visits-disputed-island-off-hokkaido-despite-protest-tokyo/#.XqIBpS-z10s.
[184] Ministry of Defense, *2019 Defense of Japan*, 21.
[185] Gabriel Dominquez, "Japan MoD increasingly concerned about North Korea's growing military capabilities," *Jane's Defense Weekly* (31 January 2020).
[186] Ministry of Defense, *2019 Defense of Japan* (2019): 97.
[187] Richard McGregor, *Asia's Reckoning: China, Japan, and the Fate of US Power in the Pacific Century* (New York, NY: Viking Penguin, 2017): 3.

around the Kuchinoerabujima and Yakushima Islands.[188] China's irredentist actions in the South and East China Seas are a cause for concern among government officials, with official documents labeling their "unilateral" and "coercive" actions as "incompatible with [the] existing international order."[189]

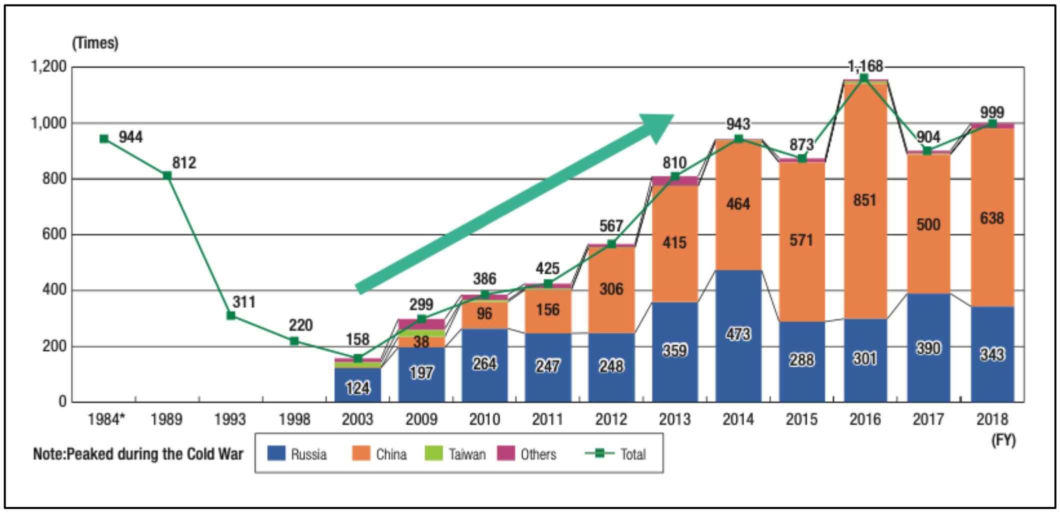

Figure 29: Number and Breakdown of JASDF Scrambles since the Cold War. Figure from Japanese Government, 2019 Defense of Japan (2019): 5

These concerns over aggressive state probing actions are compounded by the emergence of new threats to Japan's sovereign territory, particularly as it relates to China's growing missile arsenal and the addition of cyber and space-based threats.[190] The general deterioration of Japan's security environment has thus engendered a strong amount of pessimism within the Japanese populace. Indeed, in 2018—the first time in fifty years—86 percent of the Japanese populace believed the country might be involved in an armed conflict in the future.[191] Likewise, 85 percent of Japan's population express concern that a territorial dispute will spiral into a full-fledged military conflict.[192]

Japan's changing geopolitical threat calculus has direct ramifications on the evolution of their military force posture. The 2010 revision of the National Defense Program guidelines altered Japanese doctrine from a more "passive" approach to deterrence, centered around the mere presence of armed forces to a far more dynamic approach, based on the demonstration of these military capabilities in action. Three force posture developments were particularly noteworthy under this revision:

1. Japan has worked to strengthen its defense forces in the Southwestern region of the country by enhancing the JMSDF anti-submarine warfare capabilities. Under the National Defense

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[188] Ministry of Defense, *2019 Defense of Japan*, 72.
[189] *Ibid,* 5.
[190] Caverley and Dombrowski, "Introduction: A Bumpy Road to Normalcy" and Ministry of Defense, *2019 Defense of Japan,* 5.
[191] Public Relations Office, Cabinet Office, "Outline of 'Public Opinion Survey of Self-Defense Forces (SDF) and Defense Issues," *Ministry of Defense* (12 March 2018).
[192] "How Asians View Each Other," *Pew Research Center,* 14 July 2014, https://www.pewresearch.org/global/2014/07/14/chapter-4-how-asians-view-each-other/.

Program Guidelines, Japan has expanded its submarine fleet from sixteen to twenty-two boats, upgraded its antisubmarine patrol aircraft, and is introducing an upgraded verision of its *Hyuga*-class destroyer capable of carrying up to fourteen SH-60 patrol helicopters.

2. Japan has sought to strengthen its capability to defend remote islands, by setting up a dedicated amphibious assault unit within the JGSDF. The introduction of the MV-22 Opsrey tilt-rotor aircraft supports this unit, by providing airlift capabilities for personnel, amphibious landing, and assault vehicles. The acquisition of forty-two F-35A fighter aircraft and upgrades to the current F-15 fleet is meant to strengthen Japan's defensive posture in the East China Sea.
3. Japan has worked to enhance its intelligence, surveillance, and reconnaissance capabilities, by upgrading radar facilitates in the Southwestern region of the country, including the westernmost island of Yonaguni. Effort have been made to improve the maintenance infrastructure associated with early warning aircraft operating in the East China Sea.[193]

Furthermore, while Japan still frames the strategic purpose of its military within the context of deterrence and defense, recent and planned acquisitions have more notably offensive capabilities.[194] This has down-flow implications for how training may be imagined or utilized in the future by the JSDF. Indeed, one American training provider noted that as the Japanese begin to consider mission sets that may have offensive implications, synthetic environments may provide a useful medium for experimentation, one equipped with the requisite degree of operational security and stability.[195] Indeed, live exercises, can, in certain circumstances, alert an adversary to the maturation of innovative technologies, concepts of operations, or more tailored force structures. This could provide a potential adversary the needed intelligence to develop countermeasures or, potentially, emulate those innovations within its own force. Should the international system continue to shift in favor of a resurgent or revisionist China or Russia (or if North Korea becomes progressively more belligerent), one would expect a greater uptick in Japanese defense reform, with greater latitude afforded to the JSDF. This could have implications for LVC adoption, as a synthetic environment would allow the JSDF to exercise capabilities and tactical and operational scenarios that may have offensive implications, in a way that does not antagonize neighbors.

However, despite changes in Japan's geostrategic neighborhood, Japan's preference for live exercises over synthetic training may be for precisely the opposite of the reasons mentioned above—*they want to alert potential adversaries to its ongoing military developments*. Indeed, live training and exercises may help bolster potential adversaries' perceptions of Japanese capabilities, and thereby serve deterrence purposes. As Evan Braden Montgomery notes,

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[193] Bjorn Elias Mikalsen Gronning, "Japan's military response to a shifting strategic environment," *Stichting Atlantische Commissie* 38.5 (2014): 10.

[194] The 2018 *National Defense Program Guidelines* and the *Medium-Term Defense Program* highlight a range of offensive weapon systems, to include standoff missiles, joint strike missiles, anti-ship cruise missiles, a domestic hypersonic boost glide system and a hypersonic propelled scramjet system, offensive cyber capabilities, counterspace capabilities, and the conversion of their helicopter carrier to an aircraft carrier. While the conversion of the Izumo-class carrier is not clearly offensive, the media has noted it does have some offensive potential. Eric Heginbotham, "Japan's New NDPG and MTDP: An American Perspective on Operational Issues and Implications," *Sasakawa Peace Foundation USA* (2019): 14.

[195] Interview with Brent Johnson, 22 April 2020.

states often resort to demonstrations of various kinds that are intended, at least in part, to reinforce or improve perceptions of their military power, for the benefit of both adversaries and allies…the credibility of deterrence and assurance depends on military strength, especially in peacetime, and military strength is difficult to judge accurately before conflict breaks out. This gives states a strong rationale to engage in periodic hard power demonstrations.[196]

Japan's dynamic approach to deterrence and its associated force posture reforms are meant to act as signals to potential adversaries or competitors in the region. Recent large-scale exercises, like the drills held in September 2020 that featured over 100,000 personnel seem to fit squarely within this rubric.[197] As Toshiyuki Shikakta, a former lieutenant general in the Japan Ground Defense Force noted, "the joint training is a deterrent, for sure…Japan and the US are conducting this kind of training to show China that they have no chance."[198]

Finally, Mary Kaldor's argument that has argued that a "baroque arsenal" may drive acquisition decisions may be partially explanatory in the case of Japan. During peacetime, the Japanese do not necessarily invest in technologies simply because of the interconnected nature of arms manufacturers and the defense departments, as Kaldor argues. However, the Japanese do not have a strong preference for their indigenous defense industry and there are clear incentives to favor their defense enterprise over foreign alternatives—even when foreign off-the-shelf alternatives exist.[199] So long as an indigenous industry for LVC does not exist, there may not be the same incentives to acquire such a training system. Indeed, to date, it appears Japan's defense industry has focused on stand-alone simulators, like Mitsubishi pilot simulators, versus LVC capabilities. Those events that do have LVC components are often the result of the US and Japan joint training and include US developed synthetic training tools, like JTLS.

At present there is no indication that changing geopolitical circumstances is driving an uptick in synthetic training adoption or LVC. Japan is arguably located in an area of pronounced geopolitical competition, yet, it has chosen to adopt LVC at a low rate. This would seem to imply that this hypothesis fails the hoop test—it is not a necessary factor in Japan's adoption decision-making. However, Japan's perception of its geostrategic environment has arguably changed.[200] Japanese political elite, as will be shown, have pushed forward significant defense reforms in response to what they see as a progressively threatening near-abroad. Japan's choice to *not* adopt synthetic training may be a function of their geopolitical threat environment and their chosen response. Japan uses live exercises as a means of signaling. It is a form of deterrence. As a result, counterintuitively, as Japan's geostrategic circumstances worsen, it may choose to increase live exercises, at the

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[196] Evan Braden Montgomery, "Signals of strength: Capability demonstrations and perceptions of military power," *Journal of Strategic Studies* 43.2 (2020): 311.
[197] Riyaz ul Khaliq, "Japan holds large-scale military drill in 3 decades."
[198] Matthew M Burke and Mari Higa, "Weeks of US-Japan military training neat Mount Fuji winds down with F-35 mission," *Stars and Stripes,* 24 March 2022, https://www.stripes.com/branches/marine_corps/2022-03-24/marine-corps-japan-island-defense-f35-airstrike-practice-5458882.html.
[199] Of note, Japanese companies do possess a significantly close relationship with American firms on co-development and manufacturing of sophisticated weapon systems and platforms. Saadia Pekkanen and Paul Kallender-Umezu, *In Defense of Japan: From the Market to the Military in Space Policy* (Palo Alto, CA: Stanford University Press, 2010.
[200] Fravel, *Active Defense: China's Military Strategy since 1949.*

expense of synthetic training capabilities. This would seem to imply that this hypothesis passes the hoop test, but instead of driving adoption, it is driving what has been labeled in the diffusion literature as "re-invention" or, even a conscious choice of non-adoption.[201] Geostrategic competition is of relevance when seeking to understand Japan's non-adoption of LVC, but it does not necessarily confirm that it will act as a driver for adoption. Indeed, it may be just the opposite. Finally, Mary Kaldor's argument that a "baroque arsenal" may drive complex technology acquisition decisions may hold some weight in the case of Japan, particularly given the state's preference for their own domestic industry, however, there is no explicit evidence that this is the case with LVC.

Hypothesis Two: States that have a propensity for organizational reform within their defense bureaucracies will have higher synthetic training adoption rates.

Scholars that study organizational reform allege that four models can act as a guide when exploring organizational change and adoption—the interservice model, instraservice model, organizational culture model, and civil-military model (the last of which will be covered in hypothesis three).[202] In the case of Japan and its choice, to date, to not adopt LVC, there seems to be a tenuous link, if any between Japan's adoption decisions and these models of organizational reform.

When exploring the impact of interservice rivalry on the JSDF, it is best to start with the historic makeup of the services. Indeed, somewhat surprisingly for an island nation, the JSDF has historically tilted towards its ground forces. Academics have labeled the JSDF "tank based" and alleged that the JGSDF holds a budgetary "stranglehold" over the defense budget.[203] In terms of personnel resourcing, of the 250,000 men and women serving in the JSDF, 150,000 are in the ground forces, while only 46,000 are in both the JASDF and JMSDF.[204] There is some indication this is changing. Japan is slowly shifting its ground forces towards a missile-oriented denial strategy. The JMSDF is the fourth largest navy by tonnage and is seeking to enhance the size of the service via recruitment.[205] The JASDF will also soon host the largest fleet of F-35 fighter jets outside of the US. Like in many democracies, as the JSDF has changed, there has been some bureaucratic infighting both in terms of budgetary allocations, but also relevance. This is perhaps best exemplified through the debates surrounding Japan's Amphibious Rapid Deployment Brigade (ARDB).

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201 Rogers, *Diffusion of Innovations*, 174.

202 Sapolsky, "On the Theory of Military Innovation," 35-39, Rosen, *Winning the Next War: Innovation and the Modern Military,* Farrel and Terriff, *The Sources of Military Change: Culture, Politics, and Technology,* and Posen, *The Sources of Military Doctrine.*

203 Eric Heginbotham and Richard J. Samuels, "Active Denial: Redesigning Japan's Response to China's Military Challenge," *International Security* 42.4 (2018): 164.

204 Roy Hinata-Yamaguchi, "Flying Blind at Sea: Growing Japan's Naval Aviation Capability," *Texas National Security Review Policy Roundtable: The Future of Japanese Security and Defense* (1 October 2020).

205 *Ibid* and Jonathan Caverly and Peter Dombrowski, "A Bumpy Road to Normalcy." On JMSDF recruitment challenges, see Alessio Patalano, *Post-war Japan as a Seapower: Imperial Legacy, Wartime Experience, and the Making of a Navy* (London, UK: Bloomsbury, 2015).

Japan's ARDB is meant to provide the island-nation an amphibious capability for "swift landing, recapturing, and securing in the case of illegal occupation of remote islands."[206] Supporting an amphibious strategy that is clearly focused on China, requires the JSDF to act jointly and within a joint command and control construct, which remains a struggle. For instance, analysts have noted that it is unclear whether the JMSDF and JASDF would be willing to allow the JGSDF to command their units. Trust issues exist between the JGSDF and the JASDF around close air support, with some experts suggesting the F-35 should be assigned to the JMSDF to rather than the JASDF to resolve this problem.[207] However, as the F-35 fleet is currently assigned to the JASDF, it is unclear whether the JASDF would be willing to cede some of their aircrafts to a sister service. More problematically, there is a sneaking suspicion among some senior members of the JMSDF that the ARDB concept is the result of JGSD lobbying, rather than a clear operational need. As a result, the JMSDF remains focused on its traditional support role to the US Navy and has shown little interest in investing in smaller and faster ships for amphibious operations.

Some have attributed the problems around the ARDB to inherent challenges around jointness in the JSDF. As one Japan analyst has noted, "amphibious operations are joint operations, requiring all three services to cooperate and operate in a unified fashion…This lack of jointness is the [J]SDF's most serious deficiency and prevents it from being effective."[208] Indeed, analysts have noted that institutional stove pipes when combined with budgetary infighting have undermined a joint approach. This was echoed by a military official, who noted that,

> *During the drafting process of the 2011 [National Defense Program Guidelines], we decided that [the Ministry of Defense] should follow up each NDPG comprehensively and from a joint point of view, instead of letting each service do what they wanted to do. But the reality is, we still have a hard time adjusting each service's requests and aligning the service plans*.[209]

There is reason, however, to be cautiously optimistic. Some academics have stated that interservice rivalry within the JSDF is *not* more pronounced than among other democracies elsewhere.[210] Moreover, since the mid-2000s, the Japanese defense establishment has undergone a pronounced period of organizational reform—to include creating the National Security Council—so it is only natural that it would experience some growing pains.[211] Each of the services, likewise, have experienced change, both internally, but also in terms of their operational mission sets—like the JGSDF change towards missile-based denial. As the JSDF transitions to embrace these new structural and operational realities, some interservice rivalry is to be expected. However, despite

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206 "Remarks by State Minister of Defense Yamamoto at the Activation Ceremony of the ARDB," *Japan Ministry of Defense*, 7 April 2018.
207 Benjamin Schreer, "Arming Without Aiming? Challenges for Japan's Amphibious Capability," *Texas National Security Review Policy Roundtable: The Future of Japanese Security and Defense* (1 October 2020).
208 Paul Kallender-Umezu, "Japan's Amphib Capabilities Struggle with Rivalries, Budgets," *DefenseNews,* 7 October 2015, https://www.defensenews.com/naval/2015/10/07/japan-s-amphib-capabilities-stuggle-with-rivalries-budgets/.
209 Interview with Japanese Air Self Defense Force Official, 13 June 2019.
210 See Alessio Patalano's remarks on interservice rivalry in Franz-Stefan Grady, "Alessio Patalano on Japan's Growing Naval Power," *The Diplomat,* 4 June 2019, https://thediplomat.com/2019/06/alessio-patalano-on-japans-growing-naval-power/.
211 Smith, *Japan Rearmed: The Politics of Military Power,* 145.

the presence of some interservice rivalry within the JSDF, there is little to indicate that it is driving, or acting as a barrier to, LVC adoption. Indeed, no service has expressed a greater desire for LVC, nor are they attempting to acquire it because another service is adopting it. Even synthetic training, a prerequisite for LVC is not a priority within any service. Moreover, while joint exercises can benefit from LVC, there appears no real hook for it within the joint force. Indeed, apart from exercises with partners and allies, there does not appear to be a well-established joint exercise culture within the JSDF.[212]

Intraservice rivalry, likewise, does not seem to hold weight when trying to assess Japanese adoption decisions. As Japanese services reform and acquire new platforms or update existing capabilities—for instance, the F-35B joint strike fighter and the refurbishment of the Izumo-class helicopter destroyer—potential exists for each service to reimagine how they fight. This could result in infighting *within* each service as different parties in each service work to articulate differing warfighting visions. However, scholars have noted that conceptual and doctrinal foundations have not been articulated for these new assets.[213] Moreover, while LVC can help services experiment and imagine future tactical or operational scenarios, it is not a "platform" that requires new doctrinal foundations. LVC is an enabler—it is a training tool. It is far more likely that as each service acquires new platforms, that associated training capabilities will be considered on a platform-by-platform basis. For instance, as one officer noted, when speaking to me about F-35 specific training,

> *Although…the overall trend is to shift to simulated training, one challenge the JSDF faces is how to quickly ensure funding for its F-35 training program. So far there is no budget allocated for "F-35 specific" education and training systems, and there is a high possibility that it would take [a] few more years to secure the budget.*[214]

Even if the JASDF acquires more simulators to support F-35 training, synthetic training is not LVC. LVC, as described in chapter one, is far more technically challenging and would likely require an even larger budget allocation. Indeed, building an LVC capable range that allows for tethered and untethered operations is complicated. This is not necessarily a capability that a state can "leap-frog" to achieve. Other stepping-stone capabilities, like the implementation a distributed mission operations network may need to be implemented first.

It appears that an organizational propensity for reform has little weight when assessing Japan's adoption of LVC. While some interservice rivalry does exist, there is little information that would causatively link LVC adoption to competition among the services. Intraservice rivalry and organizational culture, similarly, do not seem to be acting as a barrier to LVC. As a result, it seems clear that this hypothesis fails to pass the hoop test. Likewise, it does not pass the straw-in-the-

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[212] Academics have also noted that Japanese exercises tend to be scripted. LVC can support unscripted or scripted exercises, however, for some, like the US, LVC adoption can enhance more unscripted training opportunities. Ben Schreer, "Arming Without Aiming? Challenges for Japan's Amphibious Capability," and Ministry of Defense, "Joint Exercise," accessed 26 May 2022, https://www.mod.go.jp/en/joint-exercise/.
[213] Ryo Hinata-Yamaguchi, "Japan's Defense Readiness: Prospects and Issues in Operationalizing Air and Maritime Supremacy," *Naval War College Review* 71.3 (Summer 2018): 41-60.
[214] Interview with Japanese Air Self Defense Force Official, 17 February 2019.

wind test either, as no organizational theory seems to be driving the adoption or non-adoption of LVC.

Hypothesis Three: States that have high-level "champions" for synthetic training either at the Chief of Service level or upper tiers of the defense bureaucracy will choose to adopt synthetic training at a higher level.

Organizational or institutional change within Japan can often be attributed to high-level champions among the political elite. More so than elsewhere, Japanese foreign policy practitioners have traditionally been granted a fair degree of autonomy, in part because Japanese culture allows for a certain popular deference toward expert civil servants.[215] While Japan's international behavior can largely be attributed to strategic deliberations among the state's leadership, those decisions are often dictated by the shifting dynamics of the international environment. As Kissinger remarked, "it seemed as if Japan had a finely calibrated radar that enabled it to gauge the global balance of power and to adapt its institutions to its necessities, confident that no adaptation could disturb the essence of Japanese society."[216]

This nimble ability to grasp the plasticity of the international environment can be traced back to the Meiji Restoration. Commodore Perry's forceful opening of Japan in 1853 created the political conditions for the demise and overthrow of the Tokugawa shogunate in 1868. Led by young samurai, the new Meiji leaders, motivated by values foundational to Japan's feudal period—power, realism, and respect for hierarchy—sought to remake their homeland to better ensure its security against Western imperialism. To them, success in foreign policy was contingent, first and foremost, on a sustained effort toward domestic renewal. The Meiji leaders' championing of Western institutions, for nippon aims, motivated them to dismantle traditional Japanese organizations that appeared to stand in the way of Japan's recast agenda.[217] This strategy fundamentally differed from the approaches adopted by other Asian states that chose to maintain their institutions and cultural practices often leaving them vulnerable to Western imperialist predation.[218] The nationalist ideology that undergirded Meiji decision-making set the course for the blossoming of a darker brand of Japanese imperialism and Japan's rise to great power status in the early 19th century.

After Japan's unconditional surrender post WWII, Yoshida Shigeru took up the pragmatic and realist legacy of Japan's former Meiji leaders—albeit without the more combative nationalism that had characterized the thought processes of his forebears. Serving concurrently as prime minister and foreign minister in the first decade after the war, Yoshida's decisions, more so than any other post-war leader, forged Japan's role within the international system. In brief, Yoshida took a two-pronged approach to Japan's foreign and defense policy. First, Yoshida sought to rehabilitate Japan's reputation within the international community. To convince the world that Japan had changed and was committed to a more peaceful form of international engagement, Yoshida aligned Japan closely with the United States—the world's new hegemonic power. Additionally, he

[215] Pyle, *Japan Rising: The Resurgence of Japanese Power and Purpose,* 23.
[216] Henry Kissinger, *White House Years* (Boston, MA: Little, Brown, 1979): 323.
[217] Pyle, *Japan Rising: The Resurgence of Japanese Power and Purpose,* 24, 75-77.
[218] See, for example: Julia Lovell, *The Opium War: Drugs, Dreams and the Making of China* (New York, NY: The Overlook Press, 2011).

eschewed military rearmament, recognizing that remilitarization would be deeply divisive among the Japanese people and the international community.[219] Article Nine of the Japanese Constitution allowed Yoshida to structure the recovering nation's grand strategy around a policy of economic realism by preventing Tokyo from establishing an actual military. Article Nine thus states:

> *Aspiring sincerely to an international peace based on justice and order, the Japanese people forever renounce war as a sovereign right of the nation and the threat or use of force as a means of settling international disputes. In order to accomplish [this] aim…land, sea and air forces, as well as other war potential, will never be maintained. The right of belligerency of the state will not be recognized.*[220]

As a result, since the Constitution's implementation, Japan's strategic choices have been defined by a political tug of war related to the Article Nine's interpretation. Indeed, Article Nine underlies a series of Japanese military policies, that some academics have labeled as the "Nine Nos." These policies were designed to avoid Japanese entanglement during the Cold War, and included:

1) No overseas deployment of JSDF;
2) No participation in collective self-defense arrangements;
3) No power projection capability;
4) No nuclear arms;
5) No arms exports;
6) No sharing of defense related technology;
7) No more than one percent of gross national product for defense expenditure;
8) No military use of space; and
9) No foreign aid for military purposes.[221]

In many ways, Article Nine has acted as a normative constraint on Japan's military development, as it cemented a pacifist model for the country's postwar development.[222] Eradicated from the Japanese lexicon of military policy were words related to war and the military. Words such as *senryoku* (war potential), *senkan* (battleships) and *guntai* (military forces) were eschewed in favor of terms that semantically ingrained self-defense within the political apparatus.[223] The Japanese

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[219] Yoshida opted to structure the recovering nation's grand strategy around a policy of economic realism. Japan's diplomatic efforts would thus be channeled almost entirely towards economic recovery, with the hope that Japan's revived economic power would act as the principal vehicle for its international engagement. The policies that Yoshida championed—which later became known as the *Yoshida Doctrine*—guided Japan's foreign and defense policy throughout the Cold War. While Yoshida was against Japan's remilitarization post WWII, he was not a pacifist. Yoshida was a nationalist and believed that once Japan economically recovered, Japan would rearm. Policies that were put in place by his successors under the mantel of the Yoshida doctrine largely prevented that. Pyle, *Japan Rising: The Resurgence of Japanese Power and Purpose,* 238- 247.
[220] Prime Minister of Japan and His Cabinet, "The Constitution of Japan," *Government of Japan* (3 May 1947), retrievable at: https://japan.kantei.go.jp/constitution_and_government_of_japan/constitution_e.html.
[221] Kenneth Pyle, *Japan in the American Century* (Cambridge, MA: Harvard University Press, 2018): loc. 4511.
[222] Peter J. Katzenstein, *Cultural Norms and National Security: Police and Military in Postwar Japan* (Ithaca, NY: Cornell University Press, 1996) and Thomas Berger, *Cultures of Antimilitarism: National Security in Germany and Japan* (Baltimore, MD: John Hopkins University Press, 2003).
[223] Smith, *Japan Rearmed: The Politics of Military Power,* 28.

Diet, additionally, deliberately limited the political power of the JSDF, ensuring the military exerted little to no influence over policy.[224]

Despite the oversized historic influence of the Japanese elite on foreign and defense policy, they do not always have free reign to shape those policies as they see fit. Other members of Japan's foreign policy elite—particularly the Diet— can intervene to hamper reform. Indeed, it seems that it is only when various external circumstances combine to create a clear and demonstrable need for change, that Japanese leaders can effectively champion and drive through institutional or organizational reform. For instance, shortly after President Richard Nixon articulated the Nixon Doctrine in 1969—arguing for greater burden sharing between the US and allies—then-director general of the Japanese Defense Agency, Nakasone Yasuhiro began to argue more forcefully in favor of an increasingly autonomous JSDF posture. While proposing a more autonomous defense posture was not politically problematic or new, Nakasone's willingness to push back against the fourth principle of Japan's 1957 Basic Policy on National Defense—which was the foundational bedrock of Japan's reliance on the US for its security policy—caused significant political controversy. Openly advocating for a dilution of Japan's strategic dependence on the US appeared too controversial for the Diet at the time. Nakasone's tenure proved short lived— lasting only eighteen months. His successor, Masuhara Keiichi, upon taking office set aside Nakasone's ambitions.[225] Likewise, in the late 1970s, when then-Chairman of the Joint Staff Council, General Kurisu Hiroomi argued that Japan needed to think more strategically about how they may employ the military to fight in a time of high-end conflict, he was summarily fired. By being so outspoken, he was also accused of challenging civilian control of the JSDF. Despite broad-based defense agency support for Kurisu, his championing of a more forward-leaning and tactically flexible JSDF proved politically unpalpable to the Japanese administration of the time.[226]

The 1990s laid bare the Japanese government's lack of attention to military mobilization and readiness. From the Persian Gulf War to Japan's more active role in peacekeeping, Japan's tentative moves toward a more proactive external security policy demonstrated that the JSDF was still largely underprepared to take on a more international role. The legal constraints placed on the JSDF prevented the force from adequately performing its assigned missions.[227] While a growing awareness of the excessive nature of some of these limitations did in many ways act as an impetus for reform, it was the changing geopolitical environment that provided Japanese leadership some room to champion change. Recent reforms since the mid-2000s have heralded a

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[224] The original agency responsible for defense, the Defense Agency, was not afforded ministerial level powers. In 2006, the Diet passed laws that changed the Defense Agency to a cabinet-level Ministry of Defense. The change was implemented in 2007. Ministry of Defense, "About Ministry," *Government of Japan,* accessed 26 April 2020, https://www.mod.go.jp/e/about/.

[225] Smith, *Japan Rearmed: The Politics of Military Power,* 38-39.

[226] Upon the General's departure he was greeted with full honors. *Ibid,* 49.

[227] While this partially can be attributed to a strong pacifist strain of thought within Japan and the Yoshida doctrine, it is also a function of the various legal interpretations of civilian control of the military. Article 66 of the constitution does not provide guidance on how civilians should maintain control of the military, beyond noting that the cabinet should be composed solely of civilians. Japanese legislators have interpreted this to mean that the military should operate as far from the legislature as possible—they should not testify in parliamentary proceedings or parliament. While this is starting to change as retired military personnel have now been invited to testify, the chasm between civilians and military operatives can cause defense policy to be devoid of JSDF strategic needs. *Ibid,* 148.

"security renaissance"—albeit an incremental one.[228] Indeed, with the exception of Japan's moratorium on nuclear arms, all other policies related to the "Nine Nos" have been recently changed by Japanese leadership.[229] Moreover, since the 2006 Diet vote to elevate the Defense Agency to a cabinet-level Ministry of Defense (MoD), the Japanese government has shown a remarkable willingness to implement organizational reform to enhance the effectiveness of the JSDF—from the creation of a Joint Staff Office, to the MoD integration of all major defense related bureaus to enhance civil-military cooperation, and the 2013 establishment of the National Security Council.[230] The publication of various *National Defense Program Guidelines* have also shown a marked evolution since the mid-2000s, as they have shifted defense policy from one focused on static territorial defense to one centered around developing capabilities to meet the full diversity of threats to the Japanese homeland.[231] In what has been labeled by some academics as "the most profound change that the US-Japan alliance has experienced since its inception at the end of the Occupation," Japan's Cabinet decided in 2014 to allow the JSDF to practice collective defense, thus fundamentally recasting the US-Japanese relationship to a more equitable alliance.[232] Taken together, these shifts demonstrate a willingness by the Japanese political elites to adapt to perceived geopolitical shifts within their region and drive significant change.

Interesting, despite recent reforms, the defensive nature of Japan's military—especially Article Nine of the constitution—was repeatedly highlighted by American training providers as the key Japanese barrier to acquiring more sophisticated synthetic training systems, to include LVC.[233] Their statements were unusual, not least because LVC, as a training tool, can be used for both offensive and defensive mission sets. Indeed, the value proposition of LVC is the same whether a military is training for strategic strike, close-air support, or interdiction. A military postured for defense and deterrence by denial, like the JSDF, can equally benefit from LVC. As a result, Article Nine may be, in the words, of one serving military officer, a "convenient excuse," other more explanatory reasons for the JSDF's non-adoption of LVC must exist.[234]

A better explanation than Article 9 may be the lack of civilian champion within the Ministry of Defense for the technologies. While the most recent Japanese *National Defense Program Guidelines* explicitly mentions the desire to increase simulation usage for training within the JSDF, no additional guidance is provided.[235] Indeed, given the range of ways that simulation can be applied to individual and collective training, the broad nature of the statement within the Guidelines is not necessarily conducive to the development of a procurement strategy or personnel billets tasked with synthetic training adoption and implementation. Moreover, there does not

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[228] Oros, *Japan's Security Renaissance: New Policies and Politics for the Twenty-First Century,* 12.
[229] Pyle, *Japan in the American Century,* loc. 4511.
[230] Smith, *Japan Rearmed: The Politics of Military Power,* 145.
[231] Ministry of Defense, "2019 Defense of Japan," 14.
[232] Cabinet Decision, "Cabinet Decision on Development of Seamless Security Legislation to Ensure Japan's Survival and Protect its People," *Government of Japan* (1 July 2014), retrievable at: http://www.cas.go.jp/jp/gaiyou/jimu/pdf/anpohosei_eng.pdf.
[233] Interview with Ronald (Scott) Hamman, 16 April 2020; interview with Pacific Air Forces training provider, 20 April 2020; interview with Brent Johnson, 22 April 2020; and interview with Brig Gen (ret.) Barry Barksdale, 23 April 2020.
[234] Email correspondence with serving US Navy military officer formerly stationed in Japan, 17 May 2020.
[235] Ministry of Defense, *National Defense Program Guidelines for FY2019 and beyond,* 9.

appear to be a "champion" for synthetic training adoption at the JSDF service chief or joint commander level. Indeed, no synthetic training or simulation strategies exist at the service level.

The willingness of Japanese leaders to drive change within Japan's defense establishment—from the creation of the Joint Staff Office and the establishment of the National Security Council to a change among JSDF tasking to include collective defense—demonstrates that champions can, and do, drive change. It seems clear that the presence of champions within the defense establishment is a necessary factor when driving reform, or adoption. It therefore passes the hoop test. Japan's low adoption of LVC makes sense because Japan does not have champions for LVC.

Hypothesis Four: States that have frequent military-to-military contact will have progressively convergent synthetic adoption rates and strategies.

Military-to-military contact—whether in the form of joint exercises, direct combat observation, or the placement of military officers in foreign military universities, among other activities— has been shown to be a driving factor in diffusion and adoption practices. [236] While the JSDF does engage in military-to-military activities with a range of countries, its relationship with the US is the most influential when assessing JSDF adoption decisions.

JSDF activities with regional partners has undergone a profound uptick—with a range of joint and capacity building exercises occurring each year.[237] In 2015, Japan joined the Malabar series of exercises, which was originally a bilateral naval exercise between the US Navy and the Indian Navy.[238] That same year, the JGSDF participated in the Australian-led Talisman Sabre exercise for the first time.[239] In 2017, the JMSDF and the Canadian Navy inaugurated their KAEDEX series of exercises, which seeks to deepen interoperability and familiarity between the services.[240] The JSDF additionally runs a series of capacity building exercises within the region. Capacity building assistance has been provided to Mongolia, Laos, Vietnam, the Philippines, Myanmar, Thailand, Indonesia, among many other countries.[241] However, despite these ongoing activities, there is little evidence that demonstrates JSDF military-to-military contact with regional partners act as a significant driver (or barrier) for synthetic training adoption—let alone LVC adoption. Japan does not have similar synthetic training adoption strategies to any of its regional partners with which it jointly exercises. Moreover, perhaps except for the Australians, Singaporeans, and French, most regional states do not possess sophisticated synthetic training capabilities, let alone LVC.[242]

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[236] Ryan Grauer, "Moderating Diffusion: Military Bureaucratic Politics and the Implementation of German Doctrine in South America, 1885-1914."
[237] Ministry of Defense, "Joint Exercises," accessed 26 May 2022, https://www.mod.go.jp/en/joint-exercise/ and Ministry of Defense, "Capacity Building," accessed 26 May 2022, https://www.mod.go.jp/en/capacity-building//
[238] Malabar started in 1992. For more on Japan's recent participation, see: Christian Lopez, "Japan takes lead on Malabar exercise with US and India for first time," *Stars and Stripes,* 25 September 2019, https://www.stripes.com/news/pacific/japan-takes-lead-on-malabar-exercise-with-us-and-india-for-first-time-1.600393.
[239] "Japan-Army," *Jane's Sentinel Security Assessment- China and Northeast Asia* (6 March 2020).
[240] "Japan- Navy," *Jane's Sentinel Security Assessment- China and Northeast Asia* and Riszwan Rahmat, "Canada, Japan navies enhance interoperability in South China Sea," *Jane's Navy International,* 18 June 2019, https://www.janes.com/article/89352/canada-japan-navies-enhance-interoperability-in-south-china-sea.
[241] Ministry of Defense, *Japan's Defense Capacity Building Assistance* (2016).
[242] The South Koreans have sophisticated synthetic training capabilities and have used LVC in their own exercises. The JSDF and the South Koreans have participated in US exercises together, for instance, both countries

The most long-lasting and significant military engagement is with the US. Exercises with the US have been ongoing since the 1970s. In 1978, Japan and the US started the Cope North exercises, which were originally structured as a quarterly exercise between the two air forces. Since that time, the exercise has evolved into an annual flight training exercise. The JASDF is also a regular participant in the US-led Red Flag Alaska series of exercises, which combines live and simulated air assets drawn from the US, Japan, the UK, Thailand, and South Korea.[243] Since 1980, the JMSDF has participated in the US-led multilateral RIMPAC exercise, although it has only held an operational role since 2000. Likewise, since 2010, the JMSDF has participated in the US-led "Pacific Partnership" exercises that seek to foster regional engagement, while coordinating the provision of medical care in the event of a natural disaster. Meanwhile, "Resilient Shield" an annual computer-based fleet synthetic training exercises held between the US and Japan seeks to test and align ballistic missile defense training between the two countries' navies. The most recent 2019 exercise also included participation from the US Air Force and the JASDF.[244] The largest and most complex bilateral field training exercise between the US and the JSDF are the "Keen Sword" series of bi-annual exercises. Keen Sword tests the two countries ability to defend Japan within the framework of the US-Japan alliance. The 2018 exercise included 47,000 US and Japanese personnel.[245] Exercises between the US and Japan aim to tackle lingering issues associated with the two militaries' differing doctrine and command styles.

Japan and US joint exercises do create some incentives for the JSDF to adopt US synthetic training tools. Japan is dependent on the US developed JTLS for much of its synthetic training needs, particularly as it relates to command and control. The Japanese purchase these simulation suites with the explicit permission of the US government and American contractors are typically dispatched to assist with the installation of these tools. In joint exercises, the simulation needs of the exercises are similarly supported by US contractors, while the scenario itself is dictated by both US and Japanese leads. While the close US-Japanese defense relationships acts as an impetus for the JSDF to purchase American simulations, it does not, as American training providers noted, act as a driver for broader synthetic training adoption across the force. [246]

Apart from the use of some American synthetic training tools by the JSDF, the unusual nature of the US and Japanese defense relationship may have acted as a broader *barrier* to the adoption of LVC. As Kenneth Pyle notes, "no nation was more deeply impacted by America's rise to world power in the twentieth century and its creation of a new international order than Japan."[247] After

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participated in military drills in Alaska alongside the US; however, relations between the two states are rocky and have soured despite US attempts to ease historical grievances and mistrust. "Japan and South Korea join US military drill in Alaska," *Japan Times,* 5 June 2021, https://www.japantimes.co.jp/news/2021/06/05/national/japan-south-korea-us-military-training/, Kazuhiko Togo, "Japan – South Korea Relations and the Role of the United States on History," in Gilbert Rozman, *U.S. Leadership, History, and Bilateral Relations in Northeast Asia* (Cambridge, UK: Cambridge University Press, 2010): 97-123, and Brad Glosserman and Scott Snyder, *The Japan-South Korea Identity Clash: East Asian Security and the United States* (New York, NY: Columbia University Press, 2015).

[243] "Japan-Air Force," *Jane's Sentinel Security Assessment- China and Northeast Asia* (24 March 2020).

[244] "Japan- Navy," *Jane's Sentinel Security Assessment- China and Northeast Asia* (19 March 2020).

[245] US Pacific Fleet Public Affairs, "US and Japan Kick Off Exercise Keen Sword," *US Navy,* 29 October 2018, https://www.navy.mil/submit/display.asp?story_id=107591.

[246] Interview with Scott Lovelace, 28 April 2020; interview with Ronald (Scott) Hammond, 16 April 2020; and interview with American training provider, 20 April 2020.

[247] Pyle, *Japan in the American Century,* loc. 50.

Japan's crushing defeat in WWII, the US, as a preeminent world power, sought to recast the nation-state in its liberal, democratic mold—installing American institutions and values. Under American occupation, every aspect of the new Japanese state was shaped by the US, from its constitution to women's rights, the economy, education, religion, the written language, state holidays, and even some aspects of familial relations.[248] Even in 1952, when the occupation officially ended, Japan's newly regained sovereignty remained subject to certain conditions. A military alliance was signed the same day, providing the US with long-term access to military bases on Japanese soil.[249]

The US continues to base its troops in Japan, with approximately fifty thousand troops stationed there today under the aegis of US Forces Japan (see figure twenty-nine).[250] This has significant implications for the deployment of LVC training on Japan's sovereign territory. Japan does host some cutting-edge synthetic training capabilities within its borders, however, those capabilities are *US capabilities*.

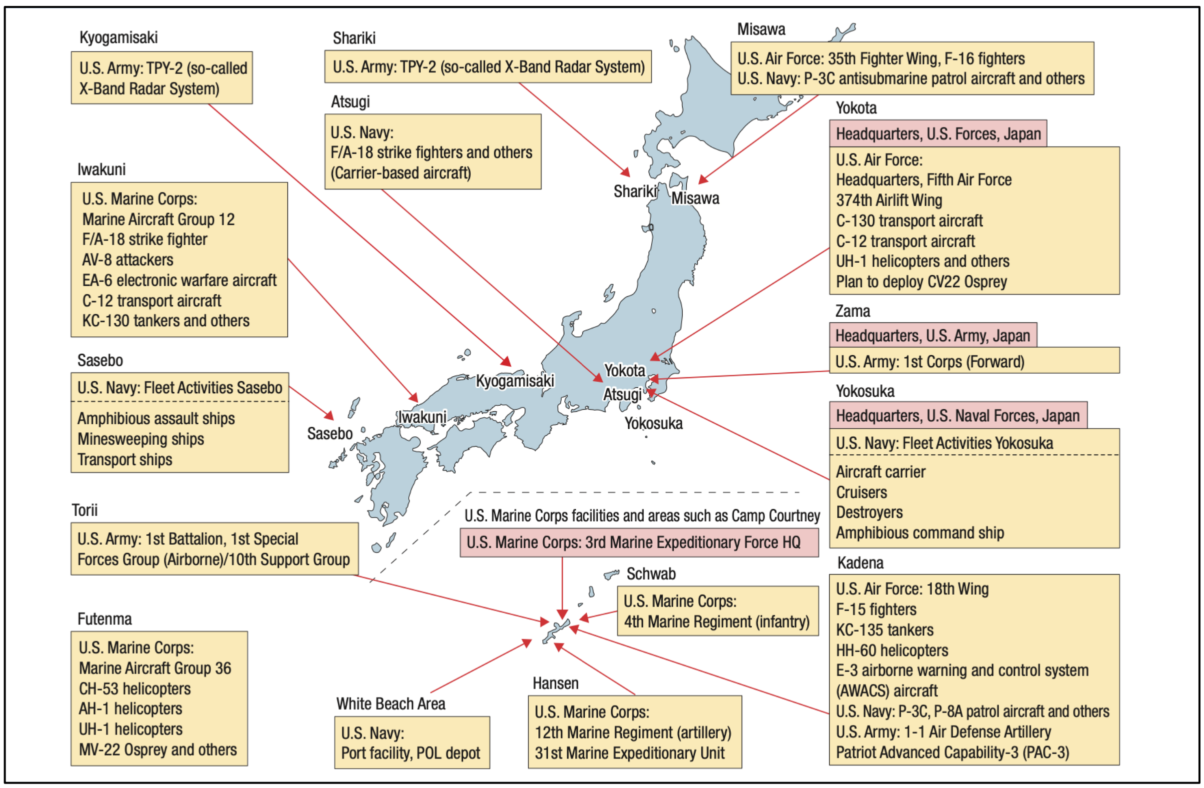

Figure 30: Deployment Map of US Forces in Japan. Image from Ministry of Defense, "2016 Defense of Japan," Government of Japan (2016): 254

As previously mentioned, the US' Draughon LVC training range is located at Misawa Air Base (see figure thirty). Misawa, characterized by US Air Force officials as "the premier range in the

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[248] *Ibid,* loc. 2657- 2749.

[249] When commenting of the nature of the US-Japan alliance, Andrew Oros noted that "*at its core, the alliance is a trade of protection (Japan) for bases (the US)—it is not a trade of like things and thus is by its nature unequal*."[249] Oros, *Japan's Security Renaissance: New Policies and Politics for the Twenty-First Century,* 58.

[250] For more on the debate around the US-Japanese alliance, most notably as it relates to the US military presence in Japan, see: Matteo Dian, *The Evolution of the US-Japan Alliance: The Eagle and the Chrysanthemum* (Oxford, UK: Chandos Publishing, 2014).

western Pacific," is the third LVC-capable US Air Force training range—and the only one outside the US. Misawa was upgraded as an LVC capable range in 2019, allowing aircraft to fly in the base's airspace, drop inert weapons on range, or fly against surface-to-air missile simulators. Those training on the Draughon range can also connect with virtual assets across the US. The constructive element of the range allows for additional aircraft and ground targets to be simulated, adding depth and complexity to training scenarios. [251] US Air Force officials note that by making Draughon LVC capable they have expanded the size of the training range—virtual and constructive assets can be simulated outside the range helping to mimic a far greater live range space. This allows for more integrated training opportunities with the JASDF. Range updates also allow for training scenarios against the JASDF fleet of F-35 joint strike fighters.[252]

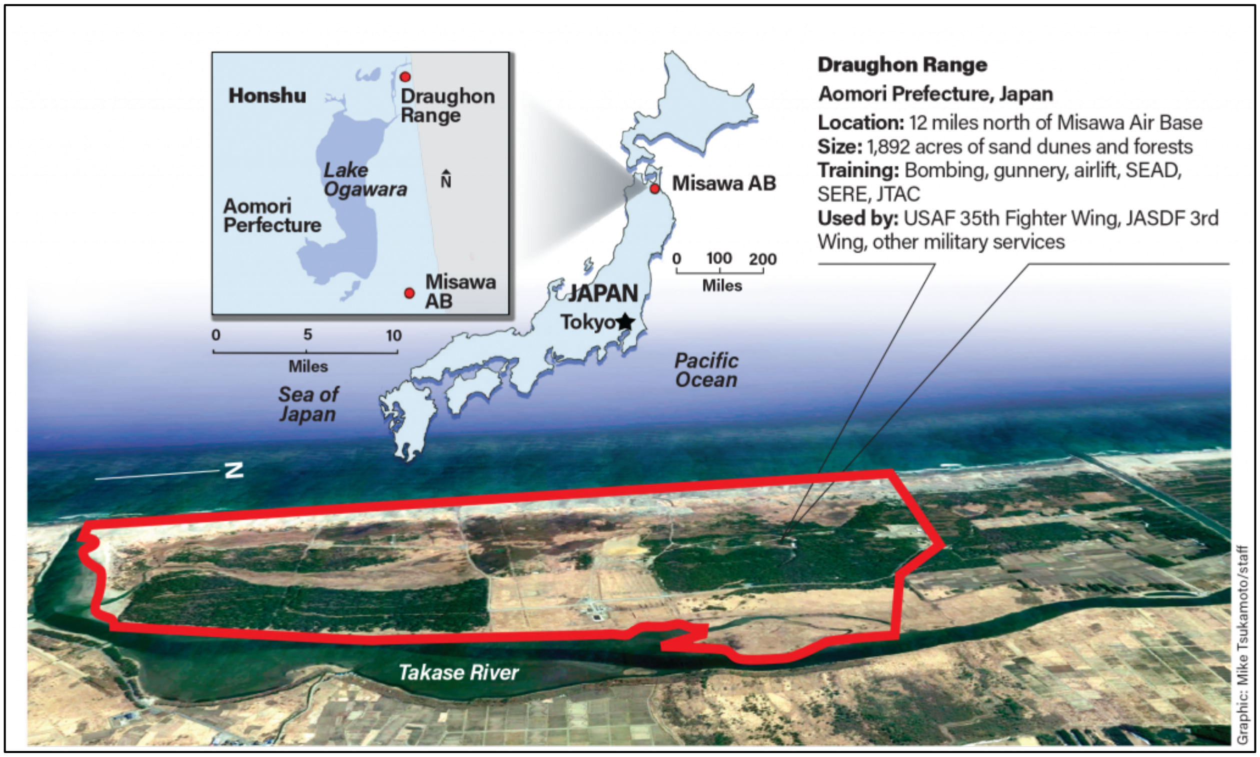

Figure 31: Draughon Range. Figure by Mike Tsukamoto in Jennifer Hlad, "Range Roving," Air Force Magazine, 1 April 2020, https://www.airforcemag.com/article/range-roving/

US military officials continue to see joint US-JSDF training, enabled in part by LVC capable ranges like Draughon, as a key element of the US-Japan alliance undergirding a credible deterrent. Lt Gen Kevin B Schneider, former commander, US Forces Japan, recently noted,

> "High levels of readiness and realistic, high-quality training by Japan's Self Defense Forces and U.S. forces are essential to providing this credible deterrence every day. They ensure that a potential adversary truly believes that the U.S. – Japan Alliance has the proper training, capability, and willingness to defend Japan an that, as a result, aggressive action would be detrimental to the adversary's own

[251] Jennifer Hlad, "Range Roving," *Air Force Magazine,* 1 April 2020, https://www.airforcemag.com/article/range-roving/ and Jennifer Hlad, "Keeping 'the Knife Sharp,' Major Boosts Realism at Japan Range," *Air Force Magazine,* 1 April 2020, https://www.airforcemag.com/article/range-roving/.
[252] *Ibid.*

survival…We have work to do. In practical terms, that means conducting high level, realistic training in Japan…Importantly, we must enhance our live-virtual-constructive, or LVC, training environments here in Japan—cutting edge technology critical to U.S. and Japanese forces achieving the most advanced, the most realistic, and also the safest security, which is absolutely essential to our mutual security. Our ability to conduct this highest quality training in Japan and the continued close cooperation between our forces are fundamental to ensuring the security of the free and open Indo-Pacific."[253]

LVC capable ranges, like Draughon, will continue to provide opportunities for the JASDF to draw on US LVC training. Indeed, As the JASDF and the US Air Force increasingly co-locate their F-35 fleet at Misawa Air Base, it is likely that both services will draw on the Misawa's LVC range capabilities for their training needs. To the extent that the JASDF can take advantage of those capabilities, without investing in them, a disincentive for wider LVC adoption across the force may continue to exist. Conversely, however, there is a chance it may also create the impetus for greater simulation use across the JSDF. Indeed, to the extent that members of the JASDF find that they receive *better* training via LVC, they may emerge as mid-level (and potentially future high-level) champions for adoption within their service. Given LVC is early in the diffusion S-curve and this study explores LVC adoption in-process, it may be worth charting whether JSDF adoption levels change with time as LVC training opportunities increase at Misawa.

US military-to-military contact with the Japanese appears to be a necessary factor in the JSDF adoption of certain synthetic training capabilities—like JTLS. For that reason, it seems to pass the hoop test. However, at the same time, the unique nature of the US and Japanese defense relationship may also be the main reason that Japan, to date, has not adopted LVC. So long as LVC capable facilities are located on Japanese territory an incentive to adopt those technologies may not exist. As a result, the US appears to be a necessary factor in the JSDF adoption and non-adoption decisions.

Hypothesis Five: States will select synthetic training adoptions that mirror the adoption strategies of states that they feel culturally aligned with.

Those countries that were identified as "culturally similar" to Japan in select attribute areas, based on the Hofstede and GLOBE studies, are found below (see table two).[254] These scores serve as a useful basis for cross-cultural comparison, allowing analysts to identify to what extent cross-cultural similarity acts as a factor in adoption decisions.

Study	Attribute	Score	Cultural Similarity	Findings
Hofstede	Power Distance Index	54	Pakistan and Italy	Indicative of pluralistic countries

[253] Kevin B Schneider, "Keynote Speech to the Center for Strategic and International Studies' 2021 Ryozo Kato Award by Lt. Gen. Kevin B Schneider," *Center for Strategic and International Studies,* 2 August 2021, https://www.usfj.mil/Site-Management/SSO-Page-Manager/Speeches2/Article/2716862/keynote-speech-to-the-center-for-strategic-and-international-studies-2021-ryozo/.

[254] Hofstede, *Culture, Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations* and House et. al., *Culture, Leadership, and Organizations: The GLOBE Study of 62 Societies.*

				with decently high levels of equality.
Hofstede	Uncertainty Avoidance Index	92 (112 when controlling for age)	El Salvador and Yugoslavia	Indicative of young democracies; weak citizen interest in politics; higher incidences of xenophobia; and presence of orthodox religions.
Hofstede	Individualism Index	46	India and Argentina	Society values individual initiative, a relative personal dependence on the collective is present.
Hofstede	Masculinity and Femininity	95 (87 when controlling for gender)	Austria	Work is prioritized over quality of life; starker societal views of gender differences.
Hofstede	Long Versus Short Term Orientation	80	Taiwan and South Korea	Strong emphasis on respect for tradition and personal stability.
GLOBE	Performance Orientation Indicator	4.22	Denmark and Ecuador	Innovation is equally weighted against societal and family belonging.
GLOBE	Future Orientation	4.29	Sweden and England	Priority towards longer-term policymaking.
GLOBE	Gender Egalitarianism	3.19	Israel and Ireland	Some women hold positions of power, but firmly skewed towards men.
GLOBE	Assertiveness	3.59	Kuwait and Switzerland	Society tends to view assertiveness as socially unacceptable.
GLOBE	Individualism versus Collectivism	5.19	South Korea and Singapore	Strongly collectivist society.

Table 7: Japan Cultural Similarity Expectations from Hofstede and GLOBE Studies[255]

Given the extreme variation of countries identified as "culturally similar" in key categories to Japan, it seems difficult to closely associate Japan with one or two countries. Indeed, only one country emerges twice between the two indexes—South Korea.[256] Finally, Japan is not part of a multilateral alliance grouping, like the FVEY, that is based on shared ideas or values.

[255] Hofstede, *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations,* 168, 355 and House et. al., *Culture, Leadership, and Organizations: the GLOBE Study of 62,* 129.
[256] Unlike Japan, Korea has adapted American synthetic training tools to their own needs, developing seven unique constructive training models ranging from logistics, to ground, sea, and even the information space. The Japanese have not augmented one US model for the JSDF. Interview with Scott Lovelace, 28 April 2020.

Cultural similarity seems to have no bearing on Japan's LVC, or even broader synthetic training, adoption. Indeed, just as the Hofstede and GLOBE studies confirm, Japan is culturally sui generis. While Japan has absorbed multiple foreign influences in the past, particularly during the Meiji restoration, even today, Japan remains conspicuous for its insularity. Despite pressing demographic challenges—most notably in the form of a rapidly aging population—Japan remains averse to accepting foreign workers, refugees, or even certain forms of foreign investment. For this reason, "cultural similarity" does not seem to be a particularly explanatory factor when considering Japan's LVC adoption decisions.

Finally, Japan is party to the Quadrilateral Security Dialogue, colloquially known as the Quad, that is a loose partnership between the US, Japan, Australia, and India. The Quad is anchored in shared democratic values and is meant to deep economic, military, and diplomatic ties between the four countries.[257] While China has complained that the Quad is acting as an "Asian NATO," no mutual-defense pact exists between the four countries. To date, it does not appear that multilateral institutions, or more specifically the Quad, has acted as a driver for Japan to adopt synthetic training—let alone, LVC.[258]

Cultural similarity, to include alliances or partnerships based on shared normative factors, does not seem to have any impact on Japan's adoption of LVC. As a result, this hypothesis appears to fail both the hoop and straw-in-the-wind test.

Studying in Process Diffusion: The JSDF and LVC Adoption?

Japan's historic experiences in wartime continues to exert a strong influence on Japan's security posture today. As one scholar notes, "contested memories of the Pacific War and imperial Japan, postwar antimilitarist security practices, and the unequal alliance relationship with the United States play an outsized role in how Japan's contemporary decisions are debated and implemented."[259] In many ways Japan's history seems to influence the JSDF's non-adoption of LVC when viewed through the lens of the five alternative hypotheses. While JSDF's adoption decisions do pass various "hoop" or "straw-in-the-wind" tests, because of their history, instead of choosing to adopt, they often, counterintuitively make re-invention or non-adoption decisions.[260]

The two theories that seem to fit this non-adoption or reinvention paradigm are the presence of geostrategic threat perceptions and ongoing military-to-military contact. In both cases, both theories appear to pass the hoop test—they are necessary factors when attempting to explain the JSDF decision-making. Yet, instead of driving adoption, they appear to be driving non-adoption.
Japan's political elite are keenly aware that they live in an area of pronounced geostrategic competition. They have passed significant political and defense reforms in response to changing geostrategic circumstances. Instead of choosing to adopt LVC, it appears that the JSDF has worked to increase the size and uptick of live exercises as they see it as a form of signaling or deterrence.

[257] Walter Lohman, *The Quad Plus: Towards a Shared Strategic Vision for the Indo-Pacific* (New Delhi, India: Wisdom Tree, 2015).
[258] India is also a low-adopter of synthetic training—to include LVC.
[259] Oros, *Japan's Security Renaissance: New Policies and Politics for the Twenty-First Century,* 3.
[260] Rogers, *Diffusion of Innovations*, 174.

Likewise, the unique nature of the US-Japanese military-to-military relationship may also be counterintuitively driving conscious decisions on the part of Japanese military officials towards non-adoption. Under the terms of the US-Japanese military alliance, the US maintains long-term access to military bases on Japanese soil. As a result, one of the most capable LVC training ranges in the world is located on Japanese soil at Misawa, but it is the property of the US military. As the JASDF and the US Air Force increasingly co-locate their F-35 fleet at Misawa Air Base, it is likely that both services will draw on the Misawa's LVC range capabilities for their training needs. As a result, the JSDF may get the LVC training that they need, without the required investment.

Reinvention is a relatively new field of research in the diffusion scholarship, only emerging in the 1970s. Prior to that date, data, like the information above on Japan and their preference for live exercises would likely be disregarded, as it was considered "noise." Diffusion studies simply studied choices to adopt or non-adopt. This is what makes in-process studies of diffusion particularly powerful, as you can get at "why" questions that don't fit traditional models of diffusional scholarship. Continuing to track JSDF decision-making with time can reveal whether re-invention and non-adoption continues to be a conscious choice, which should add to the nascent re-invention literature.

SECTION THREE: THE ADOPTION OF MULTI-DOMAIN TRAINING AMONG US PARTNERS AND ALLIES

Figure 32: US Army Training and Doctrine Command, Augmented Reality Demonstration of Multi-Domain Effects, Image, Author's Own

CHAPTER SIX: EXPLAINING MULTI-DOMAIN TRAINING ADOPTION IN THE ISRAELI DEFENSE FORCE (IDF)

On 6 September 2007, eight fighter aircraft bombed the North Korean-designed Al-Kibar nuclear facility near Deir al-Zor in eastern Syria. After flying north along the Mediterranean coast, the planes turned east, skirting the Syrian-Turkish border, before penetrating Syrian airspace. Just after midnight, the sky over Al-Kibar lit up as a volley of missiles rained down on the facility. The after-effects of the mysterious bombing raid were unusual— suspicion immediately fell on Israel, yet both Jerusalem and Damascus remained silent after the strike. It wasn't until over a decade later that the Israeli government formally claimed responsibility.[261] The other somewhat curious occurrence was the lack of Syrian military mobilization while the strike was ongoing. The non-stealthy Israeli fighters—four F-15 Eagles and four F-16 Falcons—had seemingly slipped past Syria's Russian-built air defense network.

In the years since the successful raid, defense experts have speculated as to how the Israeli Air Force (IAF) evaded Syria's air defense network. Theories exist that the images on the radar screens did not reflect reality; for the Syrian military technicians safeguarding the nation's airspace, the skies over the Euphrates had appeared clear. Indeed, according to some, the air defense network had simply relayed what the Israeli military had inserted via cyber or electronic means.[262] The Syrian Air Defense Force did not fire, as its baffled operators could find no apparent targets to prosecute.

Many hypotheses exist on how Israel spoofed Syria's air defense network. For instance, some hypothesize that a stealthy UAV may have employed remote air-to-ground electronic attack, subsequently transmitting malware through the air defense systems' radio frequency signal.[263] Others conjecture that an Israeli covert agent may have spliced a fiber optic cable connected to Syria's air defense network providing an entry point to hack the system. Another body of observers has speculated that the Russian code controlling the network may have been compromised, or that a "kill switch" may have been embedded in the air defense system for the purposes of sabotage.[264] These theories have gained traction in the cyber community. According to some cyber experts, the IAF's spectacular strike on the Al-Kibar nuclear facility—since named by the cyber community, Operation Orchard—represents the first instance where cross-domain cyber-kinetic interactions were employed to ensure mission success. [265]

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[261] Isabel Kershner, "Ending Secrecy, Israel Says It Bombed Syrian Reactor in 2007," *The New York Times*, March 21, 2018, https://www.nytimes.com/2018/03/21/world/middleeast/israel-syria-nuclear-reactor.html.

[262] David Makovsky, "The Silent Strike: How Israel bombed a Syrian nuclear installation and kept it secret," *The New Yorker*, September 10, 2012, https://www.newyorker.com/magazine/2012/09/17/the-silent-strike, and Richard B. Gasparre, "The Israeli E-tack on Syria – Part II," *Air Force Technology,* 10 March 2008, https://www.airforce-technology.com/features/feature1669/.

[263] Ward Carroll, "Israel's Cyber Shot at Syria," *Military.com,* 26 November 2007, https://www.military.com/defensetech/2007/11/26/israels-cyber-shot-at-syria.

[264] Richard Clarke and Robert Knake, *Cyber War: The Next Threat to National Security and What to Do About It* (New York, NY: Harper Collins Publishers, 2010): 1-8 and Sally Adee, "The Hunt for the Kill Switch," *IEEE* (May 2008).

[265] Max Smeets, "The Strategic Promise of Offensive Cyber Operations," *Strategic Studies Quarterly* (Fall 2018): 90-113, Max Smeets and Herb Lin, "Offensive Cyber Capabilities: To What End?," *2018 10th Annual Conference on Cyber Conflict* (2018): 21, and Thomas Rid, "Cyber War Will Not Take Place," *Journal of Strategic Studies* (2012): 16.

By any standard, the IAF's strike on Syria's covert nuclear facility was a remarkable success—Israel managed to neutralize an existential threat in a way that controlled for escalation. The IAF's operation, named by the IAF Operation Soft Melody, left such a small footprint that it provided Bashar al-Assad, the Syrian President with both deniability and a means of "keeping face"—he did not have to admit Syria was building a nuclear reactor, and therefore, did not feel under pressure to immediately lash out in response.[266] Moreover, if the IAF did manage to successfully integrate cross-domain cyber and kinetic operations in 2007, the strike was a truly significant moment in the annals of warfare. The integration of cyber and kinetic operations is no easy task, and the manifold complications surrounding such complex combat procedures continue to engender vivid debates among even the most cyber savvy of militaries, like the US. As previously outlined in chapter one, the integration of cyber and kinetic operations poses unique challenges—challenges that extend beyond the difficulties inherent to joint operations, ranging from classification concerns to timing and sequencing, authorities, and the inability to precisely predict the effects of a cyber-attack, among other problem areas. To effectively overcome these hurdles, a military would need to address these thorny issues prior to the operation—during the planning, and ideally, training phases. Due to the very uniqueness of cyber, and the difficulty of integrating cyber into a live environment, this would naturally require, as chapter one notes, a synthetic environment. For this reason, it is plausible to assume that if a military or service, like the IAF, successfully integrated cyber-kinetic cross-domain interactions in a military operation, it is likely that they already had the supporting infrastructure—like a multi-domain synthetic environment—to experiment and train for mission success. According to this logic, Israel in 2007 (and arguably even by today's standards) could be one of the most cutting-edge militaries in the world regarding the adoption of a multi-domain synthetic environment.

However, it is also possible that the story is far less complicated than many in the cyber community believe. The IAF may have simply evaded Syria's air defense network through a skillful, but more traditional employment of physical maneuver. Similarly, to the tactics employed to avoid radar detection in the IAF's 1981 raid on Iraq's Osirak nuclear reactor, the IAF in 2007 may have flown extremely low—below 200 feet—while maintaining strict radio silence. Indeed, these tried-and-true tactics have been proven repeatedly effective in the IAF's recent past. In 2003, four F-16s buzzed Assad's summer residence—shattering windows due to the low flight altitude—in the seaside community of Latakia in a blunt signal of intimidation following the death of an Israeli boy under Hezbollah rocket fire. Several months later, the IAF again penetrated Syrian airspace, bombing an Islamic Jihad training base in response to a suicide attack that claimed nineteen Israeli lives. In 2006, after the abduction of Gilad Shalit, an IDF soldier, the IAF again buzzed Assad's summer residence, not-so-subtly reminding the Syrian leader of the personal consequences he may pay for harboring Hamas' leadership in Damascus. Moreover, just prior to Operation Soft Melody, IDF special forces in a pair of Sikorsky CH-53 Sea Stallion helicopters had infiltrated Syrian airspace at night, visiting the site of the nuclear reactor to obtain soil samples. It is entirely plausible given the IAF (and the broader IDF's) now well-honed tactical proficiency in flying uncontested over Syrian airspace that a similar set of operational procedures was employed.[267] A

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[266] This was called "the deniability zone" by the IDF. If Israel managed to stay silent after the strike, Assad may restrain himself, choosing to deny that a nuclear reactor existed in lieu of escalation. Yaakov Katz, *Shadow Strike: Inside Israel's Secret Mission to Eliminate Syrian Nuclear Power* (New York, NY: St. Martin's Press, 2019): 130.
[267] *Ibid*, 160 and 169.

cyber operation—and a multi-domain synthetic support architecture—may not have been used to disable Syrian's air defense network, as it wasn't required. Conventional tactical proficiency likely ruled the day.[268]

To the more skeptically minded strategists and scholars that question the veracity of the rumor that the IDF did deploy cyber operations, the very ambiguity surrounding the mechanics of the 2007 strike served a purpose for the IDF—it acted as a deterrent. Indeed, after the IDF's poor performance in the 2006 Lebanon War, questions surrounding Operation Orchard helped restore the IDF's international military credibility, and more generally its internal mythos. As Eliot Cohen noted, "the Israeli military establishment sort of saw this as an opportunity to restore the kind of picture of a steel hand that reaches out in the middle of the night,"[269] to achieve its own national interest. Thus facilitating (or refusing to correct) a broader narrative that cyber operations were used in an expertly tailored fashion, served geostrategic purposes by enhancing Israel's reputation for warfighting prowess—even if it may not have been entirely accurate.[270]

In summary, it is unclear in the open-source literature whether the IAF exploited the cyber domain (or the EMS) alongside their air operation for mission success. Despite new open-source literature, the operation is still heavily shrouded in secrecy. To the extent offensive cyber tools were used, it is likely to remain heavily classified. However, the questions surrounding the operation (and the support infrastructure that it would naturally require), does seem to indicate that synthetic training adoption by the IDF may be more complicated than one would originally expect. Simple explanations—like those espoused by the cyber community that a cyber strike was employed—are rarely fully explanatory or useful. While Israel is a high adopter of multi-domain synthetic training, it is questionable whether Israel's scoring is as high as the Likert scale employed in this dissertation's case selection reflects.

Drawing on field research in Tel Aviv, the IDF's National Training Center in the Negev, and in Washington DC, this chapter proceeds in three parts. It first provides an overview of the IDF's adoption of synthetic training across the services, to include multi-domain synthetic training capabilities. It then assesses the diffusion literature to identify the causal paths by which the IDF may—or may not—have made adoption decisions. As will be shown in the final section, Israel's ongoing adoption of a multi-domain synthetic training environment can be primarily explained by its geostrategic threat perceptions. Other factors, like organizational agility, military champions, and military-to-military contact have relevance, but do not have the same evidentiary weight.

A note on sources prior to proceeding: the IDF is a notoriously—but understandably— secretive organization. As Yoran Peri notes,

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[268] Or Israel may have simply employed standard electronic jamming tools to blind Syria's air defense network. Makovsky, "The Silent Strike: How Israel bombed a Syrian nuclear installation and kept it secret."
[269] As quoted in Katz, *Shadow Strike: Inside Israel's Secret Mission to Eliminate Syrian Nuclear Power,* 242.
[270] More broadly, given the IDF's interoperability challenges (both cross-domain and combined arms) in the 2006 Lebanon Civil War, it seems reasonable to question whether the IDF successfully overcame those same problems in a strike just one year later. David Johnson et. al., "Preparing and Training for the Full Spectrum of Military Challenges: Insights from the Experiences of China, France, the United Kingdom, India, and Israel," *RAND* (2009): 227 and Raphael D. Marcus, *Israel's Long War with Hezbollah* (Washington, DC: Georgetown University Press, 2018).

> *The all-encompassing nature of war in Israel and the centrality of security to national existence have created a situation whereby numerous spheres…fall within the security ambit and are enveloped by secrecy*.[271]

Even for native researchers, the IDF can be a challenging organization to research. Indeed, it can be difficult to find even simple tables of the organization and equipment for an Israeli armored brigade, let alone information for more classified organizations, such as Israel's offensive cyber organization or Unit 8200. Furthermore, Israelis are notorious for successfully using deception to mislead adversaries about their military capabilities; as a result, such deception can inevitably lead to inaccuracies in scholarly research.[272] Therefore, while pains are taken to ensure that a full and accurate picture of multi-domain synthetic training is presented, it is plausible that other programs may be ongoing that this author is unaware of.

The IDF's Multi-Domain Synthetic Training Environment

While simulation has been in use by the IDF for about the last forty or fifty years, the conception of a multi-domain synthetic environment is a far newer construct.[273] First employed by the IAF for training, simulation (or simulators) have diffused across the services and the joint force for the purposes of experimentation, planning, and training. As a result, synthetic training is well-established across the force.

The Employment of Synthetic Training Across the Services

The IAF is the service within the IDF that has most heavily invested in military synthetic training. To help define training parameters and goals, the IAF has a "Master Plan for Aerial Training," which defines key terms, while also articulating live to synthetic training ratios based on platforms and missions. At present, the live to synthetic training ratio across the service is approximately 85 to 15. The aim, however, is to reach a 70 to 30 live to synthetic ratio.[274]

Platform dependent, the IAF is increasing its usage of synthetic training. The IAF plans to adopt a 60 to 40, or even a 55 to 45, live to synthetic training ratio for the F-35. For remotely piloted aircrafts, the live to synthetic training ratio is 10 to 90. The mission simulators in use by the IAF at their mission training center have reached a very high level of fidelity, mimicking with realism the actual aircraft. As one high ranking IAF official told this author, "the first cockpit in the squadron is the simulator."[275] The importance attributed to training simulators provides an incentive for the IAF to update their simulators in tandem with the actual platform (something that other military forces struggle to achieve). Meanwhile, within the mission training center the IAF has become adept at simulating the enemy battlespace. While the IAF is working to update and improve terrain databases; overall the mission training space is viewed as the only place where the enemy battlespace can be imitated with a high-level of fidelity. For instance, mission dependent, the IAF can inject simulated cyber effects within their simulators, forcing pilots to fight through

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[271] Yoram Peri, *Between battles and bullets: Israeli military in politics* (Cambridge, UK: Cambridge University Press, 1983): 1.

[272] Cohen et. al., "Knives, Tanks, and Missiles: Israel's Security Revolution," *Washington Institute for Near East Policy* (1998): 15.

[273] Interview with retired IDF ranking military officer, Washington DC, 19 September 2019.

[274] Interview with high-ranking IAF officer, Washington DC, 19 September 2019.

[275] *Ibid.*

the attack and maintain mission assurance. The IAF official interviewed was not aware of any joint synthetic training that linked cyber warfighters to pilots.[276] Additionally, the IAF does not perform any “Virtual Flags”—virtual exercises that allow pilots located in simulators (and other airmen) to train together to perform an operational mission solely in a synthetic environment. Interoperability between platforms in a synthetic environment remains an aspiration, but at present many of those opportunities take place live. Indeed, as the IAF official noted, the “live [environment] is where the initial stage of interoperability is taking place…we still need to work out how to talk to each other due to the classification issues, [particularly with the F-35].”[277]

The IDF’s ground forces employ simulated systems across the force from the individual to the headquarters level. The IDF’s National Training Center (NTC) in the Negev desert acts as the main ground forces training institution, providing custom training for each unit—to include LVC training. The NTC includes a fire training center, a tactical training center, a network-based intelligence and strike center (which acts as their key simulation asset), and a logistics training center. Within the NTC there is also urban warfare training, which includes subterranean training tunnels and a “rural village” dubbed Chicago. Participants at the NTS include companies and battalions—either armor or infantry. At the battalion level, an emphasis is placed on jointness and the IAF is always incorporated. Trainers at the NTS view the incorporation of the IAF as of upmost importance as it allows for a “common language” to be employed throughout the force.[278] Additionally, the IDF often creates scenarios in training where systems and platforms fail due to cyber or electronic attacks. The incorporation of these effects is viewed as a realistic and important way to stress warfighters.[279]

Simulators at the NTS are “nested” within each other. For instance, a soldier can train on a tactical fires’ trainer, which will then be reflected in a virtual dome for ISR, and a constructive simulation for C2, allowing all participants to train together in a common synthetic environment. The NTS’ newest virtual training environment depicts the inside of a home in Gaza, complete with a kitchen, living room, and bathroom. The windows look out towards a virtual screen, depicting a virtual battlespace that mirrors the synthetic environment seen in adjacent virtual trainers. Training scenario dependent, loud sounds, vibrations, and smoke can be injected into the home, mimicking an actual urban battle.[280]

At present, the NTC employs a 70 to 30 live to synthetic training ratio, with the hopes of achieving a 60 to 40 live to synthetic training ratio in the future. The drive towards greater synthetic training within the NTC is a largely function of cost—virtual and constructive training is seen as more cost effective than live training. However, those tasked with training feel that cost is not the only factor, as one trainer noted, synthetic training “prepares soldiers for the real thing.”[281]

Like the other two services, the Israeli Navy also employs virtual and constructive simulators in training. The IDF’s submarine unit—Shayetet 7—employs simulators for basic training through

[276] *Ibid.*
[277] *Ibid.*
[278] Interview at the National Training Center, Israel, 14 November 2019.
[279] Interview with retired IDF ranking military officer, Washington DC, 19 September 2019.
[280] Interview at National Training Center, Israel, 14 November 2019.
[281] *Ibid.*

operational missions, allowing troops to train for real-life missions, including those that may involve Israel's (unacknowledged) nuclear deterrent.[282] The multi-million dollar full-motion simulators in use by submariners provide a high-level of fidelity for those tasked with driving submarines, destroying enemy ships, controlling port entrances, or espionage in support of ground combat units. The employment of simulators within the Israeli Navy allows tactical teams of officers and operators to train on shore in an environment that mimics the operational conditions of an actual submarine at sea.[283] Additionally, as the Israeli Navy procures new Sa'ar 6 warships to better defend Israel's strategic maritime assets and sovereignty, new simulators are being acquired in tandem to better prepare the fleet to contribute to the IDF's so-called "campaign between the wars."[284]

The IDF, through its Concept Laboratory—under the Operations Directorate—also employs simulation to better facilitate joint operations across the force. Established in 2006 to serve the IDF's General Headquarters and senior command, the Concepts Laboratory serves as the professional authority for multi-force concept development, decision support, operational planning, and force build-up. Via constructive simulations, IDF and adversary doctrine are modeled and simulated alongside operations research models, allowing the laboratory to test and evaluate new weapon systems, different orders of battle, and divergent planning processes. To better assess and test emerging operational concepts or weapon systems, the IDF takes a comparative approach, running a simulation multiple times, while slightly tweaking variables to assess comparative differences.[285] The joint focus of the Concepts Laboratory does indicate that the IDF is prioritizing the employment of combined operations across the force. However, it is unclear to what extent multi-domain operations (most notably the inclusion of offensive cyber doctrine) are a key facet of those simulations.

When asked directly about the inclusion of cyber operators in training simulations during the IDF's First International Operational Simulation Summit, serving IDF officers demonstrated an understandable reticence to answer questions. They simply noted that the integration of cyber into simulations continues to be a challenge but is something that the IDF is working to resolve.[286] However, secondary sources do seem to provide some indication of where the IDF may stand from an offensive cyber standpoint, and the degree to which the support infrastructure (i.e., a simulated multi-domain synthetic environment) may exist.

The IDF's interest in computers for combat operations began in the 1990s.[287] By 2009 the IDF had declared cyberspace an "operational and strategic warfighting domain" and the following year a

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[282] See: Anna Ahronheim, "Military Affairs: The Simulators training the next generation of navy officers," *Jerusalem Post,* 18 July 2019 and "Israel's Submarine Capabilities," *NTI,* 16 October 2019, https://www.nti.org/analysis/articles/israel-submarine-capabilities/.

[283] Givet Shumel, "DSIT Solutions Successfully Delivers to Israeli Navy the First Stage of the Dolphin Submarine Tactical Trainer Project," *DSIT Solutions,* 12 March 2009, retrievable at: https://dsit.co.il/dsit-solutions-successfully-delivers-israeli-navy-first-stage-dolphin-submarine-tactical-trainer-project/.

[284] *Ibid.*

[285] Col. (res.) Gabi Siboni, "The IDF Concepts Laboratory," (IDF's First International Operational Simulation Summit, Tel Aviv, Israel, 12 November 2019).

[286] "Supportive Tools for Planning of Force Build Up and Employment," panel discussion (IDF's First International Operational Simulation Summit, Tel Aviv, Israel, 12 November 2019).

[287] Gil Baram, "Israeli Defense in the Age of Cyber War," *Middle East Quarterly* (Winter 2017): 5.

cyber headquarters was established in the Israeli National Signals Intelligence and Code Decryption Unit, also known as Unit 8200, to coordinate and direct military cyberspace operations.[288] A cyber defense department was also established in the C4I Corps, to better protect the digital systems and platforms. In 2011, the IDF established its first cyber units, which later evolved into the Cyber Defense Division and in 2012, the IDF's Operations Directorate released a draft document, defining cyberspace as another battlefield alongside the land, sea, and air.[289]

The Cyber Defense Division has an unusual organizational structure when compared against other IDF divisions. A brigadier general was appointed to command the division, in comparison to a colonel, which is typically tasked to lead staff divisions. The division also has a unique structure, allowing soldiers to contribute to a large cyber task force or be seconded to a combat branch in the IDF to work independently or as a small team.[290] In addition to the Cyber Defense Division, the IDF also created two other cyber centric organizations—a cyber branch within the IDF multi-corps command headquarters, tasked with protecting IDF offensive and defensive military capabilities and a Cyber Situation Center, to manage cyber related emergencies and track emergent cyber trends.[291]

To support defensive and offensive cyber operations, the IDF has made significant investments in infrastructure and training.[292] For instance, officers in the IDF's C4I and Cyber Defense Directorate take part in a two-week long drill, entitled "Colosseum" testing their ability to respond to adversarial cyber-attacks.[293] The IDF's offensive cyber school called Ashalim trains between 500 and 600 cadets per year, ensuring the IDF maintains, according to one cyber trainer, "freedom of action in cyberspace."[294] Cyber training, however, is only one facet of multi-domain operations. States must also integrate cyber alongside traditional combat operations.

The Emergence of IDF Multi-Dimensional Joint Training Environment

There is indication that the IDF is developing a multi-domain synthetic training environment—what they call a *multi-dimensional* joint training environment. The IDF's conception of multi-dimensional operations builds off joint operations, linking ground, air, and naval forces to cyberspace, the EMS, and information warfare. To train for multi-dimensional operations, the IDF has outlined a vision for their future synthetic training environment that cuts across operational planning, training (basic and advanced), and force design (see figure thirty-two).

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[288] *Ibid,* 6.

[289] Lior Tabansky and Isaac Ben Israel, *Cybersecurity in Israel* (Tel Aviv, Israel: Springer, 2015): loc. 1650 and Avi Jager, "The Transformation of the Israel Defense Forces," *Naval War College Review* 74.2 (Spring 2021): 29.

[290] Jager, "The Transformation of the Israel Defense Forces," 29.

[291] *Ibid,* 30.

[292] Gadi Eizenkot, "Cyberspace and the Israeli Defense Forces," *Cyber, Intelligence, and Security* 2.3 (December 2018): 102.

[293] Anna Ahronheim, "Colosseum: Challenging the IDF officers on the frontlines of cyber campaigns," *The Jerusalem Post,* 12 September 2019, https://www.jpost.com/Israel-News/Colosseum-Challenging-IDF-officers-on-the-frontlines-of-cyber-campaigns-601481.

[294] Amitai Ziv, "In this secret School, the Israeli Army is Breeding Future Cyber Warriors, *Haaretz,* 31 May 2019, https://www.haaretz.com/israel-news/.premium.MAGAZINE-in-this-secret-school-the-israeli-army-is-breeding-future-cyber-warriors-1.7301838.

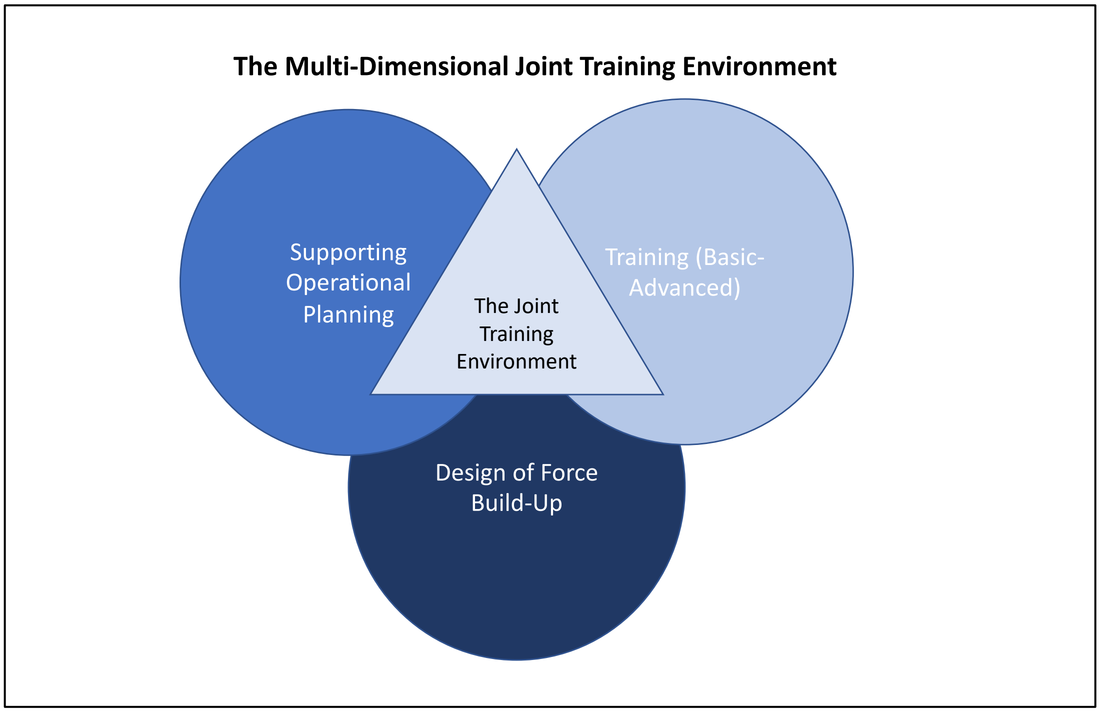

Figure 33: The IDF's Multi-Dimensional Joint Training Environment. Adapted from Baruch presentation "IDF's Future Simulation Environment's Contribution to Operational Simulation"

To achieve this vision, the IDF is developing a cloud-based, shared, centralized, synthetic training architecture that transcends domains and services. Operating on a closed network, the Multi-Dimensional Joint Training Environment is designed to provide an accurate and reliable "touch of the button" simulation of the IDF multi-dimensional force, while also realistically simulating enemy behavior across domains. This single synthetic asset is intended to deepen coordination across domains. As one IDF officer noted, "we want all the brains, all the things that need to be upgraded…as many assets as possible, linked into one architecture…[Once that happens], these services…will become accessible to each other."[295] This desire for a single synthetic environment is not unique to the IDF. Indeed, in conversations with multiple western military officials, many have highlighted the aspiration for a single synthetic environment that cuts across training and decision-support.[296] What makes the IDF unique is that the IDF has translated its ambitions into a technical proposal with eight key attributes:

1. IDF warfighters should perceive a difference in training quality through consistent software updates to training platforms and systems.
2. The synthetic training environment must operate alongside live assets—providing a gamut of LVC or mixed reality training opportunities.
3. Training must be always accessible (i.e., 24 hours a day, seven days a week) and at all levels—individual to headquarters.
4. All warfighters should be able to act as a "head coach," allowing them to get the training feedback they need whether a qualified trainer is available or not.

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[295] Baruch, "IDF's Future Simulation Environment's Contribution to Operational Simulation."
[296] See for instance the UK call for a single synthetic environment, "20220218- DSEP Early Market Engagement Event," accessed 12 August 2022, available at: https://www.techuk.org/what-we-deliver/events/20220218-dsep-early-market-engagement-event.html.

5. The multi-dimensional training environment should build on current combined joint abilities and employ simulated 3D terrain imagery.
6. The operational training environment should rely on the IDF's operational cloud.
7. To ensure consistent deployment, standardization must take place across systems and the affiliated technical staff.
8. The synthetic environment must also provide for after action reviews, operational analysis, and research.[297]

However, like all acquisitions, a technical proposal does not indicate that a project has moved from the incubation phase into research and development—and perhaps most importantly into implementation across the force. There are some indications, however, that the IDF has made progress. As Major General Motti Baruch noted, the IDF is ahead of schedule in developing their multi-dimensional joint training environment—they have managed to develop the system's underlying architecture. Moreover, approvals have been granted for simulators to be co-located on the IDF's operational cloud for mission-sets. According to Baruch, the IDF "already has the technical know-how" to make the environment a reality.[298] The IDF is waiting for government approval—and the associated budget—to take the concept to full implementation. This may be somewhat difficult to obtain. While Israel still devotes a significant portion of its GDP to defense (4.34% in 2018), the IDF no longer enjoys the same degree of budgetary prioritization as in the past. Indeed, while the defense budget was at one time sanctuaried, it now is subject to critical review—it has been slashed 13% over the past two decades.[299] It was therefore not surprising that when Baruch was asked for clear specifics as to when the IDF planned to deploy their multi-dimensional joint training environment, he eschewed to establish a firm date for its implementation. Various rounds of budgetary approvals, which may prove on occasion somewhat difficult to obtain, continue to act as hurdles to the seamless adoption of such technologies.[300]

More generally, despite Baruch's description, it is still somewhat unclear to outside observers how multi-domain—or in IDF parlance, multi-dimensional—synthetic training will take place. While Baruch did mention that IDF training simulators would be integrated onto the cloud, it is unclear to what extent this cloud-based environment will link synthetic training tools across domains. Without more information, or greater insight into the IDF's planned system, it is difficult to ascertain to what extent their planned multi-dimensional joint training environment will truly be a cross-domain solution set.

Past Examples of Multi-Domain Training?

Outside of the multi-dimensional joint training environment, there is anecdotal evidence that the IDF may have some capacity to conduct cross-domain cyber kinetic operations. A former IAF officer, who now runs an Israeli cyber corporation as a reservist, has published on the challenges and benefits of integrating cyber with conventional operations. Highlighting that the timing and sequencing of cyber and kinetic operations can pose unique problems, Ron Tira observes, with a certain degree of granularity, that the integration of cyber into a conventional campaign requires

[297] *Ibid.*
[298] *Ibid.*
[299] The World Bank, "Military Expenditure (% of GDP)- Israel," https://data.worldbank.org/indicator/MS.MIL.XPND.GD.ZS?locations=IL, accessed 8 January 2019.
[300] Baruch, "IDF's Future Simulation Environment's Contribution to Operational Simulation."

preliminary "enabling operations" before the onset of a conflict. This would naturally require some sort of cross-domain integration during mission planning or training. Perhaps more interestingly, when discussing how cyber can contribute to a conventional campaign, Tira highlights several examples, including a cyber operator's role disrupting enemy air defenses or attacking air-gapped or isolated systems.[301] While Tira doesn't provide explicit historic parallels for each example, it is notable that his chosen examples happen to mirror alleged Israeli cyber operations—Operation Orchard and Stuxnet, respectively.[302]

Meanwhile, when commenting on 2014's Operation Protective Edge in Gaza, one IDF cyber defense division commander noted that "[the operation] wasn't…like previous operations. For the first time, there was an organized cyber defense effort alongside combat operations in the field. This was a new reality."[303] The cyber defense division commander could simply have been referring to information assurance efforts across the IDF—the need to protect the IDF's digitally-based military platforms and systems. However, it is also possible that the commander could have been referring to offensive cyber operations that fall under the guise of "active defense." Within the cyber community, active defense—at times known as "hacking back"—is often referred to as aggressive and proactive cyber measures taken against an adversarial cyber operator, system, or platform.[304] Cyber active defense measures operate in a gray zone. In many ways these actions are offensive, but they serve defensive purposes, mitigating potential cyber (and, at times, conventional) threats. Given Israel's penchant for active defensive outside the cyber sphere, it is highly plausible that cyber falls within this rubric.[305] If that is the case, Operation Protective Edge may be among the first instances where cyber operators worked offensively in tandem with conventional warfighters for mission success.

Identifying the "Why" Behind IDF Multi-Domain Synthetic Training Adoption

The drivers behind the IDF's adoption of a multi-domain synthetic training environment are complex and multi-faceted (see table seven). Israel is a high adopter of a multi-domain synthetic training environment, and synthetic training more generally, but its adoption is not primarily explained by its defense budget, as theories like adoption-capacity theory would posit. Indeed, Israel possesses a similar defense budget to Canada (a low adopter), but its adoption rate fundamentally differs. As will be shown, Israel's adoption of a multi-domain synthetic training environment is primarily a function of its geostrategic threat environment. Other factors, like

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[301] Ron Tira, "Developing a Doctrine for Cyberwarfare in the Conventional Campaign," *Cyber, Intelligence, and Security* 2.1 (May 2018): 97 and 102.
[302] For an overview of Stuxnet see: Kim Zetter, *Countdown to Zero Day: Stuxnet and the Launch of the World's First Digital Weapon* (New York, NY: Crown Publishers, 2014).
[303] Baram, "Israeli Defense in the Age of Cyber War."
[304] Anthony D. Glosson, "Active Defense: An Overview of the Debate and a Way Forward," *Mercatus Working Paper* (August 2015), Dorthy E. Denning and Bradley J. Strawser, "Active Cyber Defense: Applying Air Defense to the Cyber Domain," in George Perkovich and Ariel E. Levite, *Understanding Cyber Conflict: Fourteen Analogies* (Washington, DC: Georgetown University Press, 2017): 193- 209, and Center for Cyber and Homeland Security, "Into the Gray Zone: The Private Sector and Active Defense against Cyber Threats," *The George Washington University* (October 2016).
[305] IDF doctrine explicitly states that while at the strategic level they remain defensive, tactically they are offensive. Israel Ministry of Foreign Affairs, "THE STATE: Israel Defense Forces (IDF,"
https://mfa.gov.il/mfa/aboutisrael/state/pages/the%20state-%20israel%20defense%20forces%20-idf-.aspx.

organizational agility, military champions, and military-to-military contact have relevance, but does not hold the same evidentiary weight.

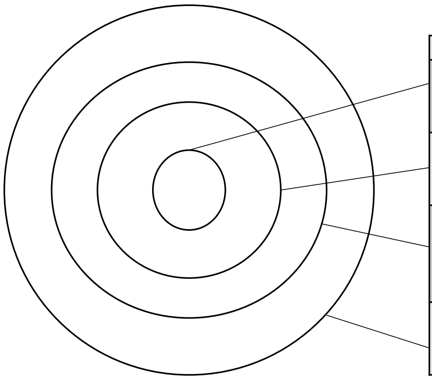
Alternative Hypotheses	Evidentiary Threshold: Process Tracing Test
One: Presence of Geo-Strategic Competition	Hoop test
Two: Organizational Propensity for Reform	Straw-in-the-wind
Three: Presence of High-Level Champions	Straw-in-the-wind (military champions); does not pass evidentiary threshold (civilian champion)
Four: Military-to-Military Contact	Straw-in-the-wind
Five: Cultural Similarity	Does not pass evidentiary threshold (quantitative indicators of culture and normative alliances); straw-in-the-wind (religion)

Table 8: Explanatory Value of Alternative Hypotheses to the IDF

Hypothesis One: States that live in regions of intense geo-strategic competition will adopt synthetic training at a higher rate

Perhaps the greatest explanatory factor for the IDF's adoption of multi-domain synthetic training is Israel's unique threat environment, which has ripple effects across the nation's defense strategy, doctrine, and force posture. Indeed, it is difficult to understate the security challenges posed by Israel's perilous geographic position. A long and narrow territory devoid of any natural obstacles, Israel fundamentally lacks strategic depth. Abutting the Mediterranean, the country sits on less than 21,000 km2 of land and at its narrowest is less than 10km wide. Its population of approximately 6.5 million are heavily concentrated along the coast, rendering it more vulnerable to massed fires from long-range weapon systems, artillery, and rockets.[306] The threats to the Israeli state are many and varied. Israeli defense planners often conceptualize their threat perceptions in terms of a series of concentric circles. The first circle is the conventional threat stemming from hostile states with varying military capabilities, to include armored and mechanized units, infantry, artillery, aerial, and maritime forces. The second ongoing threat circle is the nonconventional (or strategic) threat, which involves various regional adversarial states and other entities seeking to develop and acquire offensive nuclear weapons capabilities. The third circle includes sub-conventional or hybrid threats posed by terrorist or guerilla organizations—to include Hamas—operating within or against the state. The final, and more recently identified threat circle, are "non-physical" threats, which include cyber threats against Israeli military and civilian digital infrastructure and "cognitive efforts" that seek to undermine Israel's standing within the international community (see figure thirty-three).[307]

[306] Charles Freilich, *Israeli National Security: A New Strategy for an Era of Change* (Oxford, UK: Oxford University Press, 2018): 15-19, Johnson et. al, "Preparing and Training for the Full Spectrum of Military Challenges: Insights from the Experiences of China, France, the United Kingdom, India, and Israel," 202, and Chris Demchak, "Numbers or Networks: Social Constructions of Technology and Organizational Dilemmas in IDF Modernization," *Armed Forces and Society* 23.3 (Winter 1996): 185.
[307] Gadi Eizenkot, "Cyberspace and the Israeli Defense Forces," 100-101 and Eizenkot and Siboni, "Guidelines for Israel's National Security," iv.



Type of Threat	
Conventional	Conventional arms-build up—armor, infantry, aerial, or maritime forces—by Syria. Potential for conventional conflict in the Golan Heights. Maintaining conventional military balance with Egypt.
Non-Conventional / Strategic	Development of nuclear weapons and long-range ballistic missile capability by Iran. Potential for nuclear weapons and ballistic missile to diffuse to radical Islamist groups within region.
Sub-Conventional	Internal and cross-border attacks by militant groups, such as Hezbollah, Hamas, or Palestinian terrorists. Tactics to include kidnapping Israeli soldiers, rocket attacks, anti-aircraft fire, or other less sophisticated tactics (i.e. stabbings, etc.)
Cyber and Cognitive	Cyber threats to Israeli military or civilian ICT based systems. Information operations that seek to undermine international public opinion towards Israel (i.e. ensure Israel loses support in international organizations, like the UN).

Figure 34: Depiction of Israeli Concentric Circle Threat Perceptions. Adapted from Gadi Eizenkot, Eisenkot and Siboni, and Raska.[308]

Underlying all these threat perceptions is a longstanding, more existential concern over the nation's survival. Since the creation of the modern state of Israel in 1948, it has been surrounded by hostile actors bent on its very annihilation. While Israel has normalized its relations with many previously adversarial states—Jordan and Egypt—it still must contend with a variety of hostile state and non-state entities. Israel does not have a peace agreement with Syria. Over the horizon, Iran and failing states, like Libya, pose security challenges. Non-state entities, like Hezbollah and Hamas, who are actively abetted by Iran, seek to destroy, or at the very least, wage a war of attrition against Israel. Additionally, Palestinian terrorists, both home-grown, or within the West Bank and Gaza, present a persistent challenge.

The antipathy these entities hold towards Israel is most explicit in their public statements. Hamas' charter states that "Israel will exist and continue to exist until Islam obliterates it, just as it obliterated others before it" and Hezbollah, likewise, has actively called for Israel's destruction.[309] The Iranian regime has repeatedly called for the annihilation of Israel. Iran's supreme leader, Ayatollah Khameini, has not minced words when speaking about the Israeli state calling it a "true cancerous tumor," a "disgraceful blot," and "an illegitimate regime" led by "untouchable rabid dogs." These statements are typically followed by pronouncements that Israel is "doomed to failure and annihilation," or that the state "should be cut off and it definitely will be cut off."[310] As recently as 2014, Khameini outlined a fourteen-point plan for Israel's extinction.[311] These incendiary

[308] Adapted from Gadi Eizenkot, "Cyberspace and the Israeli Defense Forces," *Cyber, Intelligence, and Security* 2.3 (December 2008): 100-101, Gadi Eizenkot and Gabi Siboni, "Guidelines for Israel's National Security," *The Washington Institute for Near East Policy* (October 2019): iv, and Michael Raska, "The Revolution in Military Affairs and Security of Small States: Israel's RMA Trajectory and Force Modernization Programs (1995-2008)," (Working Paper, Lee Kuan Yew School of Public Policy, National University of Singapore, February 2009): 14.
[309] Charles D. Freilich, *Israeli National Security: A New Strategy for an Era of Change* (Oxford, UK: Oxford University Press, 2018): 37.
[310] Ayatollah Khameni as quoted in Ewan MacAskill and Chris McGreal, "Israel should be wiped off the map, says Iran's president" *the Guardian,* 26 October 2005, https://www.theguardian.com/world/2005/oct/27/israel.iran and Ariel Ben Solomon, "Iran's Leader Calls Israel an 'Unclean Rabid Dog'," *Jerusalem Post,* 20 November 2013.
[311] Antonia Molloy, "Iran's supreme leader Ayatollah Khamenei outlines plan to 'eliminate' Israel" *Independent,* 10 November 2014, https://www.independent.co.uk/news/world/middle-east/irans-supreme-leader-ayatollah-khamenei-outlines-plan-to-eliminate-israel-9850472.html.

statements certainly impact the thinking of some security managers—particularly as Iran seeks to deepen its sphere of influence within the region's so called "Shia Crescent," while also actively pursuing a nuclear break-out capability.

The primal fear of extinction has permeated aspects of the Israeli national security discourse, leading some to refer to it as Israel's "Masada Complex" or "Holocaust Syndrome."[312] As former Prime Minister Menachem Begin noted "[Israel's] fate… is that we have no choice but to fight with selfless dedication. The alternative is Auschwitz."[313] It is this very belief that Israel has *ein breira* or "no choice" to fight, and to fight successfully, that provides the simplest explanation for the driving impetus behind IDF innovation.[314] Others, however, have highlighted that while such language is jarring, Israel has not faced a truly existential threat since it made peace with Egypt in 1979, and perhaps before. According to these scholars, Israel has shifted from solely wars of necessity to wars of choice.[315]

Of more immediate concern—and what some would consider "wars of choice"—to the IDF is the protracted state of low-level conflict, or "the war between the wars," that Israel currently grapples with. The "war between the wars" has become a descriptor for the clandestine air raids, missile engagements, border skirmishes, and other low-level military and police operations that have become semi-routine missions for the IDF.[316] Armed threats and terrorism are a daily facet of Israeli life.

Israel's geography and geostrategic threat perception has also, in turn, influenced its military strategy and force posture.[317] The 2015 "IDF Strategy" rests on three key pillars: deterrence; early warning in the face of existential threats; and decision [i.e., offensive power], in the event the other two pillars fail. The last of the three pillars is undergirded by an Israeli focus on quick campaigns and the possibility of successful preemption, which in turn, according to Israel, buttresses deterrence.[318] Israel's small size, lack of strategic depth, and dense population clusters necessitate the adoption of such a proactive defensive posture. Israel relies on a people's army and a reserve system, in which a significant portion of the population—both men and women—participate in the nation's defense. During peacetime, the IDF's active-duty force is skeletal. In the event of a protracted conflict that requires reserve mobilization, the Israeli economy suffers disruption.[319] A

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312 Freilich, *Israeli National Security: A New Strategy for an Era of Change,* 15.
313 As quoted in *Ibid,* 15.
314 Cohen, Eisenstadt, and Bacevich, "Knives, Tanks, and Missiles: Israel's Security Revolution," 51.
315 Freilich, *Israeli National Security: A New Strategy for an Era of Change,* 37.
316 Arie Egozi, "Is Israel Ready for War?" *Breaking Defense,* 29 April 2019, https://breakingdefense.com/2019/04/is-israel-ready-for-war/.
317 This aligns with Taylor Fravel's argument that a state's perception of its security environment influences its strategic goals, conception of future operations, and the structure of its armed forces, which would naturally influence training as well. Fravel, *Active Defense: China's Military Strategy since 1949* (Princeton, NJ: Princeton University Press, 2019).
318 Belfer Center for Science and International Affairs, "Deterring Terror: How Israel Confronts the Next Generation of Threats, English Translation of the Official Strategy of the Israeli Defense Forces," *Belfer Center Special Report* (August 2016): 5.
319 The IDF totals 641,500 soldiers, but only 176,500 are active-duty (mostly conscripts). The rest, more than 72 percent, are reservists. Stuart A. Cohen, "The Israeli Defense Force: From a People's Army to a Professional Military—Causes and Implications," *Armed Forces and Society* (Winter 1995) and Raphael S. Cohen et. al., "From Cast Lead to Protective Edge: Lessons from Israel's Wars in Gaza," *RAND* (2017): 47.

strategy based on preemption mitigates the need to mobilize the reserve force for long, and potentially economically damaging deployments. From a force design perspective, such a strategy necessitates that the IDF's Defense Military Intelligence (which includes the IDF's offensive cyber capacity), IAF, and Navy are primarily composed of a more exquisitely specialized backbone of professionalized forces, whereas the IDF's Ground Forces are heavily supported by reserve manpower. Additionally, the IDF has invested heavily at the operational level in C4ISR (command, control, communications, computer, intelligence, surveillance, and reconnaissance) capabilities, viewing them as effective force multipliers during combat operations.[320] During procurement, the IDF pays close attention to systems integration—ensuring that new technologies are integrated across the force structure, to include updated tactics and training.[321] Such a force design inevitably favors the use of synthetic training technologies, as air forces and navies, as platform centric services, are consistently earlier adopters of synthetic training technologies over ground forces.[322] Furthermore, cyber forces require virtual environments for training. These trends have the potential to influence overall multi-domain synthetic training adoption.

Finally, while a baroque arsenal can be used to explain adoption of some technologies in some instances, that does not appear to be the case with the IDF. Indeed, Mary Kaldor's theory explores how indigenous industries can expand during times of peace due to uncertainty over how much technical change is needed, leading to the adoption of technologies that should contract.[323] While Israel does have an extensive defense industry, and is labeled a cybersecurity powerhouse, Israel is constantly on war footing. There are no incentives for their military-industrial complex to artificially expand, as it is designed to quickly respond to present threats and intelligence. [324]

The presence of geostrategic competition as a driver for multi-domain synthetic training adoption appears to pass the "hoop test" – it is a necessary causative factor. Indeed, throughout its existence, Israel has viewed itself as a vulnerable state surrounded by a sea of hostile actors. Even as it has normalized its relations with previously adversarial states, like Egypt, it still must contend with a variety of hostile state and non-state entities. Israel's threat perceptions drive its force posture decisions, particularly with regards to future multi-domain operations. The development of a more multi-domain force (or in the words of the IDF, a "multi-dimensional" force) has down-stream procurement impacts. The IDF's planned procurement of a multi-dimensional training environment falls within this rubric.

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[320] Raska, "The Revolution in Military Affairs and Security of Small States: Israel's RMA Trajectory and Force Modernization Programs (1995-2008)," 4-5.
[321] Anthony Cordesman, "Israel and Syria: The Military Balance and Prospects of War," *Center for Strategic and International Studies* (15 August 2007): 77.
[322] This is largely because air forces and navies are platform centric services (i.e., they are largely dependent on platforms to operate within their domain—ships, planes, etc.).
[323] Mary Kaldor, *The Baroque Arsenal* (New York, NY: Hill and Wang, 1981).
[324] For more on the Israel military-industrial complex, see, Gregory Giles, "Continuity and Change in Israel's Strategic Culture," *Defense Threat Reduction Agency* (2002): 4. Israel is a global cybersecurity powerhouse—leading the market for both defensive and offensive cyber solutions."Factbox: Israel a global leader in growing market for cyber weapons," *Reuters,* 22 August 2019 https://www.reuters.com/article/us-israel-hackers-factbox/factbox-israel-a-global-leader-in-growing-market-for-cyber-weapons-idUSKCN1VC0Y4 and Gill Press, "6 Reasons Israel Became a Cybersecurity Powerhouse Leading the $82 Billion Industry," *Forbes,* 18 July 2017, https://www.forbes.com/sites/gilpress/2017/07/18/6-reasons-israel-became-a-cybersecurity-powerhouse-leading-the-82-billion-industry/#3732807f420a.

Hypothesis Two: States that have a propensity for organizational reform within their defense bureaucracies will have higher synthetic training adoption rates.

Scholars that study organizational agility allege that four models can act as a guide when exploring organizational change and adoption—the interservice model, instraservice model, organizational culture model, and civil-military model (the last of which will be covered in hypothesis three).[325]

Like in most democracies, interservice rivalry in the IDF is present, particularly when competing for manpower and budgets for force development. As will be covered under hypothesis three, civilians, in particular the defense minister, have little bearing on the IDF, particularly on strategic decisions. However, the presence of interservice rivalry does allow the defense minister some room to maneuver, as the minister is traditionally presented with different force development options from the services and can adjudicate between the three.[326]

The competition between the air force, and to a lesser degree the navy and ground forces over the size and share of the defense budget becomes even more fierce during periods of fiscal austerity. This was perhaps most notable in the 1980s when the Israeli defense budget was cut in real terms by hundreds of millions of dollars. In 1989, amid those cuts, the IDF acquired the Apache attack helicopter. In the lead-in to that decision, the ground forces favored the procurement of a larger number of less-sophisticated Cobra helicopters that were already in service in the IDF. The ground forces highlighted the important ground support mission of the helicopters, and their need for greater numbers. The air force, meanwhile, extensively lobbied for the acquisition of the Apache—citing their need to maintain a qualitative edge in conflict. After weighing the two positions, the defense minister, Yitzhak Rabin, sided with the air force.[327]

No evidence presently exists that interservice rivalry is impacting multi-domain synthetic training adoption decisions, however it could. The IDF's "multi-dimensional joint training environment" is occurring at the joint level, not within any of the services, so there may not be service level advocates to argue and compete for its procurement in front of the defense minister. At the same time, however, the IDF has clearly prioritized developing cyber capabilities. Even if the services are not explicitly advocating for its adoption, other constituent organizations, such as the Cyber Defense Division, cyber branch within the multi-domain headquarters, the IDF Cyber Situation Center, or even the IDF's Concept Laboratory under the Operations Directorate might. Additionally, alongside the IDF's offensive cyber capacity, the IAF and Navy are expected to be "specialized backbone" of professionalized forces, whereas the IDF's Ground Forces are heavily supported by reserve manpower. As a result, potential exists that during periods of greater austerity, some bureaucratic infighting may occur amongst the services. How those fights are adjudicated could impact multi-domain synthetic training adoption.

Intraservice rivalry is a fundamental part of the IDF's organizational culture. The IDF has long been an organization that prized individual agility or mavericks over those that may follow

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325 Sapolsky, "On the Theory of Military Innovation," 35-39, Rosen, *Winning the Next War: Innovation and the Modern Military,* Farrel and Terriff, *The Sources of Military Change: Culture, Politics, and Technology,* and Posen, *The Sources of Military Doctrine.*
326 Yehuda Ben Meir, *Civil Military Relations in Israel* (New York, NY: Columbia University Press, 1995): 157.
327 *Ibid.*

command, which at times, has led to a willingness to disobey orders on the part of some officers.[328] This willingness to foster free thought was most clearly articulated by Ezer Weizman, former president of Israel, when commenting on his time in service in the air force.

> *In whatever role I was assigned in the air force, I nurtured freedom of expression. I abhorred officers who wanted to hasten their career advancement by blindly agreeing to my views. I could never stomach yes-men. The air force needs thinking officers who develop his own tools for independent analysis and uses them openly for assessing things...I wanted to have an ongoing polemic with those with disagreed with me, a real confrontation, out in the open, in which those who thought differently had an equal opportunity to justify their evaluations. I frequently utilized the 'commander's evening' to encourage officers and pilots to argue with me.*[329]

When assessing past instances of instraservice rivalry, the debate within the IAF on the role of unmanned aerial vehicles (UAVs) is notable—much like the US. This isn't surprising as Israel was the first adopter of UAVs and is one of the most tactically proficient in their use.[330] While details of the IDF's use of UAVs are classified, it is not challenging to discern that a strong debate exists between UAVs and manned fighters. The IAF has grappled with what mission sets could be trusted to unmanned systems, noting that confidence did not yet exist to trust unmanned systems with the most vital missions. By 2010, the ratio of squadrons remained firmly in favor of manned systems (15 manned fighter-bomber squadrons to three unmanned squadrons), but the list of missions that were deemed suitable for UAVs continued to grow.[331] While much of the debate has centered around mission sets, it is also likely that aspects of this debate have clear budgetary implications. Indeed, since the cancellation of the Lavi fighter project in the late 80s, Israeli has procured its fighter aircraft from the US, and acquisitions like the F-35 are expensive. Any acquisition decision must be adjudicated against platform-based acquisitions elsewhere. As unmanned system technology improves, this debate within the IAF will continue and will occasionally appear in muted form in reports and periodicals associated with the Fisher Institute for Air and Space Strategic Studies, the research arm of the IAF.[332] Officers within the IDF, in short, are allowed and encouraged to engage in intraservice rivalry. It is part and parcel to the IDF organizational culture.

The rivalry within the services for scarce resources becomes more interesting when viewed through the lens of the IDF's burgeoning cyber capabilities, which may have some implications for multi-domain synthetic training acquisition. Indeed, the establishment of the IDF's Cyber Defense Division, cyber branch in their multi-domain headquarters, and their Cyber Situation Center marked a significant shift for the IDF. The Israeli military has long prioritized the combat units in each of the services in competitions for manpower, budget, and positions. New recruits were directed first to combat units, over non-combat specialties. In 2011, however, the IDF prioritized cyber defense as one of their most pressing needs, opening the door for recruits to

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[328] Gil-li Vardi, "Pounding their Feet: Israeli Military Culture as Reflected in Early IDF Combat History," *Journal of Strategic Studies* 31.2 (2008): 310.
[329] Ezer Weizman, *On Eagle's Wings: the personal story of the leading commander of the Israeli Air Force* (New York, NY: Macmillan Publishing Company, 1977): 192.
[330] Borg, "Assembling Israeli drone warfare: Loitering surveillance and operational sustainability." 401-417.
[331] David Rodman, "Unmanned Aerial Vehicles in the Service of the Israeli Air Force: 'They will Soar on Wings like Eagles," *Middle East Review of International Affairs* 14.3 (September 2010): 81.
[332] *Ibid.*

consider cyber service alongside combat unit service. While combat units were cut in strength, the cyber units were allocated hundreds of new positions, in addition to the ten thousand posts they already held.[333] Visions within each service that focus on cyber and multi-domain integration are being prioritized and pushed forward. It is too early to tell whether this will have downstream effects for the acquisition of a multi-domain synthetic training environment.

The IDF has a unique organizational culture, one that has been labeled by scholars as "innovative, fast to adapt, fast to react, and sometimes ruthless—all qualities necessary for survival in a hostile environment."[334] Such attributes have been reflected in the IDF since its founding. Indeed, the IDF had had to quickly adapt and change in the face of evolving geopolitical circumstances, military failure, and even victory. Prior to the IDF's inception, it was the Hebron riots in 1929 that created the impetus for the expansion of the *Haganah,* a volunteer force that became the de-facto army when Israel achieved independence in 1948.[335] Equipped with solely nine light brigades and local defense groups, the nascent IDF lacked armor, artillery, and air power. As the IDF struggled with a diverse range of threats in the following years—from Palestinian terrorism to multiple invasions of Arab armies—the IDF transformed into a force buttressed by paratroops (early 1950s), a fighter bomber air force (late 1950s and beyond), armor dominance (1960s), static defense (early 1970s), and combined arms (mid-1970s and beyond). As Jeffrey Isaacson notes, each historic IDF military evolution, except for static defense, required IDF innovation. [336]

Beyond changes to their overall force posture, the IDF has also demonstrated a strong capacity to adapt in battle. Described by one analyst as a "relational" approach to the battlefield, the IDF has demonstrated a unique ability to "marry existing concepts with integrative mechanisms" to heighten the fog of war, while meeting the particular demands of their localized conflicts.[337] The IDF's penchant for battlefield confusion dates back to the 1950s when Ariel Sharon, the then commander of the 202nd paratroop battalion, chose to forgo conventional "fire and movement" tactics in favor of a silent tactical approach, that maximized surprise and confusion in raids against Egyptian and Jordanian fortifications.

This was again demonstrated in the leadup to an air campaign against Syria in June 1982. The IAF flew UAVs into Syrian air space, forcing the Syrian air defense system to lock onto the systems—thus revealing their locations. On the 9 June 1982, using the sun's position to their advantage, the IAF again sent the unarmed UAVs—which appeared to be F-4s—into Syrian airspace. The Syrian air defense operators, unable to verify the radar images using traditional optical methods due to the dazzling effects of the sun, engaged the UAVs with the surface-to-air missiles, depleting their SAM missile stock and leaving the air defense systems defenseless. The IAF, following quickly behind the UAVs, destroyed Syrian air defenses. The mission was a success.[338]

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333 Jager, "The Transformation of the Israel Defense Forces," 30.

334 Vardi, "Pounding their Feet: Israeli Military Culture as Reflected in Early IDF Combat History," 297.

335 Eliot Cohen, "Ben-Gurion Holds a Seminar," in *Supreme Command: Soldiers, Statesmen and Leadership in Wartime* (New York, NY: Simon and Schuster, Inc., 2002): 133- 172.

336 Jeffrey Isaacson et. al., "Predicting Military Innovation," *RAND* (1999): 23.

337 *Ibid,* 24.

338 *Ibid,* 25 and Ralph Sanders, "An Israeli Military Innovation: UAVs," *Joint Forces Quarterly* (2002): 114-118.

This cultural penchant for adaption, and in particular deception, in warfare provides a useful lens through which to assess the IDF's adoption of a multi-domain synthetic training environment. The integration of cyber operations into IDF operational planning naturally applies to strategies that seek to generate confusion in the adversary. By manipulating information or sabotaging systems through cyber means, the IDF can amplify the fog of war, while maintaining existing conventional operational concepts. A multi-domain synthetic training environment provides the capacity to integrate cyber into conventional planning and training, and this would largely comport with the IDF's history of continuous organizational adaptation. As a result, it seems possible that organizational culture is relevant when assessing IDF multi-domain synthetic training adoption, even if that has not been explicitly highlighted by any members of the IDF as a factor.

An organizational penchant for reform, overall, only seems partially explanatory when assessing IDF multi-domain synthetic training adoption. It appears to pass the "straw-in-the-wind" test. Organizational change, in the former of interservice rivalry and culture appear relevant, but the information at hand does not confirm the hypothesis. It is plausible that intraservice rivalry does pass the hoop test, particularly when accounting for the preference of cyber forces over combat forces, but it is challenging to assert as a necessary factor. Therefore, it appears that organizational agility is relevant when understanding adoption but does not appear necessary or sufficient. It is no smoking gun.

Hypothesis Three: States that have high-level "champions" for synthetic training either at the Chief of Service level or upper tiers of the defense bureaucracy will choose to adopt synthetic training at a higher level.

The actions of a "high-level" champion appear to provide only a partially explanatory factor for Israel's adoption of a multi-domain synthetic training environment. Indeed, no individual within the IDF leadership or the civilian defense bureaucracy has singlehandedly advocated for the adoption of multi-domain synthetic training. However, the current Chief of Staff has acknowledged the importance of a synthetic environment for future training needs, stating that "a simulated training environment close to reality, enhances skill and mental capacity, which provides an incentive for improvement in combat methods and force build up."[339] Likewise, while it is unclear whether a high-ranking military official has advocated for the development of the IDF's nascent synthetic Joint Multi-Dimensional Training Environment, the fact that the IDF is ahead of schedule to develop their planned synthetic "architecture," and that the environment is in the advanced approvals process for future acquisition would indicate some high-level buy-in.[340]

When assessing the impact of "champions" on technical adoption within the IDF, a useful place to start are the multi-year government defense plans, which are released approximately every four years during a new IDF Chief of Staff tenure. What the new chief of the IDF chooses to prioritize in their defense plan shapes subsequent acquisition decisions particularly as it relates to force

[339] Lt. General Aviv Kochavi on 29 May 2019 as quoted by Major General Motti Baruch, "IDF's Future Simulation Environment's Contribution to Operational Simulation," (IDF's First International Operational Simulation Summit, Tel Aviv, Israel, 12 November 2019).
[340] *Ibid.*

posture and operational concepts. Since the mid-1990s there have been seven publicly known force modernization plans that would influence IDF multi-domain training adoption (see table eight).[341]

Defense Plan	IDF Chief of Staff	Year Enacted	Overview
"Readiness and Change" Plan	Aviv Kochavi	2019	Modernize the IDF with new combined-arms units; improve air-ground cooperation; advance intelligence targeting; implement a new digital C2 network.
Gideon	Gadi Eizenkot	2015	Built on Teuza reforms with additional cuts to IDF soldiers, headquarters staff, and platforms. Opted for a smaller better trained force. Investments in airpower, intelligence, and cyber.
Teuza	Benny Gantz	2013	Emphasis on airpower, intelligence, and cyber; dramatic structural change, including cutting armored brigades, outdated air wings, a logistics regiment, two older ships, and reducing headquarters by 21%.
Tefen 2012	Gabi Ashkenazi	2007	Development of the IDF ground forces, missile, and rocket programs. Address key IDF training and capability shortfalls identified in 2006 Lebanon War by reconstituting the role of maneuver warfare.
Kela 2008	Moshe Ya'alon	2003	Slogan of "less force, less power, but more effect," with focus on C4ISR systems, intelligence, and precision munitions. Significant cuts to platforms and personnel across the force, with extensive reductions to the IDF's Armored Corps.
Idan 2003/2010	Shaul Mofaz	1999	Focus on integrating "high-technology" systems—smart munitions, UAVs, real-time intelligence and battlefield management, etc.—into existing platforms and force structure.
Crossword	Shaul Mofaz	1999	Established the new Ground Forces Service. Launch of the Operations Directorate under the Chief of Staff. Greater autonomy afforded to IDF Regional Commands—North, Central, and Southern.

Table 9: Overview of Multi-Year Defense Plans Since 2000[342]

A quick assessment of defense plans reveals a tension in IDF leadership thinking between those characterized as "traditionalists" and those referred to as "reformers." Traditionalists in the IDF view armored formations supported by considerable modern weapon systems as the foundation of the IDF. Reformers view Israeli military dominance as dependent upon emerging technologies, precision-guided munitions, C2 systems, and cyber.[343] For the most part, each IDF Chief of Staff has fallen into one of these two categories—either reversing the policies of his predecessor (as was

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[341] One IDF Chief of Staff is missing from this list, Dan Halutz. Halutz was IDF Chief of Staff from 2005-2007, however, no publicly acknowledged force modernization plan is associated with him.

[342] Of note, former IDF Chief of Staff, Benny Gantz's *Halamish* plan was meant to go into effect in 2011. Budgetary issues prevented its implementation. As a result, Gantz worked to implement Tefen 2012 reforms until finally releasing his Teuza (Boldness) plan in 2013. Yaakov Katz, "IDF fears election will again postpone multi-year plan," *The Jerusalem Post,* 8 May 2012, https://www.jpost.com/Defense/IDF-fears-elections-will-again-postpone-multi-year-plan. Table six source information from: Arie Egozi, "Is Israel Ready for War?," *Breaking Defense,* 29 April 2019, https://breakingdefense.com/2019/04/is-israel-ready-for-war/, Aram Nerguizian, "The Military Balance in a Shattered Levant: Conventional Forces, Asymmetric Warfare and the Struggle for Syria," *Center for Strategic and International Studies* (15 June 2015), Freilich, *Israeli National Security: A New Strategy for an Era of Change,* 199-200, and Raska, "The Revolution in Military Affairs and Security of Small States: Israel's RMA Trajectory and Force Modernization Programs (1995-2008)," 22-28.

[343] Freilich, *Israeli National Security: A New Strategy for an Era of Change,* 195.

the case with Ashkenazi) or, if in agreement, choosing to build on them (Eizenkot). While in both cases, broader investments to training could theoretically drive the adoption of a multi-domain synthetic training environment, it is more likely that multi-domain training champions would emerge among those considered "reformers." Indeed, multi-domain operations are contingent on the effective integration of cyber into conventional operations. Those that choose to prioritize cyber, are therefore, more likely to adopt enablers, like multi-domain training, to ensure the effective integration of cyber operations.

Beyond the IDF leadership, it also appears unlikely that a high-level civilian within the Israeli defense bureaucracy has advocated for synthetic training. Institutionally, the civilian defense bureaucracy is somewhat marginalized. The security system is dominated by the uniformed military. Senior generals and staff handle many of the issues that would typically be the responsibility of civilian officials—such as undersecretaries of defense, assistant secretaries, or the national security council—elsewhere.[344] Even the minister of defense, which is typically a retired military official is marginalized when it comes to issues of strategic importance. As noted in hypothesis two, they can weigh in on force posture decisions, but they do not have the ability to develop their own options, instead, simply adjudicating between the various options presented by the services.[345] If the services do not put forward an option which drives synthetic training adoption, no option will be decided upon. More generally, even if civilian leadership did get involved as advocates, it is questionable whether the military would follow their directives without explicit buy-in. Indeed, scholars have noted that a tendency does exist within the IDF to act regardless of civilian expectations, or even direct orders.[346]

Additionally, a reticence does exist within the broader policy-making community to weigh in on specific issues of substance. As Charles D. Freilich has noted,

> *In a highly politicized coalition system, premiers, as well as defense and foreign ministers, do not wish to be bound by process that require they present the cabinet with a systematic analysis of Israel's objectives and the optimal means of achieving them…As a result, Israel's premiers have manifested a long-standing predilection to either avoid systematic policymaking processes or to limit them to narrowly focused issues*.[347]

Given that any advocacy of a multi-domain synthetic training would likely require some articulation of overall national security objectives (and how synthetic training may enable some of those objectives), it seems unlikely that civilian premiers within the defense establishment have promoted its adoption. Unlike the US or the UK, the Israeli defense bureaucracy has not released an Israeli equivalent of a US National Security Strategy or Quadrennial Defense Review or a UK-style white-paper, or any other overall national strategic statement—either classified or

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[344] For more on Israeli civil-military relations, see: Cohen, Eisenstadt, and Bacevich, "Knives, Tanks, and Missiles: Israel's Security Revolution," 78 and Alan Weinraub, "The Evolution of Israeli Civil-Military Relations: Domestic Enablers and the Quest for Security," *Naval Postgraduate School* (December 2009).
[345] Meir, *Civil Military Relations in Israel,* 179.
[346] Gil-li Vardi, "An Army Like No Other: The Origins of the IDF's Military Culture," in Peter Mansoor and Williamson Murray, *The Culture of Military Organizations* (Cambridge, UK: Cambridge University Press, 2019): 265 and Vardi, "Pounding their Feet: Israeli Military Culture as Reflected in Early IDF Combat History."
[347] Freilich, *Israeli National Security: A New Strategy for an Era of Change,* 7.

unclassified.[348] So long as a reticence exists in the broader defense policy-making community to get more deeply involved in defense strategy, a civilian champion for something like synthetic training, that is fundamentally an enabler, seems unlikely.

As mentioned, the presence of a "high-level" champion appears to provide, at best, only a partially explanatory factor for multi-domain synthetic training adoption. It appears to pass the straw-in-the-wind test, but only because various IDF chiefs of staff have promoted IDF force modernization plans, some of which have clearly been focused on multi-domain operations and cyber. Such force modernization plans have trickle down effects on training decisions. The presence of civilian champions, however, does not appear to be a factor in adoption decisions.

Hypothesis Four: States that have frequent military-to-military contact will have progressively convergent synthetic adoption rates and strategies.

Military-to-military contact is a powerful means by which new ideas are communicated between militaries—they can be, and are, a source of technical diffusion.[349] While Israel does not partake in a formal alliance that calls for mutual security, like NATO's Article V, it does have close diplomatic and military relations with many countries that facilitate military-to-military contact. As part of those relationships, the IDF participates in a range of annual and bi-annual military exercises. Since 2013, the IAF has hosted Blue Flag, an exercise aimed at simulating extreme combat situations and enhancing international cooperation. Aircraft from Germany, Italy, Poland, and the US took part in the earliest iterations. The exercise has since expanded with participants joining from India, Greece, Poland, and France, among others. Other recent exercises have included special operations training with the Czech Republic and long-distance bombing runs with the Greek, Italian, and German air forces.[350] Israel additionally hosts exercise Juniper Cobra, a bi-annual US-Israeli exercise that is designed to test joint preparations in the face of missile attacks on Israel. In tandem to Juniper Cobra, other field training exercises have included Juniper Stallion, Juniper Falcon, and Juniper Hawk.

Security cooperation between Israel and Middle Eastern states have enhanced in recent years. In 2021 and 2022, Morocco and Bahrain, respectively, each signed memorandums of understanding (MoU) with Israel on security cooperation. Following a series of missile and unmanned system strikes against the UAE by Iran-allied forces in Yemen, the UAE expressed interest in a closer security cooperation with Israel. The MoUs facilitate increased intelligence sharing, joint exercises and training, and arms sales, all of which facilitates closer military-to-military cooperation.[351]

Military-to-military contact seems to have little to no impact on the IDF's multi-domain synthetic training adoption decisions. While the IDF does have security relationships with a variety of international partners, the IDF harbors little expectations that it will be compelled to join future

[348] The one exception is the 2015, IDF Strategy, however, that is a military strategy and not a national strategy released by the civilian defense establishment. *Ibid,* 6.
[349] Ryan Grauer, "Moderating Diffusion: Military Bureaucratic Politics and the Implementation of German Doctrine in South America, 1885-1914."
[350] Freilich, *Israeli National Security: A New Strategy for an Era of Change,* 298.
[351] Congressional Research Service, "Israel: Background and US Relations in Brief," *Congressional Research Service* (2022): 9.

coalition operations.[352] The limited likelihood that the IDF will be forced to participate in future coalition operations is primarily attributed to two factors. First, the IDF's geopolitical threat environment ensures that it maintains a high operational tempo, and its resources are finite. Accordingly, it is unlikely that IDF personnel would be sent further afield to support security partners for peacekeeping, peace-enforcement, or humanitarian operations. Secondly, while Israel's relations with Egypt and Jordan have thawed and its cooperation with the Gulf States is on the rise, Israeli defense planners must still plan for all manners of contingencies within the Middle East.[353] As a result, as some analysts note, it is challenging to imagine a scenario where IDF forces would overtly work alongside forces from another regional state.[354] Therefore, to the extent incentives exist for exercise partners to adopt similar synthetic training systems to ensure interoperability in future coalition operations, these motivations would likely be given very little weight by IDF leadership. No evidence exists that Israelis have decided to follow the synthetic training approaches of security partners based on military-to-military contact. Indeed, in conversation, only the US was mentioned as a potential model for the IDF when conceptualizing synthetic training.[355]

While the US Army's planned synthetic training environment (STE) was explicitly mentioned as an architecture and tool of interest to the IDF, it is unlikely that the IDF is following the US Army program simply because of military-to-military contact.[356] In this case, the driver is less ongoing cooperation between the two militaries (which is significant), and more so the fact that the US has emerged as Israel's superpower patron.[357] Deep bilateral ties exist between Israeli and US bureaucratic institutions, to include the IDF and the DoD; the IDF General Staff and the US Joint Staff; the Israeli Ministry of Foreign Affairs and the US State Department; and the IDF and US European Command (now US Central Command based on changes to the command structure in 2021), Joint Forces Command, and Training and Doctrine Command.[358] Israel remains reliant on US support for its defense against missiles and non-conventional weapons.[359] High-tech cooperation between the US and Israel is flourishing—many weapon systems are co-developed or coproduced in Israel. Likewise, the US has emerged as the number one export market for Israeli arms.[360] Most importantly, the US provides Israel $3.3 billion in foreign military financing per

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[352] Freilich, *Israeli National Security: A New Strategy for an Era of Change*, 278.
[353] Neri Zilber, "Gulf Cyber Cooperation with Israel: Balancing Threats and Rights," *The Washington Institute Policywatch 3066,* 17 January 2019, https://www.washingtoninstitute.org/policy-analysis/view/gulf-cyber-cooperation-with-israel-balancing-threats-and-rights and Ian Black, "Why Israel is quietly cosying up to the Gulf monarchies," *The Guardian,* 19 February 2019, https://www.theguardian.com/news/2019/mar/19/why-israel-quietly-cosying-up-to-gulf-monarchies-saudi-arabia-uae.
[354] Johnson et. al., "Preparing and Training for the Full Spectrum of Military Challenges: Insights from the Experiences of China, France, the United Kingdom, India, and Israel," 227.
[355] Baruch, "IDF's Future Simulation Environment's Contribution to Operational Simulation."
[356] *Ibid.*
[357] Yaacov Bar-Siman-Tov, "The United States and Israel since 1948: A 'Special Relationship,'" *Diplomatic History* 22.2 (1998): 231-262 and Mitchell Bard and Daniel Pipes, "How Special is the US-Israel Relationship," *Middle East Quarterly* (June 1997): 41-48.
[358] In January 2021, former US President Donald Trump determined that Israel should be added to US Central Command's (CENTCOM) area of responsibility, partially to encourage military interoperability, but also to strengthen ties between Israel and Arab states. Congressional Research Service, "Israel: Background and US Relations in Brief," 9.
[359] Johnson et. al., "Preparing and Training for the Full Spectrum of Military Challenges: Insights from the Experiences of China, France, the United Kingdom, India, and Israel," 227.
[360] Freilich, *Israeli National Security: A New Strategy for an Era of Change,* 292.

year as part of a ten-year memorandum of understanding (signed in 2016).[361] This is not a trivial amount—it constituted almost 20 percent of the entire Israeli defense budget for 2019. The magnitude of the defense package likely removes some external agency from the IDF. Indeed, as one analyst somewhat hyperbolically quipped, "if you receive $30 million a year, you are a welfare case, if you receive $3 billion, you are a line item."[362] This superpower patron relationship could drive the IDF to adopt a multi-domain synthetic training environment that mirrors elements of the STE.

However, the presence of the US as Israel's superpower patron does not remove all agency from the IDF. The Israeli's, despite their financial dependence on the US, are deeply pragmatic. They are aware, as Stuart Cohen noted when commenting on the strategies of small states, that

> *compensatory strategies of that sort—even when available—are rarely satisfactory. Great powers, after all, are notoriously fickle patrons. They are also discriminating and expensive partners and tend to attach costly diplomatic and political price-tags to even a minimal military commitment*.[363]

This pragmatism springs from a strongly held ethos of self-reliance, which can be partially attributed to Israeli historic experiences. After the birth of the Israeli state, the French emerged as a key military and diplomatic ally—supplying the bulk of Israeli weapon systems and assisting Israel in the development of its nuclear program.[364] However, just three-days before the Six Days War in 1967, the French government under Charles de Gaulle, desirous of being perceived as a more balanced power broker in the Middle East, imposed a general arms embargo across the region. For Israel this was a bitter lesson in the perils of overreliance on a foreign defense supplier—one which subsequently acted as an impetus for the Israeli development of indigenous arms and further stressed the need for a tailored form of strategic autonomy. Thus while the US succeeded in compelling Israel to withdraw from the Sinai in 1949 and 1956, it failed to convince it to open the Red Sea to shipping in 1967.[365] More recently, Israel has regularly demonstrated its willingness to act autonomously within its near-abroad, even when those actions may actively conflict with existing US policies.[366] For these reasons, while the IDF may choose to adopt elements of a US multi-domain synthetic training environment, it is likely that the IDF will choose to adopt an architecture that is uniquely "Israeli," helping to preserve autonomy in their training architecture, tools, and training delivery.

Military-to-military contact appears to pass the straw-in-the-wind test—it is relevant when assessing the IDF's multi-domain synthetic training decisions, but it is not necessary. As mentioned, military-to-military contact between the IDF and security partnerships, such as Europe or the Middle East has little bearing on the IDF's training decisions. The US may be an exception

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[361] Jeremy M. Sharp, "US Foreign Aid to Israel," *US Congressional Research Service* (7 August 2019).
[362] As quoted in, Freilich, *Israeli National Security: A New Strategy for an Era of Change,* 293.
[363] Stuart A Cohen, "Small states and their armies: Restructuring the militia framework of the Israeli Defense Force," *Journal of Strategic Studies* (1995): 79.
[364] Binyamin Pinkus and Moshe Tlamim, "Atomic Power to Israel's Rescue: French-Israeli Nuclear Cooperation, 1949-1957," *Israel Studies* 7.1 (Spring 2002): 104-138.
[365] Freilich, *Israeli National Security: A New Strategy for an Era of Change,* 16-17.
[366] Ilai Z. Saltzman, "Not So "Special Relationship"? US-Israel Relations During Barak Obama's Presidency," *Israel Studies* 22.1 (Spring 2017): 50-75.

to this rule, but that seems to be more a function of the unique relationship between Israel and the US, with the US acting as its superpower patron, more than ongoing military-to-military contact. However, due to the nature of the IDF's security environment, the IDF will likely still choose to pursue a uniquely Israeli training approach.

Hypothesis Five: States will select synthetic training adoptions that mirror the adoption strategies of states that they feel culturally aligned with.

Hofstede and GLOBE studies seek to identify cross-country cultural similarities via a range of attributes. These scores serve as the basis for cross-cultural comparison, allowing analysts to identify to what extent cross-cultural similarity acts as a driver in adoption decisions. Israel's results, and those countries that were identified as "culturally similar" to Israel are found below (see table nine).

Study	**Attribute**	**Score**	**Cultural Similarity**	**Findings**
Hofstede	Power Distance Index	13	Denmark and Austria	Indicative of more pluralistic forms of government; centrist political parties that stress equality; gradualist changes in government; and broad-based civic satisfaction in government.[367]
Hofstede	Uncertainty Avoidance Index	81 (73 when controlling for age)	Mexico and Columbia	Indicative of young democracies; weak citizen interest in politics; higher incidences of xenophobia; and presence of orthodox religions.
Hofstede	Individualism Index	53	Austria and Spain	Indicative of "independent collectivism"—no strict authority exists, but a relative personal dependence on the collective is present.

[367] Israel's low power distance index score reflects a society that developed around an ultra-egalitarian kibbutz system. However, the data from the Hodstede study was collected in the 1970s. Since that time, Israel's population has almost tripled, with a significant portion of the growth a result of immigration from higher PDI states. Therefore, potential exists that Israel's PDI may have changed. Israeli politics have also grown increasingly polarized, with political deadlock and frequent elections fomenting partisan polarization. Lotem Bassan-Nygate and Chagai Weiss, "Israel is voting- for the third time in a year. That's polarizing voters even more," *The Washington Post Monkey Cage,* 27 February 2020, https://www.washingtonpost.com/politics/2020/02/27/israels-voting-3rd-time-year-thats-polarizing-voters-even-more/ and Hofstede, *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations,* 116.

Hofstede	Masculinity and Femininity	47 (41 when controlling for gender)	Singapore, Brazil, and Indonesia	Quality of life is prioritized over work; minimum societal gender differences.
Hofstede	Long Versus Short Term Orientation	Unranked[368]	N/A	N/A
GLOBE	Performance Orientation Indicator	4.08	England and Brazil	Innovation is equally weighted against values of societal and family belonging.
GLOBE	Future Orientation	3.85	Albania and Brazil	Indicates that Israel adjudicates between long-term and short-term policymaking.
GLOBE	Gender Egalitarianism	3.19	Japan and Taiwan	Some women hold positions of power, but firmly skewed towards men.
GLOBE	Assertiveness	4.19	Australia and Argentina	Society views assertiveness as socially acceptable.
GLOBE	Individualism versus Collectivism	4.46	Kuwait and Netherlands	Society weighted towards collectivism, but some prioritization of individualism.

Table 10: Israel Cultural Similarity Expectations from Hofstede and GLOBE Studies[369]

Given the range of countries identified by these two culture indexes, it is difficult to associate Israel with one or two countries based on cultural similarities. However, if one were to select countries, Israel would be "culturally" most like Singapore, Austria, Taiwan, and Brazil. Finally, Israel is not part of an alliance grouping, like the FVEY that are based on shared ideas or values.

Quantitative indicators of culture, as outlined in the Hodstede and GLOBE studies seem to have no bearing on Israeli adoption decisions; nor does the IDF's adoption strategy of a multi-domain synthetic training seem to mirror those countries with whom it has strong quantitative cultural linkages. Singapore, Austria, Taiwan, and Brazil are not highlighted as models (or drivers) for the IDF's adoption of a multi-domain synthetic training environment. Likewise, Israel is not part of any formalized intelligence and/or military alliance grouping based on shared values. It appears that cross-cultural similarity fails to pass both the hoop and straw-in-the-wind test.

While not a function of cross-cultural similarity, Israel does have a unique culture, which is tied to its religious identity. Israel was founded as a Jewish state. Little work explores the explicit role of religion as a diffusion agent or barrier of technical innovations. Indeed, diffusion studies often

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368 Hofstede assumes that Israel would likely fall somewhere in the middle based on a previous study that examined mother gift giving trends in the country. Other mid-ranked countries include the Netherlands and Singapore. *Ibid,* 255.

369 *Ibid,* 225, 286, 355 and House et. al., *Culture, Leadership, and Organizations: the GLOBE Study of 62 Societies,*129.

fold religion under culture and norms, thereby assessing diffusion from a broader norms-based lens that includes the work of cultural geographers, among others.[370] More recent work has sought to examine that connection between diffusion, innovation, and religion.[371] Indeed, studies have assessed religiosity and innovativeness across countries, states, and individuals, noting that a negative relationship exists between religiosity and scientific or technical innovation at all three levels.[372] Religious societies, according to these studies, are less apt to technically innovate (or adopt innovations).

This dissertation is not exploring the connection of religion to adoption decisions across cases and does not assume that religion is a key causative factor when assessing state (or military) level adoption decisions. However, in the case of the IDF, there appears to be a confessional component to their decision-making, that is worth considering in greater depth. Indeed, IDF thinking, in many ways, is deeply connected to the original conceptions of the Zionist enterprise and broader Jewish historical narratives. Arguably, some of the more spiritual or religious elements of IDF thinking have the potential to act as a barrier, to multi-domain synthetic training adoption.

Combat motivation has often been referred to as the "secret weapon" of the IDF.[373] The IDF's ability to maintain constant war footing and prevail in a conflict against numerically superior adversaries has been attributed to their qualitative superiority, which is partially a function of technology, but also results from cohesion, tactical skill, and morale. Academic studies have compellingly linked combat effectiveness and morale to the quality and intensity of training regimens.[374] The IDF is no exception to this rule. IDF soldiers undergo extensive training, which when combined with their battlefield experience, helps to enhance their martial faculties and self-confidence.[375] Yet, in the case of the IDF, combat motivation cannot simply be chalked up to training and battlefield experience, it also takes on a more collectivist and even spiritual element. As Sergio Catignani notes,

> *Whereas cohesion tends to develop mostly during military service in other Western armies, in Israel such solidarity also has been the result of the collectivist character of Israeli society. Thus, such cohesion is already in part present before conscription takes place. In effect, Israeli society has been socialized into a cohesive society based on the principle of gibush (crystallization)…The social idea of gibush involves an emphasis…on joint endeavors, on cooperation and shared sentiments, on solidarity, and a sense of togetherness*.[376]

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[370] Blaut, "Two Views of Diffusion," 343-349 and Young, "Cooperative Diffusion through Cultural Similarity: The Postwar Anglo-Saxon Experience," 93- 113.

[371] Peter Fleissner, "Can religious belief systems influence technological and social innovations?" *International Journal of Information Ethics* 2 (November 2004).

[372] Roland Bénabou, David Ticchi, and Andrea Vindigni, "Religion and Innovation," *National Bureau of Economic Research Working Paper 21052* (March 2015) and Roland Bénabou, David Ticchi, and Andrea Vindigni, "Forbidden Fruits: The Political Economy of Science, Religion, and Growth," *Dietrich Economic Theory Center, Princeton University Research Paper 65* (2014).

[373] Reuven Gal, *A Portrait of the Israeli Soldier* (London, UK: Greenwood Press, 1986): 151.

[374] King, "On Combat Effectiveness in the Infantry Platoon: Beyond the Primary Group Thesis," and Strachan, "Training, Morale and Modern War."

[375] Sergio Catignani, "Motivating Soldiers: The Example of the Israel Defense Forces," *Parameters* (2004).

[376] *Ibid,* 116.

This emphasis on the collective was a key feature of the early Zionist enterprise.[377] The early Zionist founders of the Israeli state drew on Jewish history as a source of motivation. The concept of the "few against the many" is a recurrent theme within Biblical Old Testament stories—from the Battle of Siddim, in which Abraham rescues his nephew Lot from five kings, to Gideon defeating a numerically superior force of Midianities with just three-hundred men.[378] To Ben Gurion, the founder of the state of Israel and the first Prime Minister, it was only through sheer intellect, motivation, and fighting spirit that the nascent Jewish state would survive. This belief system is still embedded within the IDF's collective consciousness. Just prior to the 1967 war, an IDF military leader, Moshe Dayan drew on the biblical story of David and Goliath to describe the IDF position:

> *David did not forego arms for spirit and did not rely on the Lord God of Hosts alone to do battle for him, but rather sought and found a way of fighting that gave him a military advantage over Goliath. But this approach to combat hinges on one thing: he who 'has the spirit of God in him' can employ it. Only those who possess that spirit become daring, fearless fighters…moral superiority must find military-technical expression if it is to carry weight in battle.*[379]

The focus on the more spiritual aspects of motivation has endowed some members of the IDF with a form of techno-skepticism. For IDF leadership, Israeli military success is, and will continue to be, a function of national morale and the passion of Israeli youth to serve.

Furthermore, a preference exists within Israel for the *bitsuist*, the practical doer, over the careful bookish academic that may pore over simulations to make the "perfect" plan or decision. This inclination is rooted in the founding labor Zionist ideology that rejected the stereotype of the "brainy," timid, and vulnerable Jew for the caricature of a "fighting farmer" that is reclaiming and defending the land.[380] Such a belief is apparent in the way Jewish people have shaped their own history. The series of uprisings that comprise the Great Revolt of 66-70 AD, in which the Second Temple was destroyed loom large in the Israeli imagination. While many nations, when reflecting upon their history, will cast external blame for their weakness or defeat, in contrast, the Jewish tradition indicts, rather than acquits, the Jewish people. As Yehoshafat Harkabi notes when commenting on the relationship between Zionism and Jewish historic memory:

> *As a result of their defeats [in the Great Revolt], the Jews were pushed to the margins of history, to become history's object, acted upon as opposed to active. In*

[377] The main objectives of the early Zionist movement have long been achieved—the establishment of a Jewish state, its preservation, and well-being. As a result, the contemporary definition of Zionism is unclear and according to some Israelis, has left the state with a need to craft new unifying objectives. In the absence of that, Zionism has become a source of friction and competing visions. Freilich, *Israeli National Security: A New Strategy for an Era of Change,* 142.
[378] Genesis 14; Judges 7.
[379] Moshe Dayan, "The Fighter's Spirit," as quoted in Cohen et. al., "Knives, Tanks, and Missiles: Israel's Security Revolution," 57.
[380] *Ibid,* 75.

contradistinction, the Zionist enterprise is an effort to restore Jews to the status of subjects in history, making them molders of their own destiny.[381]

For these reasons, when weighted against other priorities, or training options, a multi-domain synthetic training environment may not be a priority (or desirable). Due to the very nature of synchronizing operations across a diverse set of domains, a multi-domain training environment inevitably centralizes command towards potentially more bloated command structure of staff and support units. Centralized command, while useful when attempting to conduct complex time-asynchronous operations, can undermine mission command—a core tenet of IDF operations.[382] Mission command, by rewarding those on the front for their *bitsuist* initiative, willingness to take risk, and ingenuity, in many ways cements and rewards combat motivation. For those reasons, while in some ways useful, a multi-domain training environment could also, inadvertently, undermine two key spiritual facets of the IDF—motivation and a practical doer spirit. To the extent this is clear to IDF leadership, adopting such a technology may prove undesirable.

Additionally, the Jewish historic experience may endow some IDF leadership with a natural skepticism towards the use of simulation, more broadly. Over the course of conversations with IDF leadership, some noted their hesitancy towards the use of simulation due to its perceived lack of friction. A simulation simply cannot emulate the dirt, dust, and sweat of armed conflict. While this can be easily be attributed to the IDF's acute sensitivity to the role of friction in combat, a deeper, and more religious explanation emerged during conversations. Indeed, one reserve officer during a conference presentation quoted a Jewish proverb, noting that after the destruction of the Second Temple in 70 AD, prophecy ceased to exist in Israel.[383] Israelis are mistrustful towards those that profess to know the future as they are reminiscent of false prophets.[384] For that reason the use of simulation for experimentation, planning, and even training is greeted with a certain degree of apprehension.[385]

It is challenging to assess to what degree religion has impacted IDF adoption decisions to date. Indeed, the IDF is a high adopter of multi-domain synthetic training, but various elements of the Jewish historic experience may act as a barrier to adoption. It does seem that religion is relevant and passes the straw-in-the-wind test, but its relevance may be superseded by other causative factors, like Israel's geostrategic environment.

Studying in Process Diffusion: The IDF and Future Multi-Domain Synthetic Training Adoption?

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[381] Yehoshafat Harkabi, *The Bar Kokhba Syndrome: Risk and Realism in International Politics* (Chappaqua, NY: Rossel Books, 1983).
[382] Eitan Shamir, *Transforming Command: The Pursuit of Mission Command in the US, British, and Israeli Armies* (Stanford, CA: Stanford University Press, 2011).
[383] Siboni, "The IDF Concepts Laboratory."
[384] Benjamin D. Sommer, "Did Prophecy Cease? Evaluating a Reevalutation," *Journal of Biblical Literature* 115.1 (Spring 1996): 31-47.
[385] This does not mean that all IDF leadership holds these views. Indeed, IDF efforts since 2007 to establish the Concepts Laboratory and their more recent International Operational Simulation Summit does signify a significant interest among leadership for simulation and wargaming to support planning, decision-making, and training.

What explains the IDF's high-adoption of a multi-domain synthetic training environment—or in the IDF's parlance, their "Multi-Dimensional Joint Training Environment"? Interestingly, in the case of Israel, no hypothesis passes the hoop test, except for a state's geostrategic threat environment. Israel is located in particularly perilous geostrategic environment that has left the state *ein breira* or "no choice," but to innovate technologically, tactically, operationally, and strategically. Simulation is clearly emerging as a key part of that innovation process as demonstrated by the IDF's Concept Laboratory and their willingness to be one of the first state's, worldwide, to experiment with building a multi-domain training environment.

All other alternative hypotheses within the diffusion literature either pass the straw-in-the-wind test, affirming their relevance, or do not pass the evidentiary threshold. For instance, interservice rivalry is present within the IDF and does impact military acquisition and decision-making, but there is no evidence to indicate that it is necessary in their decision-making to date when it comes to a multi-domain training environment. The same can be said of military champions within the IDF. The IDF Chief of Staff has significant influence over the direction of the IDF, and in the case of those that have emphasized emerging technologies and enablers, like training, they may have influenced, even indirectly, IDF decisions to adopt a multi-domain synthetic environment, but no direct evidence confirms that.

Perhaps the most interesting factor that may be worth exploring in greater depth is the relevance of religion on IDF decision-making. Indeed, core tenants of Judaism and Zionism may endow the IDF with a healthy skepticism toward simulation. As the IDF works to implement their multi-dimensional training environment, tracking how religion impacts its implementation over time may be a worthwhile avenue for future scholarly inquiry. Additionally, assessing other theocratic states and their synthetic training adoption strategies in more depth may be useful to further bolster or question this hypothesis.

CHAPTER SEVEN: EXPLAINING MULTI-DOMAIN TRAINING ADOPTION IN THE CANADIAN ARMED FORCES (CAF)

It was an unconventional platform for a Canadian politician. During the 2015 election campaign for the House of Commons, Liberal party leader Justin Trudeau, seeking to wrest control from the Conservative government, made a promise: "we will not buy the F-35 stealth fighter-bomber. We will immediately launch an open and transparent competition to replace the CF-18 fighter aircraft."[386] The liberal platform was unusual; defense debates rarely rise to the level of a Canadian campaign issue. Since the cessation of the Cold War, just twice has a defense issue become an election platform—the 1993 procurement of the EH-101 helicopter and the 1998 question of whether the CAF should procure nuclear submarines.[387]

The Trudeau campaign's promise to not procure the F-35 should not be viewed in isolation. Since the 2010 Conservative government's announcement of its intended acquisition of the F-35, the fighter jet has been something of a political lightning rod. Shortly after the announcement, a Parliamentary Budget Office report released a cost estimate undercutting the government's cost projection.[388] When Stephen Harper's Conservative government refused to provide cost details to a parliamentary committee, the opposition found the government in contempt of parliament, subsequently prompting an election. While the Conservative party ultimately won the election, their plans to procure the F-35 stalled. In 2012, the Office of the Auditor General released a damning report, noting that the decision to acquire the F-35 through a sole source acquisition lacked due diligence.[389] In response, Harper announced a seven-point plan to review the acquisition of the fighter jet. Despite completing the review in 2014, the Conservative government chose not to push forward with the acquisition of the fighter jet. While the aging CF-18 fleet was in desperate need of replacement, the F-35 acquisition issue had become too politically fraught.

When defense issues do become "hot button" campaign or election issues, they are often divorced from any detailed and nuanced understanding of the CAF's genuine operational requirements. Trudeau's pledge to not procure the F-35—while responding to legitimate cost and accountability concerns—was, at its root, a domestic political decision. The decision was fundamentally disconnected from the CAF's strategic and operational reality. Indeed, since Trudeau's election, thirteen RCAF generals have come forward and publicly questioned the government's decision.[390] The Canadian government expects RCAF to simultaneously meet both its commitments to NATO and the North American Aerospace Defense Command (NORAD). However, those commitments are built upon an expectation of interoperability—to include equipment interoperability.

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[386] Brian Lilley, "Lilley: Trudeau's promise to replace fighter jets is far over the horizon," *Toronto Sun,* 23 June 2019, https://torontosun.com/opinion/columnists/lilley-trudeaus-promise-to-replace-fighter-jets-is-far-over-the-horizon.

[387] Roy Rempel, "Achieving Consensus and Effectiveness in Canadian Defence Policy," in Juneau et. al., *Canadian Defence Policy in Theory and Practice,* 5898.

[388] Office of the Parliamentary Budget Officer, *Comparing PBO and DND Cost Estimates on Canada's Proposed Acquisition of the F-35 Joint Strike Fighter: Some Preliminary Questions and Answers on Key Issues* (23 March 2011).

[389] Office of the Auditor General of Canada, "Chapter 2- Replacing Canada's Fighter Jets," *2012 Spring Report of the Auditor General of Canada* (Spring 2012).

[390] Daniel Lang and Mobina SB Jaffer, "Reinvesting in the Canadian Armed Forces: A Plan for the Future," *Report of the Standing Committee of National Defence* (May 2017): vi.

As a result of Trudeau's decision, the CAF was compelled to extend the life of its CF-18 fighters into the 2020s. [391] A capability gap also started to emerge between the Royal Canadian Air Force (RCAF) and the US Air Force (and RCAF and some NATO partners), one that will expand as the F-35 is fully onboarded in the US and other NATO member states.[392] By choosing to exclude the F-35 from any follow-on competition, the government chose to deliberately ignore key CAF (and RCAF) interoperability concerns, while also undermining the government's stated intention of being "open." Interesting, seven years later, the government switched tack. On 28 March 2022, when domestic political considerations (or an election) were no longer an issue, Canada again selected the F-35 in its fighter replacement program.[393]

The F-35 saga is symptomatic of a broader trend within Canada, the extent to which domestic politics takes primacy over defense issues, writ large. Granted, one could argue that this is the case in most modern democracies; in Canada, however, the asymmetry in voter interest is particularly stark. The Canadian electorate simply does not view national security issues with the same urgency as it does questions of social security, health care, or the environment. In the event defense issues do become campaign issues, the analysis tends to be skin-deep. It is within this framework that Canada's (lack of) adoption of a multi-domain synthetic training environment should be viewed.

Drawing on previously unpublished internal government documents, field research in Montreal, and follow-on interviews with industry and CAF military officials, this chapter proceeds in three parts. It first provides an overview of the CAF's current, and planned adoption of simulation across the services. It then examines the diffusion literature to identify the causal pathways by which the CAF may—or may not—have made adoption decisions. As will be shown, the CAF's lack of adoption of a multi-domain synthetic training environment can primarily be explained by its lack of geostrategic threat perceptions. While CAF adoption decisions are partially driven by its alliance obligations, these obligations are not given equal weight to domestic considerations, like the provision of social services.

The CAF's (Lack of a) Multi- Domain Synthetic Training Environment

Simulation has been employed by the CAF for training since WWII, when RCAF first utilized the Link Trainer for pilot training. While synthetic training has developed since that time, the employment of simulation by the CAF to train for multi-domain operations is still somewhat aspirational.[394] A multi-domain synthetic environment does not yet exist in Canada.

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[391] David Axe, "Canada's Air Force: Destined to Become Old and Obsolete?," *The National Interest,* 5 January 2019, https://nationalinterest.org/blog/buzz/canadas-air-force-destined-become-old-obsolete-40802.

[392] JAPCC Editorial Board, "F-35, The Backbone of Next Generation NATO Operations," *Joint Air Power Competence Centre,* accessed 27 January 2019, https://www.japcc.org/f-35-the-backbone-of-next-generation-nato-operations/ and "Joint Strike Fighter Program and the Challenge of Interoperability," *National Defense Industrial Association,* 4 November 2019, https://www.ndia.org/policy/recent-posts/2019/11/4/joint-strike-fighter-program-and-the-challenge-of-interoperability. Adam Chapnick and J. Craig Stone, "From Policy and Strategic Outcomes," in Thomas Juneau et. al., *Canadian Defence Policy in Theory and Practice* (Switzerland: Palgrave Macmillan, 2020): loc 2258.

[393] Rob Gillies, "Canada picks the F-35 in fighter replacement competition," *Defense News,* 28 March 2022, https://www.defensenews.com/air/2022/03/28/canada-picks-the-f-35-in-fighter-replacement-competition/.

[394] Former RCAF commander, LGen Yvan (ret.) Blondin characterizes the level of simulation development within the CAF as "networked simulation training," in essence, different simulators are linked together. The next level of

The Employment of Synthetic Training Across the Services

Like many militaries, RCAF is the most forward-leaning of the services regarding synthetic training adoption. In 2015, RCAF released its *Simulation Strategy 2025,* which emerged as a reference point for nations working to develop a rationale for simulation usage. RCAF defines its simulation vision as follows:

> *By 2025 the RCAF will have a simulation focused training system, which skillfully leverages live, virtual, and constructive (LVC) domains within a networked common synthetic environment. The systems will optimize the means by which RCAF aviators achieve and maintain readiness, fully exploiting advances in both technology and training methodologies, to deliver world-class capabilities for the full spectrum of operations*.[395]

While the vision is specifically focused on aircrew training, its implementation is meant to provide a foundation for synthetic training and procurement across the entirety of RCAF.[396] In tandem with the release of its strategy, RCAF developed a strategic roadmap to achieve its 2025 synthetic training vision. Indeed, RCAF has directed a 'simulation first' approach to training, noting that simulators should be prioritized as training aids against live options. As a result, RCAF has attempted to lean heavily into simulation usage. For instance, while RCAF current employs a live to simulation training ratio of 40/60 for the CH-147 Chinook, it aspires to achieve a 95% synthetic training simulation goal.[397] Training for RCAF's future CF-18 fighter replacement is also expected to meet a live to synthetic training ratio of 40/60.

Beyond increasing simulation usage at the platform level, RCAF is also investing in a common synthetic environment for collective training. In 2012, the service stood up their Air Synthetic Environment Centre, which later emerged as RCAF's distributed mission operations center, thereby supporting RCAF participation in exercises, like Coalition Virtual Flags.[398] More recent LVC programs, include the Advanced Distributed Combat Training System and the Canadian Advanced Synthetic Environment, aim to build the core enabling architecture and virtual training environment for future distributed training across Canada.[399] Additionally, RCAF is in the process

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development, which he characterizes as "strategic simulation level" would, in essence, be a multi-domain synthetic environment. Email correspondence with LGen (ret.) Yvan Blondin, 26 January 2020.

[395] Royal Canadian Air Force, "New simulation strategy sets roadmap for RCAF future," *Royal Canadian Air Force*, March 13, 2015.

[396] Jeff Loube, "RCAF Simulation Strategy 2025," *Military Simulation& Training Magazine* (2015). Retrievable at: http://bluetoad.com/publication/?i=282993&article_id=2335705&view=articleBrowser&ver=html5#%7B%22issue_id%22:282993,%22view%22:%22articleBrowser%22,%22article_id%22:%222335705%22%7D.

[397] *Ibid.*

[398] J.A. Bowser, "An Examination of the RCAF's Simulation Strategy 2025," *Canadian Forces College* JCSP 42 (2016).

[399] Office of the Auditor General of Canada, "Costly delays: The Advanced Distributed Combat Training System project," *Report of the Auditor General* (2004) and National Defence, "Defence Investment Plan 2018: Ensuring the Canadian Armed Forces is well-equipped and well-supported," *Canadian Armed Forces* (2018).

of updating its training ranges—Cold Lake Weapons Range and Bagotville—to ensure they are LVC capable.[400]

RCAF's efforts, thus far, have been geared towards developing an LVC-capable network, not necessarily a multi-domain environment. Indeed, when weighted against other RCAF priority areas—such as replacing or updating aging platforms and training ranges—securing funding to achieve its LVC goals by 2025 appears difficult enough. However, there is indication that interest does exist within RCAF to eventually achieve a multi-domain training environment. RCAF leadership has noted that a major argument in favor of moving toward LVC is the advent of multi-domain operations.[401] Yet despite RCAF's interest in LVC, its utilization is still very much in development. In the course of conversation, Gene Colabatistto, the former President of CAE's Defence and Security Group, noted that RCAF was employing simulation "the way [the US] was using it ten years ago—largely as an adjunct to pilot training."[402] Colabatistto went on to note that RCAF is starting to see simulation more than simply an "add-on" to hone pilot skills, but as something that could be employed for mission training. For RCAF to reach a level whereby it could train for multi-domain operations, it would need to move beyond mission training, and begin to employ simulated solutions to rehearse for more tailored missions, that include cyber and space warfighters.

The Canadian Army has not adopted synthetic training options with the same frequency as RCAF. One Canadian officer described the Army's historic relationship with synthetic training as a "rocky relationship," due in part to technical and culture issues within the service.[403] Yet, despite a reluctance to use synthetic over live training options, the Army does have extensive experience using simulation. In 1988, the Canadian Army procured the US Janus simulation—a simulation that allows users to control opposing simulated armies—for experimentation purposes.[404] In 1995, the Army's Joint Command and Staff Training Centre (since renamed the Canadian Army Simulation Centre) was established. Since then, the Canadian Army has been employing various types of co-located virtual and constructive simulations for collective training.[405] The Canadian Army has a range of simulators to support tactical and operational training, such as the Light Armored Vehicle 6.0, Leopard 2 Main Battle Tank, and the Tactical Armored Patrol Vehicle. Alongside simulators, the Army also employs a range of lower-fidelity training devices, like multipurpose computer-based systems with screens and controllers, that can elicit key tactical, or even operational, learning outcomes.[406] In 2021, it procured a far more flexible and reconfigurable

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[400] David Pugliese, "Canada takes initial step in modernizing fighter aircraft training ranges," *Ottawa Citizen,* 21 February 2019, retrievable at: https://ottawacitizen.com/news/national/defence-watch/canada-takes-initial-step-in-modernizing-fighter-aircraft-training-ranges.
[401] MGen Alain Pelletier, "Shaping the human contribution to achieve operational advantage," (Presentation at the Military Flight Training Conference, London, UK, 26 March 2019).
[402] Interview with Gene Colabatistto, Washington DC, 4 February 2020.
[403] Alex Nitu, "More than Meets the Eye: Army Vehicle Simulations in the 21st Century," *Canadian Forces College* JCSP 45 (2019): 1.
[404] George Nikolakakos and Maude Amyot-Bourgeois, "Combat Simulation: How the Army is revitalizing a critical experimentation capability," *Canadian Army Today 4.2* (2020): 70.
[405] Stephen Fritz, "The Canadian Army Simulation Centre: Delivering World Class Collective Training in a Synthetic Environment," *Canadian Defence Review* (December 2017).
[406] Richard Bray, "From the road to the simulator: Combat vehicle training in a virtual environment," *Canadian Army,* 18 May 2020, https://canadianarmytoday.com/from-the-road-to-the-simulator-combat-vehicle-training-in-a-virtual-environment/.

military driving simulator, that mimics the driving conditions for a range of military vehicles, weather conditions, terrain, and environments—from rural to urban environments.[407]

In 2020, the Canadian Army released its modernization strategy, *Advancing with Purpose: The Canadian Army Modernization Strategy*, that outlines how the Army is positioned to address a turbulent and changing "pan-domain" conflict environment.[408] To ensure that end, the Army aspires to create a modern and robust training system that draws on "virtual and constructive simulation for both collective and individual training, as well as distributed learning in order to ensure that basic skills have been learned before engaging in live simulation events like field exercises."[409] LVC is seen as a key way to meet that need. As a result, presently, the Canadian Army is developing a distributed training capability and expects that in the future—through a "Virtual Training Environment Network"—ground exercises may include divisions located at disparate locations.[410] Entitled the "Land Vehicle Crew Training System," which is expected to be procured in 2026, the Army aspires to connect simulators at five bases across the country—Edmonton, Shilo, Petawawa, Valcartier, and Gagetown.[411]

In 2015, the Royal Canadian Navy (RCN) released their *Future Naval Training System Strategy*, in a bid to overhaul collective training across the force. The strategy aspires to "introduce Fleet Synthetic Collective Training, leveraging rapidly evolving network technologies to enable greater training effectiveness and expanded training capabilities in increasing realistic distributed environments."[412] The strategy identified a range of gaps in the Navy's synthetic training capabilities, such as the inconsistent exploitation of technology, aging physical and digital infrastructure, and that training was not considered a capability, so it often lagged behind the capability platforms that it was designed to simulate.[413] Indeed, synthetic training across the Navy required an overhaul—not just collective training. Many simulators in use by the RCN are in high-demand by the RCN's two fleets—the Atlantic and Pacific Fleets—resulting in simulators being fully booked to meet service-level requirements. The RCN's training infrastructure is outdated and widely dispersed across the country. These concerns were echoed two years later, when the RCN released its *RCN Strategic Plan 2017-2022,* which highlighted pressing concerns within the service and their strategy to address service shortfalls, to include synthetic training.[414]

There has been some notable progress towards the Navy's Future Training System, which is being developed and integrated under the Naval Training System Transformation Program. The RCN intends to develop a "holistic, integrated, System of Systems that provide the full breadth of

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[407] SimLeader, "Canadian Armed Forces welcomes new training simulator," *SimLeader,* 25 May 2021, https://simleader.ca/en/canadian-armed-forces-welcomes-new-training-simulator/.
[408] Canadian Army, *Advancing with a Purpose: The Canadian Army Modernization Strategy* (Ottawa, Canada: HQ Canadian Army, 2020): 23
[409] *Ibid,* 33.
[410] Jarmasz and Martin, "Distributed Simulation for Training: Promises, Barriers, and Pathways," and "Training in Transition," *Canadian Army Today,* 9 April 2018, https://canadianarmytoday.com/training-in-transition/.
[411] Canadian Army, *Advancing with a Purpose: The Canadian Army Modernization Strategy,* 34 and Bray, "From the road to the simulator: Combat vehicle training in a virtual environment."
[412] Royal Canadian Navy, "Future Naval Training System Strategy," *National Defence* (2015), 2.
[413] *Ibid.*
[414] Royal Canadian Navy, "Royal Canadian Navy: Strategic Plan 2017-2022," *National Defence* (2017) and AJ Armitage, "Fighting the Last War Tomorrow: A Recommendation for Restructuring Naval Force Development," *Canadian Forces College* JCSP 45 (2019): 6.

training to address the RCN's Force Development, Force Generation, and Force Employment requirements."[415] To meet that need, the RCN has stood up its distributed mission operations center at the Naval Fleet School Atlantic and is now working to bring disparate simulators into a single cohesive synthetic environment.[416] In 2019, the Naval Training System released their "Concept of Training," that seeks to integrate seven diverse training RCN platforms through the adoption of cloud technology to deploy training at the point of need, while enhancing collective training. It is expected that the investments and technology for their future training concept should be rolled out in the mid-2020s.[417] Platform based acquisitions, like the Canadian Surface Combatant, is also driving training reform, as the RCN has noted that they will need to integrate next-generation simulators at sea and at shore to meet the platform's training needs.[418] While the RCN is working to update its synthetic training enterprise, there is reason to be cautious when assessing their future training plans. Indeed, according to Colabatistto, it is unclear whether the RCN institutionally knows how it wants to achieve its future collective training ambitions.[419]

From a joint perspective, the CAF's newly minted JOINTEX series of exercises may incentivize joint distributed synthetic training across the force. JOINTEX, an annual series of activities built around a four-year campaign concept (2019-2021), is meant to develop a whole-of-nation multi-domain approach to warfare in the information age—with an emphasis on non-munitions targeting, to include cyber, information, and space operations (see figure nineteen). [420] Canada's JOINTEX series of exercises indicate that the CAF is starting to think strategically about how they can integrate cyber and space operations, alongside conventional operations for battlefield success. While JOINTEX's campaign concept is still in its nascent phase, it could act as a catalyst for the development of a future multi-domain synthetic environment, dependent on how the exercises evolve.

[415] Royal Canadian Navy, *Royal Canadian Navy: Future Naval Training System Strategy* (July 2015), Royal Canadian Navy, *Concept of Training* (December 2018) and Royal Canadian Navy, "Collective Training: Strategy, Policy, and Guidance Paper," *Assistant Chief of Naval Staff* (May 2016).
[416] Bill Sanson, "Train as You Fight: How Synthetic Training Will Shape RCN Combat Readiness," *Canadian Forces College* JCSP 44 (2018): 18.
[417] Bardley White, "Transforming Canada's Naval Training System" *The Maple Leaf,* 21 Map 2019, https://ml-fd.caf-fac.ca/en/2019/05/28933.
[418] Royal Canadian Navy, *Concept of Training* (December 2018): 4 and Royal Canadian Navy, *Canada in a New Maritime World: LEADMARK 2050* (2016): 36.
[419] Interview with Gene Colabatistto, Washington DC, 4 February 2020.
[420] Government of Canada, "Overview: JOINTEX 2019.1 Joint Operations Symposium," *Canadian Armed Forces,* October 2018, retrievable at: https://www.canada.ca/content/dam/dnd-mdn/documents/campaigns/jos-2019-letter.pdf.

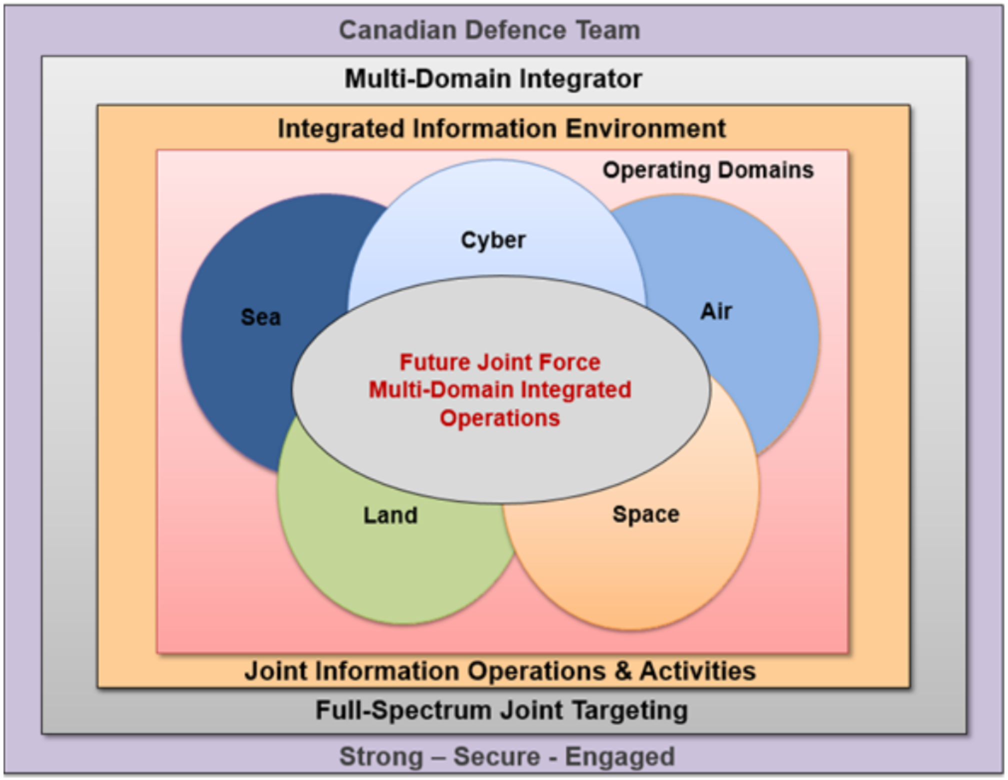

Figure 35: JOINTEX Canadian Defence Team Operating Environment. Image from Government of Canada, "Overview: JOINTEX 2019.1 Joint Operations Symposium," Canadian Armed Forces, October 2018

A prerequisite, however, for integrated cyber-conventional operations is a cyber force. While the CAF has engaged in offensive cyber operations for some time, it was only in 2017 with the release of the *Strong, Secure, and Engaged* defense policy that the CAF was granted permission to develop an offensive cyber capability for future operations.[421] In January 2018, the CAF welcomed its first cyber operators to the force and updated its doctrine by publishing *Joint Doctrine 2017-02 Cyber Operations*.[422] Despite recent organizational changes, it will take time for the CAF to develop their needed cyber support infrastructure. This will require sustained investment and development efforts. Indeed, in 2017, researchers at Defence Research and Development Canada, highlighted the need for a "real world" operational environment to test, validate, experiment, and train with new cyber capabilities.[423] In short, it does not appear that the CAF, at present, has cyber range capabilities. Arguably a cyber range is a foundational element of any multi-domain synthetic environment. Indeed, many multi-domain training architectures under development integrate cyber training ranges with kinetic mission training environments through an application programming interface.[424] Moreover, while the CAF does have some space based programs (i.e.,

[421] Canadian Armed Forces, "Strong, Secure, Engaged: Canada's Defence Policy," *National Defence* (2017) and Alex Grigsby, "Canada's Military Gets More Cyber, and the Headaches that come with it," *Net Politics,* 22 June 2017, https://www.cfr.org/blog/canadas-military-gets-more-cyber-and-headaches-come-it.
[422] Government of Canada, "DND/CAF welcomes first cyber operators," *The Maple Leaf,* 8 January 2018, https://ml-fd.caf-fac.ca/en/2018/01/9092 and Malcolm Day, "Developing the CAF Cyber Capability: The Need to Integrate the Reserve," *Canadian Forces College* JCSP 43 DL, Exercise Solo Fight (2018): 8.
[423] MG Dondo, "The Cyber Capbility Development Centre (CCDC): A business case," *Defence Research and Development Canada,* Reference Document DRDC-RDDC-2017-D003 (January 2017): iii.
[424] See, the previously discussed COATS program. Wells and Bryan, "Cyber Operational Architecture Training System – Cyber for All."

the governments RADARSAT Constellation), and have set research and development funds aside for "all domain situational awareness," it does not appear that the CAF has a synthetic training environment for space based operations. [425] In short, there is no unclassified open source data that indicates that the CAF has a multi-domain synthetic environment.

Despite the CAF's lack of a multi-domain synthetic environment, there are indications that the conceptual foundations for such a future training environment may be in development. In February 2019, the Commander of Joint Forces Command, Lt. Gen. Mike Rouleau released an internal handwritten memo, entitled "How We Fight."[426] The memo, which has since been widely circulated across the services and among allies, was later expanded into a *Pan-Domain Force Employment Concept*.[427] Operating as a "pan-domain" force is, in short, the CAF's planned response to a multi-domain battlespace. With a five-year horizon, the concept is meant to spur immediate investment in planning, C2 concepts, education, training, and interoperability across the force, while also guiding CAF future capability requirements.[428] According to the CAF, any change to training also needs to provide experiential learning across domains—to include space, cyber, and the information space.[429] While the concept, and its affiliated planning documents, do not explicitly address the creation of a multi-domain synthetic training environment, one could extrapolate that such an environment could be identified as a future investment need.

Identifying the "Why" Behind the Lack of CAF Multi-Domain Synthetic Training Adoption

The drivers, or more specifically barriers, behind the CAF's (lack of) adoption of synthetic training are complex. This section assesses the diffusion literature to identify the causal pathways by which the CAF may have made their adoption decisions, thus helping to prove or disprove the five alternative hypotheses. It subjects each alternative hypothesis to "straw-in-the-wind" or "hoop tests" (see table ten for a summary of findings).

Alternative Hypotheses	Evidentiary Threshold: Process Tracing Test
One: Presence of Geo-Strategic Competition	Hoop test
Two: Organizational Propensity for Reform	Straw-in-the-wind
Three: Presence of High-Level Champions	Hoop test
Four: Military-to-Military Contact	Hoop test
Five: Cultural Similarity	Does not pass evidentiary threshold (quantitative attributes of culture); straw-in-the-wind (alliances based on shared norms)

Table 11: Explanatory Value of Alternative Hypotheses to the CAF

[425] Ryan McKeown and Alex Wilner, "Deterrence in Space and Cyberspace," in Juneau et. al., *Canadian Defence Policy in Theory and Practice,* loc 9268, Stephanie Carvin, "Canadian Defence and New Technologies," in Juneau et. al., *Canadian Defence Policy in Theory and Practice,* loc. 8914, and Desmartis, "Knowledge Exchange- Canada."
[426] Rouleau, "How We Fight: Commander, CJOC's Thoughts."
[427] Conversation with Brig. Gen. David Anderson, 14 November 2019, Tel Aviv, Israel and Canadian Joint Operations Command, "How We Fight: V8 Final."
[428] National Defence, "Pan-Domain Force Employment Concept: Prevailing in an Uncertain World," *Canadian Armed Forces* (under review): 9.
[429] Canadian Joint Operations Command, "How We Fight: V8 Final," *Canadian Armed Forces* (2019): 7-8.

Hypothesis One: States that live in regions of intense geo-strategic competition will adopt synthetic training at a higher rate.

The greatest explanatory factor for the CAF's lack of a multi-domain synthetic training environment may be its geo-strategic threat environment. Bestowed with an advantageous geographic position, Canada is physically removed from centers of great power competition.[430] Flanked on the East and West by the Atlantic and Pacific Oceans and bordered to the North by the inhospitable Artic, Canada is, for all intents and purposes, surrounded on three sides by ocean-sized moats. As Canadian political scientist, Douglas Alan Ross noted, Canadians are fortunate to be endowed with "three ocean barriers plus an 'Artic desert' to deter any conceivable attack."[431] To the South, Canada is bordered by the US, a formidable ally, with which it maintains close cultural, economic, and military ties. Canada's geography is enviable—since confederation it has lacked existential threats. When commenting on Canada's remoteness from any perceived threats, Senator Raoul Dandurand quipped in 1924 that Canadians live in a "fire-proof house, far from inflammable materials."[432] Apart from concerns during the Cold War that Canada may become collateral damage in a Soviet-US nuclear standoff, Danduranad's comment has largely rung true.[433] Indeed, in recent testimony to the Parliamentary Standing Committee on National Defence, the then Assistant Chief of Defence Intelligence at the Canadian Forces Intelligence Command, Stephen Burt, noted that the CAF does not perceive "a state actor that has both the capability and the intent to harm Canada militarily."[434] Even the threat of a large-scale terrorist attack on the Canadian homeland has been deemed somewhat remote by the government. Shortly after the September 11 terrorist attacks on the US, the Prime Minister notably downplayed the risk to Canada as slight.[435]

Instead, rather than perceiving threats as material or existential risks to the state, the government's historically articulated threats—and its resultant defense priorities—have largely been colored by ideology.[436] Even a quick perusal of Canada's defense white papers reveal that Canada's threats have always been ideologically or alliance-driven, rather than driven directed by concerns over its survival as a nation state: USSR (1964, 1971, 1987, 1989, 1992) Yugoslavia (1994), Afghanistan

[430] Pre-confederation, Canada's largest threat came from the American colonies. While the threat from the US had abated post 1814, the Canadians did not scrap Canadian Defence Plan 1 (their plan for a war with the Americans) until 1920. The Americans shelved their plan— "War Plan Red"— for the invasion of Canada in 1939. Desmond Morton, *Understanding Canadian Defence* (Toronto, Ontario: Penguin Group, 2003).
[431] Douglas Ross, "Canadian International Security Policy in the 21st Century: Closing the Book on the Sutherland Era? Not at All," in Duane Bratt and Christopher Kukucha, *Readings in Canadian Foreign Policy: Classic Debates and New Ideas* 3rd ed. (Toronto, Canada: Oxford University Press Canada, 2015): 327.
[432] As quoted in Juneau et. al., *Canadian Defence Policy in Theory and Practice,* loc. 404.
[433] Canadian author, Mel Hurtig noted, that "*because Canada is geographically located between the superpowers, Canadians are in particular danger. In any serious military confrontation between the Soviet Union and the United States, Canada would become the incinerated meat in the nuclear sandwich*." As quoted in David Haglund and Joel J. Sokolsky, *The US-Canada Security Relationship: The Politics, Strategy, and Technology of Defense* (New York, NY: Routledge, 2019).
[434] Stephen Furh, "Canada and the Defence of North America: NORAD and Aerial Readiness," *Report on the Standing Committee on National Defence* (September 2016): 6.
[435] Elinor Sloan, *Revolution in Military Affairs: Implications for Canada,* (Montréal, Canada: McGill-Queens University Press, 2002): 118.
[436] For instance, the threat of communism during the Cold War was highlighted in the 1964, 1971, 1989, and 1992 defense white papers. Thomas Juneau et. al., *Canadian Defence Policy in Theory and Practice,* (Switzerland: Palgrave Macmillan, 2020): loc. 824.

(2005, 2008), and Russia (2017).[437] This has led one defense analyst to quip that "Canada's defense problem is that it has no defense problem."[438] Indeed, in a country that is unlikely to fight a war in defense of its political and economic heartland, Canadians have had the luxury of investing their money in social or public services, in lieu of defense. Far from facing a competitor or adversary, Canadians live in what some scholars call "systemic peace."[439]

Furthermore, while the Canadian government has dealt with some instances of internal public unrest—for instance, during the October Crisis and the Oka Crisis—these incidents have been notably rare. Rather, a key domestic source of anxiety for the government has been, and continues to be, maintaining sovereignty over its vast geographic state.[440] Comprising 9.985 million square kilometers of land and freshwater, Canada is the second largest state in the world, possessing the world's longest coastline. Canada's relatively small population—37.59 million, less than the state of California—is predominantly located in the South, abutting the US border, placing enormous pressure on it to maintain control (and emergency services) on its northern outer expanses. Yet, it is not just Canada's expansive geography that proves challenging—it is its climate and topography. Canada's territory is diverse, comprising mountains, plains, rainforests, desserts, forests, and the Artic. Exerting control of the North, to include providing search and rescue, requires the CAF to operate in temperatures as low as -60 degrees C, often with high winds, and for at least half the year, in darkness.[441] This creates a unique situation—Canada's geography is, in many respects, a blessing, but also, a challenge. As former Prime Minister Mackenize King stated in 1936, "if some countries have too much history, we have too much geography."[442]

Canada's anxiety stemming from its geography drove Canadian hemispheric defense investments and policy during the Cold War. Concerns that Soviet tanks may invade from the Artic caused Ottawa to sanction Operation Muskox in 1946—Canada's largest military deployment to the Artic which spanned 2000 km. The deployment—designed in part to train for a ground and air war in the region—proved it was unlikely that the Soviets would invade by ground through the Artic.[443] Instead, Ottawa—in tandem with Washington DC—turned its attention to securing North America's air and maritime domains. The same year as Operation Muskox, Canada and the US, under the aegis of the Permanent Joint Board on Defense, began planning what would become the Pinetree Line—a radar line running east to west designed to detect an impending Soviet bomber attack. By the mid 1950s, US and Canadian personnel installed the DEW Line (Distance Early Warning Line) in the outermost reaches of the US and Canadian arctic tundra as an early warning system against a potential Soviet inter-continental ballistic missile attack. The DEW line worked in tandem with the Pine Tree Line, and the Royal Canadian Air Force constructed Mid-Canada

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[437] *Ibid,* loc. 824.
[438] Joel Sokolsky's presentation to incoming US Ambassador to Canada as quoted by Morton, *Understanding Canadian Defence,* 3.
[439] Juneau et. al., *Canadian Defence Policy in Theory and Practice,* loc. 470.
[440] For more on the October and Oka crisis, see, William Tetley, *The October Crisis, 1970: An Insider's View* (Montreal, Quebec: McGill University Press, 2007) and Gerald Alfred, *Heeding the Voices of our Ancestors: Kahnawake Mohawk Politics and the Rise of Native Nationalism* (Oxford, UK: Oxford University Press, 1995).
[441] *Ibid,* loc. 531.
[442] As quoted in Kim Richard Nossal, "The Imperatives of Canada's Strategic Geography," in Juneau et. al., *Canadian Defence Policy in Theory and Practice,* loc. 352.
[443] Daniel Campbell, "The Long Way Home," *Uphere Magazine,* 24 May 2016, https://uphere.ca/articles/long-way-home-0.

Line (or McGill Fence) as an air alert system (see figure thirty-five).[444] In 1957, the North American Air Defense Command (now NORAD), was created, a combined bi-national command organization between the US and Canada to provide air space early warning, air sovereignty, and to protect the territorial integrity of Canada and the continental US.[445] The Pine Tree Line and the DEW Line became part of the NORAD early warning system—helping to assuage US and Canadian Cold War concerns. Additionally, in the late 1980s, as concerns rose that Soviet and American vessels may violate Canada's maritime sovereignty, defense policy sought to increase surface and subsurface investments.[446]

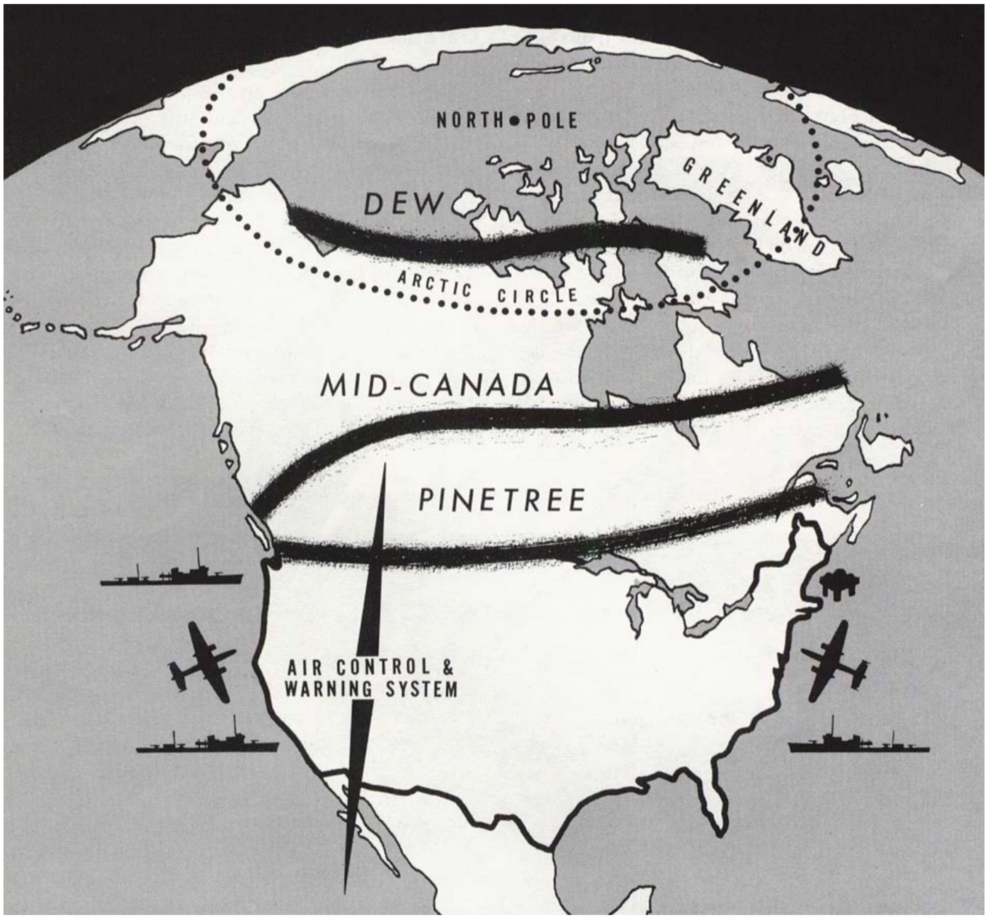

Figure 36: NORAD's Triple Radar Defense Structure. Figure from John Douglas Belshaw, Canadian History: Post-Confederation (Open Commons: University of British Columbia, 2012): Chapter 9.4.

The need to protect its sovereignty has led to a uniquely Canadian phenomenon, that has been labeled "defense against help" —the belief that Canada must defend itself against American help. "Defense against help" is derived from Nils Ørvik's 1973 thesis, which argues that small states may seek to maintain some semblance of military capacity against external threats to prevent a

444 "Post World War II Radar," *Federation of American Scientists,* 16 October 1997, https://fas.org/nuke/guide/usa/airdef/annexf.htm, John P. Rafferty, "Distant Early Warning Line," *Encyclopedia Britannica,* accessed 18 May 2020, https://www.britannica.com/technology/Distant-Early-Warning-Line.

445 North American Aerospace Defense Command, "A Brief History of NORAD," *North American Aerospace Defense Command Office of History* (31 December 2013).

446 Greg C. Kennedy, "The Canadian-American Alliance, 1955-1988: Some Maritime Considerations," *Naval War College Review* 46.4 (1993).

larger neighbor from stepping in and "helping;" thus impeding on its sovereignty.[447] In short, some academics allege that the Canadian government fears if they do not invest in a minimal level of defense, the US will take unilateral actions to provide for it, without their consultation.[448] Concerns related to "defense against help" can be traced back to the interwar years. In 1938 Mackenzie King noted,

> *We too, as a good and friendly neighbor [to the US], have our responsibilities. One of them is to see their country is made immune from possible invasion as we can reasonably be expected to make it, and, that should the occasion ever arise, enemy forces should not be able to make their way, either by land, sea, or air, to the United States across Canadian territory.*[449]

Shortly after the creation of NORAD, Canadian strategist, Robert J. Sutherland echoed this sentiment, stating "…the price of Canadian national survival is a willingness to respect the security interests of the United States."[450] In the midst of the Cold War, and one of the primary impetuses for the creation of NORAD, was that the US saw Canadian territory as crucial to their defenses against potential Soviet bombers. The Canadian electorate would not tolerate the mass defense expenditures required to meet American concerns, nor would the Canadian government allow the US to unilaterally provide those defenses on Canadian soil. NORAD gave the Americans the security they sought, while also providing Canadians some guarantee that the Americans would not violate their airspace. Canadians were active participants in air defense, thus succeeding in defending themselves against help.

However, it is not just sovereignty concerns that drives Canada's need to "defend itself against help"—it is also economic concerns. The aftermath of 11 September 2001 had severe economic implications for Canada. Lines of trucks snaked back from the US Canadian border, as the US tightened security for entry, creating a bottleneck in goods. Nearly $1.6 billion in trade crosses the US Canadian border each day, totaling $718 billion in 2018 ($354.7 billion of which, were Canadian exports).[451] Since that time, Canada has tried to assuage any concerns that Canada could be the "soft underbelly" of a potential terrorist strike on the US, by passing legislation, like the 2015 Anti-Terrorism Act.[452] According to some, "defense against the lock-down" is a better characterization of US-Canadian relations, than "defense against help."[453]

[447] Nils Ørvik, "Defence against help- a strategy for small states," *Survival* 15.5 (1973): 228-231.
[448] Morton, *Understanding Canadian Defence.*
[449] Mackenzie's thinking helped drive the Ogdensburg Agreement two years later. As quoted in Ben Lombardi and Bill Ansell, "Military Planning, Canada's Strategic Interests and the Maritime Domain," *Canadian Military Journal* 18.4 (Autumn 2018): 8.
[450] Department of National Defence, *Report of the Ad Hoc Committee on Defence Policy* (30 September 1963): 8.
[451] Office of the US Trade Representative, "Canada," *Office of the Presidency,* accessed 11 February 2020, https://ustr.gov/countries-regions/americas/canada.
[452] The view of Canada as the "soft underbelly" of US defense began with the Assad Ressam case. Ressam, an Algerian born al-Qaeda member, living in Montréal attempted to bomb Los Angeles airport in 1999. The attack was foiled, and he was convicted in 2001 to 22 years in prison. Sloan, *The Revolution in Military Affairs: Implications for Canada and NATO,* 121.
[453] Justin Massie and Srdjan Vucetic, "Canadian Strategic Cultures: From Confederation to Trump" in Juneau et. al., *Canadian Defence Policy in Theory and Practice*," loc. 962.

To other academics, "defense against help" isn't fully explanatory and may be analytically misleading. For one, the US has never provided Canadian "help" without its express permission; and secondly, the US and Canada are culturally similar and economically interdependent. Instead, Canada's strategy may be better coined as one of "borrowed power," whereby the government is able to ensure control over its territory, while utilizing US military assets and financial investments to meet its own security needs.[454]

When examining national innovation rates among states, political scientists find that countries whose domestic sources of angst overshadow external security concerns, tend to adopt innovations at lower rates than those states focused on external security issues.[455] Despite debates on the nature of "defense against help" or "borrowed power," Canada seems to fit squarely within this category—ensuring sovereign control over and within its borders transcends any perceived external threats. The lack of external threat perceptions has clear implications for how Canada's populace and political elites prioritize defense. In short, defense is largely a non-issue, politically. No real incentive exists for the Canadian politicians to prioritize defense over other social or economic issues. Indeed, only in one general election—April 1963—did defense become a decisive issue.[456] Conservative or liberal, the electorate has not punished the Canadian government for slashing the defense budget to anemic levels. Instead, defense—to include the defense budget—is subordinated to other Canadian concerns. As two analysts noted, "in retail shopping terms, Canada has no need for an upscale Saks Fifth Avenue level of grand strategy, when it has fared well with Walmart…[just] enough practical utility and superficial style to keep the country secure, prosperous, and stable."[457]

This situation has two notable implications for defense strategy and acquisitions. The first, is that Canadians are often characterized by defense analysts as "easy riders;" they elect governments that devote as little funding as possible to defense.[458] When funding is allocated, it is first directed to those areas in which the CAF must "go it alone," such as the protection of borders or search and rescue. It is unlikely a multi-domain synthetic training environment would fall within this category, as offensive multi-domain operations would project force and defense resources outward, away from Canada's sovereign territory. Second, defense strategy is often subordinated to politics—at times being employed as a political prop to meet politicians' electoral needs. The most recent example of this trend was Trudeau's political pledge in 2015 not procure the F-35 joint strike fighter, only to reverse tack seven years later when it became clear his original position was untenable. Likewise, since 1964, defense white papers have also, as scholars have noted, been

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454 Andrea Charro and James Fergusson, "Canada and Defence Against Help: The Wrong Theory for the Wrong Country at the Wrong Time," in Juneau et. al., *Canadian Defence Policy in Theory and Practice,* loc. 2545.
455 Taylor, "Toward an International Relations Theory of National Innovation Rates," 114.
456 During the 1963 election, the Tories split partially over the proposal to station American nuclear missiles on Canadian soil for North American defense. Prime Minister Diefenbaker was against the proposal, and subsequently lost reelection. Patricia McMahon, *Essence of Indecision: Diefenbaker's Nuclear Policy, 1957-1963* (Montreal, Canada: McGill University Press, 2009).
457 Christian Leuprecht and Joel Sokolsky, "Defense Policy 'Walmart Style': Canadian Lessons in 'Not-so-Grand' Strategy," *Armed Forces and Society* 41.3 (2015): 543.
458 Joel Sokolsky, "Realism Canadian Style: National Security Policy and the Chrétien Legacy, *Policy Matters* 5.2 (2004): 11.

"unabashedly political." They allow the new government to differentiate their defense policy from their predecessor, even when continuity exists across administrations.[459]

There are some recent signs, however, that external threat perceptions are beginning to change within Canada, with potential implications for defense. Current and emerging threats, like cyber and hypersonic weapon systems, erode the traditional security provided by Canada's geography—much like Soviet ballistic missile threats during the Cold War. Russia has become increasingly provocative within the Artic, consistently probing Canada's border to better understand RCAF's and the RCN's air and littoral defenses.[460] Recent polling of the Canadian public reveals that the country feels increasingly vulnerable; viewing the world as a far more dangerous place.[461] While parts of the military, likewise, perceives itself on persistent war footing, operating daily in the "grey zone" against nation states.[462] As a result of these trends, the Trudeau government has sought to raise defense spending, allocating $62.3 billion in new spending over a 20-year time horizon. The new funding is meant to cover big ticket items, like new warships and fighter jets, along with increased personnel. At present, however, it is unclear how the additional defense funding will be raised.[463] Even as perceptions of Canada's geostrategic environment are changing, the government and military still sees Canada as secure. As Rear Admiral Scott Bishop, the current commander of the Canadian Forces Intelligence Command, stated, the CAF views "no direct military threat from another state in the next ten years."[464] Instead, more diffuse concerns such as climate change's near-term impact on the Artic are highlighted as more pressing concerns.[465]

Canada's lack of adoption of a multi-domain synthetic training environment seems to be directly related to Ottawa's perceptions of its geostrategic threat environment. Indeed, hypothesis one appears to pass the hoop test—Canada's secure geostrategic environment is a necessary factor when assessing adoption rates.

Hypothesis Two: States that have a propensity for organizational reform within their defense bureaucracies will have higher synthetic training adoption rates.

Canada is unique among Western countries when assessing models of organizational innovation due to the degree that its armed forces have been unified under one uniform and one command structure. The unification of the Canadian armed forces in the 1960s, even if short-lived, impacted CAF interservice rivalry, organizational culture, and to a degree intraservice rivalry.

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[459] For instance, the last four defense white papers were strikingly similar. All three advocated for the defense of the homeland, defense of North America, and a commitment to international security. Juneau et. al., *Canadian Defence Policy in Theory and Practice,* loc. 511, 531

[460] Andrea Charron and Jim Fergusson, "NORAD: Beyond Modernization," *Centre for Defence and Security Studies* (31 January 2019).

[461] Jean Christophe Boucher, "Public Opinion and Canadian Defence Policy," in Juneau et. al., *Canadian Defence Policy in Theory and Practice,* loc. 3842- 4343.

[462] Mike Rouleau, "How We Fight: Commander, CJOC's Thoughts," *Canadian Joint Operations Command,* 10 February 2019.

[463] Guy Eastman, "Canadian Defence Budget," *Jane's Defence Budgets,* 16 January 2020.

[464] Stephen Fuhr, "Canada and the Defence of North America: NORAD and Aerial Readiness," *Report of the Standing Committee of National Defence* (September 2016): 7.

[465] Lang and Jaffer, "Reinvesting in the Canadian Armed Forces: A Plan for the Future," 61.

In the 1960s, Prime Minister Lester Pearson's government became increasing concerned by spending across the Canadian military services. The Canadian Department of Defence had allocated 25 percent of the government's budget in direct spending yet had incurred large cost overruns on all major acquisition projects. The government felt something had to be done—too many efforts and organizations were being replicated across the services, and interservice rivalry was identified as one of the culprits for budget overruns. In 1966, the government introduced Bill C-234, the Canadian Forces Reorganization Act, which unified the services under one single command. The three services were abolished and replaced with generic structures, called "environments," such as the sea, air, and land environment. In 1968, the bill came into effect—abolishing traditional ranks and uniforms, and replacing them with a common green uniform across the force.[466]

The response was mixed. Unification was greeted with hostility by leaders within each of the services, particularly within the RCN, which caused the RCN's senior operational commander, Read Admiral Landymore to be fired. In 1972, however, the *New York Times,* interviewed members of the single service to assess opinions, and some voiced optimistic views, particularly with regards to the mitigation of rivalries across the services. As one officer stated, "on the whole it has resolved interservice rivalries and controversies…It is now much more difficult for the narrow views of any one service to prevail in our councils." This was echoed, by an airman, who stated "when you sit down at a planning session, all in the same uniform, it has a psychological effect. You reach a common point of view and a common decision much quicker."[467] Yet, despite some positivity by some servicemembers about the change towards unification, the policy was a failure. This was primarily due to a lack of direction by the government and latent resistance within the services. The services were left to their own devices to implement the policy without real government interest or support.

By the election of Pierre Trudeau in 1980, defense had become a low priority, generating little interest from the prime minister. As a result, the armed forces began to languish, capabilities were diminished, and the much-vaunted savings that were the impetus behind the 1966 bill never materialized. By 1986, the separate service uniforms were reintroduced. In 1997, the service chiefs were reinstated in the National Defence Headquarters.[468]

Just two years after the reinstatement of service chiefs, academic assessments of interservice rivalry within the CAF were scathing. As Douglas Bland noted, at a Conference of Defence Associations Institute seminar, the CAF appeared resistant to change due to a "persistent and deep-seated idea in the minds of Canadian officers" that "a triservice organization of the Canadian Forces based on the army, navy, and air force is the preferred structure for the armed forces."[469] Bland felt these leaders saw their primarily responsibility as protecting the institutional interests of their service, over that of national defense policy, writ larger. This situation continues today, with academics alleging that officers are rewarded within their service when they gain resources

[466] Harriett W. Critchley, "Civilization and the Canadian Military," in D.B. Hunt and R.G. Haycock, ed. *Canada's Defence* (Toronto, Canada: Copp Clark Pitman): 232-237 and Wilf Lund, "Integration and Unification of the Canadian Forces," *CFQ Esquimalt Naval and Military Museum* (15 October 2008).
[467] Drew Middleton, "Unity of Military Works in Canada," *New York Times,* 12 February 1972.
[468] Wilf Lund, "Integration and Unification of the Canadian Forces."
[469] Douglas Bland, "Canada's Officer Corps: New Times, New Ideas," paper presented at the Conference of Defence Associations Institute XVth Annual Seminar *The Profession of Arms in Canada: Past, Present, and Future* (1999).

for that service. As a result, interservice rivalry is alive and well, but cloaked in a level of civility.[470] Interestingly, while interservice rivalry is considered an innovation driver in the US, in Canada, it has been highlighted as an attribute that holds the force back.

While unification did not last into the 21st century, it did have more lasting effects by changing culture within the CAF's officer corps. As administrative and bureaucratic efficiency were key goals from unification, civilian bureaucrats were brought into the military decision-making process, confusing the chain of command. Administrative acumen became prized over military tactical and operational excellence. This had the perverse effect of causing the rise of "military technocrats" – mid and senior rank military officers who espoused civilian bureaucratic and administrative values over traditional military values.[471] The replacement of "combat warriors" with "desk warriors" has led to the bureaucratization and civilianization of the Canadian Department of National Defence. Scholars and analysts have noted that this led to an ethos within the CAF that is focused on business practices and servicemembers being more interested in their careers than service to the nation.[472]

Due to these trends, the CAF has elected to publish a written ethos statement.[473] During the drafting of the document, issues such as "service before self," "unlimited liability," ethical behavior, commitment, integrity, and bureaucratic control were all raised as issue areas.[474] The document espouses a vocational ethos, but CAF culture presently supports an occupational ethos. Service members take a check-list approach to implementing policy recommendations and often demonstrate a reluctance to pass bad news up their chain of command. Leadership, meanwhile, tends to value risk-reducing management practices, rather than initiative.[475]

Despite the presence of interservice rivalry or the bureaucratization of the military, new historic scholarship has sought to demonstrate that the CAF does have the capacity to tactically and operationally reform in both peacetime and wartime, even in the midst of unification and the alleged bureaucratization of the force. Andrew Godfrey, writing on Canada's military space program in the mid 20th century, challenged academic assertions that the government lacked an innovation ecosystem, noting that Canada successfully leveraged its technical military space prowess into broader political and military influence vis à vis its allies.[476] Godfrey, adopting Paul Kennedy's "history of the middle approach," has likewise argued that from early pre-federation militias to the modern CAF, Canadian soldiers have always demonstrated a capacity for innovation in the face of challenges or threats—even if the results are far from perfect.[477] Godfrey's historic

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[470] Allan D. English, *Understanding Military Culture: A Canadian Perspective* (Montreal, Canada: McGill-Queen's University Press, 2004): 105.
[471] *Ibid,* 96.
[472] *Ibid,* 109 and Barry Cooper, Mercedes Stephenson, and Ray Szeto, "Canada's Military Posture: An Analysis of Recent Civilian Reports," *The Fraser Institute* (2004): 14.
[473] Government of Canada, "The Statement of Canadian Military Ethos," in *Duty with Honor; The Profession of Arms in Canada 2009* (2009): Chapter two, available at https://www.canada.ca/en/department-national-defence/corporate/reports-publications/duty-with-honour-2009/chapter-2-statement-of-canadian-military-ethos.html.
[474] Allan D. English, *Understanding Military Culture: A Canadian Perspective*, 100.
[475] *Ibid,* 109.
[476] Andrew Godefroy, *Defence and Discovery: Canada's Military Space Program, 1945-74* (Vancouver, Canada: University of British Columbia Press, 2011).
[477] Paul Kennedy, "History of the Middle: The Case of the Second World War," *Journal of Military History* 74 (2010): 35-74.

study of the adaptation during the Cold War highlights the mechanisms by which Canadian Army officers, supported by a large civilian workforce, innovated to meet the challenges of conventional-nuclear warfare. Indeed, as Godfrey notes,

> *Staffed by smart, educated, innovative, and dedicated soldiers and civilians, many of whom were veterans of previous wars, these organizations first identified the complex problems associated with fulfilling the government's defence and security objectives and then worked endlessly to propose solutions to those problems. Ultimately, their combined goal was to create combat-effective ground forces for Canada that could live, move, and fight on the modern conventional-nuclear battlefield. It was a daunting task to be sure, but knowing that failure was not an option, these men and women rose to the occasion repeatedly despite the seeming impossibility of completing their task.*[478]

Godfrey views the actions of these "mid-level" officers and civilians as the largest explanatory factor—besides actual war—for institutional innovation. They presented a different approach within their service or institution and acted on it. However, Godfrey also concurs that the idiosyncrasies of Canadian political system can affect the CAF's innovation ecosystem. Indeed, while the CAF did develop an effective combat innovation process during the Cold War, it could only serve to inform and guide Canada's political elite. When differences of opinion exist, particularly in times of peace without clearly ordered threat perceptions, and when politicians may have other fiscal priorities, this military advice can be more freely disregarded or ignored.[479]

While little has been published to date on the CAF's military culture, academic studies do point to Canada and the CAF's historic experience as facets of its military culture. As Adrian Preston notes in his study of Canadian military culture, Canada's historic experience have endowed it with an "imperative sense of compromise and negotiation in all matters affective of sovereign power." The CAF's willingness to compromise, when combined with its lack of imperialist ambitions, non-violence, and technical acumen, make it a strong fit for peacekeeping, one of the CAF's main historical focal areas.[480] Others, when discussing the CAF's military ethos have pointed to its key role protecting Canadian values—from bilingualism to the acceptance of gay and lesbian service members.[481] However, others take issue with this view, noting that Canada's military culture has been "demilitarized," as successive governments have seen the CAF as simply a testbed for various social norms.[482] Others still see the CAF as requiring change, noting that the CAF still reflects its "Anglo-Saxon Old Army" culture and must evolve to be representative of Canadian multiculturalism.[483] When assessing organizational culture, social issues remain front and center

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[478] Andrew Godefroy, *In Peace Prepared: Innovation and Adaptation in Canada's Cold War Army* (Vancouver: Canada, University of British Columbia Press, 2014): 7.
[479] *Ibid.*
[480] Adrian Preston, "Profession of Arms in Postwar Canada," *World Politics* 23 (1971): 193.
[481] C.A. Cotton, "Canadian Military Ethos," *Canadian Defence Quarterly* 12.3 (1982/83): 13, 15.
[482] See, for instance, D.C. Loomis and D.T. Lightburn, "Taking into Account the Distinctness of the Military from the Mainstream Society," *Canadian Defence Quarterly* 10.2 (Autumn 1980): 16-21.
[483] Albert Legault, "Report to the Minister, Part 2: Canadian Society and the Canadian Armed Forces."

of CAF ongoing reform conversations, particularly as it relates to sexual harassment and abuse in the military.[484]

It is unclear to what degree the CAF's previous experience with force unification, ongoing interservice rivalry, intraservice rivalry, and organizational culture impacts CAF multi-domain synthetic training adoption decisions. No explicit evidence exists linking past CAF synthetic training adoption decisions to those factors. However, it is plausible that these factors are relevant when assessing multi-domain synthetic training adoption. Indeed, interservice rivalry when combined with the CAF's more bureaucratic and administrative culture have been highlighted as factors that hold the CAF back from reform and innovation. It is possible that those factors hamper multi-domain synthetic training adoption. Likewise, other scholars have shown that the CAF can be innovative, thanks in part to mid-level officers that have driven reform. Synthetic training adoption, more generally to date, may be partially a result of that factor, but it is challenging to decisively say that is the case. As a result, it appears that an organizational propensity for reform passes the straw-in-the-wind test—it is a relevant, but not necessary factor when assessing multi-domain synthetic training adoption in the CAF.

Hypothesis Three: States with high-level "champions" for synthetic training either at the Chief of Service level or at the upper tiers of the defense bureaucracy will choose to adopt synthetic training at a higher level.

High-level champions for synthetic training have appeared at the service level within the CAF. Perhaps the most forward leaning of the services, RCAF released their *RCAF Simulation Strategy 2025* in March 2015. The simulation strategy, then driven and endorsed by former RCAF Commander Lt. Gen. (ret.) Yvan Blondin laid out a vision whereby the RCAF would employ simulation to achieve LVC training by 2025 for future aviators.[485] Soon after RCAF's strategy release, the Royal Canadian Navy and the Canadian Army released their *Future Naval Training Strategy* and their *Canadian Army Simulation Strategy Version 2.0,* respectively. It is uncertain, however, to what extent these two latter documents were driven by service level champions, like RCAF's strategy.[486] What is known, is that senior level service officials and program managers have sought to push training more into the virtual and constructive environment.[487] Indeed, in e-mail correspondence, former RCAF commander, Lt. Gen. (ret.) Yvan Blondin, commented that in the case of both "asset specific simulation" (i.e. the use of a simulator that mimics the functioning of a platform) and "network simulation" (i.e. distributed simulation), "the support for this training has mainly been accomplished by military personnel."[488] This view was echoed by personnel in other services, like the Navy, who noted that mid- and senior-level advocates are to thank for the

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[484] Maya Eichler and Karen Breek, "Canada's problematic military culture warrants an oversight agency," *Policy Options,* 12 March 2021, https://policyoptions.irpp.org/magazines/march-2021/canadas-problematic-military-culture-warrants-an-oversight-agency/.
[485] Royal Canadian Air Force, "Executive Summary: RCAF Simulation Strategy 2025," *Government of Canada,* 12 March 2015, http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=executive-summary-rcaf-simulation-strategy-2025/i6mj0r6z.
[486] Jerzy Jarmasz and Blake Martin, "Distributed Simulation for Training: Promises, Barriers, and Pathways," *NATO STO-MP-MSG-159*.
[487] Royal Canadian Air Force, "Executive Summary: RCAF Simulation Strategy 2025."
[488] Email correspondence with Lt. Gen. (ret.) Yvan Blondin, 26 January 2020.

services broader adoption of these technologies.[489] While there isn't evidence that a champion has emerged for a multi-domain synthetic training environment, champions, like Lt. Gen. Mike Rouleau, have emerged for the operational concepts, like pan domain operations, that would support the acquisition of such a training environment.[490] The desire to spur investments in C2, cyber, education, training, and interoperability across the force, could have downstream effects that could spur investment in synthetic training.

Even if the CAF does push for the adoption of a multi-domain synthetic training environment, it is possible, and likely probable, that they will fall short without a civilian champion. Indeed, as Blondin noted in email correspondence with this author, if Canada were to move beyond "network simulation" to a multi-domain training environment, that would require both high-level military and civilian champions.[491] Blondin argues the need for both military and civilian champions is a function of the complexity of the environment. Indeed,

> *[A multi-domain synthetic training environment's] operational training enhancing potential requires more than just intra- and inter-service coordination. It now requires directed safety requirements and protocols, directed development standards and directed specific joint acquisitions to ensure optimized intra- and inter-service operational training…With this vast amount of training, it would be impossible for a military organization to use military personnel only to cover the instruction or virtual asset coordination and operational roles. The need for technological security, industry coordination, and government liaison would bring an increased role for civilians in this field to support and complement military operators. The study and development of future potential use of this [environment], its linkage to overall military strategic doctrine and civilian industrial requirements could not remain in the hands of military people only. At this strategic level, the requirements would be similar to other strategic military fields with an important civilian component that would necessarily bring military and civilian experts and champions at the strategic level*.[492]

For this reason, the lack of a high-level civilian champion is a fundamental barrier to multi-domain synthetic training adoption. A broad-based disconnect exists between the civilian and military elites within the Canadian government.[493] Civilian champions, like in most healthy democracies, determine the success—and failure—of acquisitions. When examining the CAF's historic procurement process, the role of civilian leadership is a crucial factor, but the general lack of civilian interest and oversight in military affairs causes civilian champions to rarely emerge.

The present state of the CAF is largely due to political, not military, decisions. Canadian defense decisions have always fallen behind social and economic issues, in order of priority. As previously mentioned, no government—whether conservative or liberal—have been punished for cutting the

[489] Conversation with 7, CAN, former Lt. Colonel in Royal Canadian Navy, 14 February 2022.
[490] Rouleau, "How We Fight: Commander, CJOC's Thoughts."
[491] Email correspondence with Lt. Gen. (ret.) Yvan Blondin, 26 January 2020.
[492] Emphasis Blondin's own. *Ibid.*
[493] Stepehn Saideman, "Canadian Civil-Military Relations in Comparative Perspective: It Could be Worse?," in Thomas Juneau et. al., *Canadian Defence Policy in Theory and Practice* (Switzerland: Palgrave Macmillan, 2020): loc 3017.

defense budget to anemic levels. Additionally, as former deputy prime minister, John Manley, noted, foreign policy guides defense policy, not the other way around. [494] Few incentives exist for civilian interest to emerge on defense. The effects of the government's low prioritization of defense is significant. No defense committees in Parliament possess security clearances and they rarely engage with military officers. Members of the Commons do not view their role as providing civilian oversight of the military and lack expertise on defense issues.[495] When military leaders or Department of Defence officials are asked to speak to Parliamentary committees, members were "not always convinced that senior officials and bureaucrats appearing before them were being frank," for the reasons listed in hypothesis two. A belief among civilian officials that military officials embrace "timidity with the truth" or have a "misguided loyalty" to their service over the security of the country, does not create a conducive environment for civilian champions to emerge on any topic, let alone synthetic training, which naturally requires more specialized knowledge.[496]

Additionally, Canada's procurement process has developed a domestic and international reputation for being somewhat broken. As one former CAF officer noted, "while some projects are delivered on time and on budget, many have experienced delays, cost over-runs and cancellation."[497] The acquisition process in the Canadian government is riddled with complexities, challenging to navigate, and often strained by fiscal austerity.[498] Those programs that do eventually survive this labyrinthine process—for instance, the long-range patrol aircraft, and the Canadian patrol frigate, among others in the 1970s—all benefited from political support, civilian and military leadership, interdepartmental coordination, and industrial engagement.[499] Without powerful civilian political champions, programs can languish for years absent proper funding or fall victim to a governmental turnover in an election year.

A lack of civilian champions appears to be a key factor when assessing the lack of multi-domain synthetic training adoption—it appears to pass the hoop test. The presence of military champions does account for the CAF's adoption of synthetic training, to date, but without the requisite civilian champions it is unlikely we will see a significant uptick in adoption, particularly for something as complex as a multi-domain synthetic training environment.

Hypothesis Four: States that have frequent military-to-military contact will have progressively convergent synthetic adoption rates and strategies

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[494] Barry Cooper, Mercedes Stephenson, and Ray Szeto, "Canada's Military Posture: An Analysis of Recent Civilian Reports," 30.
[495] Saideman, "Canadian Civil-Military Relations in Comparative Perspective: Could it be Worse?," loc. 3017.
[496] Cooper, Stephenson, and Szeto, "Canada's Military Posture: An Analysis of Recent Civilian Reports," 14.
[497] Douglas Dempster, "Capability Acquisition and Canadian Defence Policy: Programme Achievability and Resilience?," in Juneau et. al., *Canadian Defence Policy in Theory and Practice,* loc. 7595. See also, Elinor Sloan, "Something has to give: why delays are the new reality of Canada's Defence Procurement Strategy," *Canadian Defence and Foreign Affairs Institute* (October 2014).
[498] The acquisition process is particularly complex in Canada because multiple departments are involved. National Defence is responsible for determining military needs and requirements; while Public Services and Procurement Canada manages the acquisition process. Innovation, Science, and Economic Development Canada is charged with industrial offset requirements and the Treasury Board is tasked with approving budgetary milestones. The whole process is overseen by the central agencies, to include the Privy Council Office. Dempster, "Capability Acquisition and Canadian Defence Policy: Programme Achievability and Resilience?," loc. 6013.
[499] *Ibid,* loc. 7662.

Military-to-military contact—whether in the form of attaches, joint military exercises, or exchanges, among many other activities—can be powerful drivers for the diffusion and adoption of technologies or military practices. This appears to be particularly the case with Canada—a country that participates in a range of military activities with partnered and allied nations, and who, often use the CAF as a tool of alliance politics.[500]

The CAF participates in a range of annual and bi-annual military exercises each year with partners and allies. These exercises are normally a function of the CAF's alliance commitments. For instance, Canada, as one of the founding members of NATO, has viewed its commitment to the military alliance as a means of buttressing multilateralism while also raising Canada's stature in the world.[501] To better ensure interoperability within the alliance, the CAF participates in a range of NATO exercises each year, such as exercise Trident Juncture, exercise Precise Response, and exercise Joint Cooperation.[502] These exercises cover a range of military missions, from Article V collective defense scenarios, to CBRN scenarios (chemical, biological, radiological, and nuclear), and civil-military cooperation, among other tactical and operational scenarios. Canada is also host to NATO Flying Training in Canada (NFTC). Starting in 2000, and recently renewed through 2027, NTFC provides a combination of simulated and live basic, advanced, and lead-in fighter training for NATO member states and partners at the Moose Jaw and Cold Lake training ranges.[503]

Since the creation of NORAD in 1957, the US and Canadian forces have operated together, and pooled resources, through a bi-national command. Training is one mechanism, amongst many, to ensure interoperability of US Air Force and RCAF forces.[504] Canada and the US participate in exercise Vigilant Shield, an annual homeland defense exercise focused on defending North America from attack.[505] Canada also participates in the annual US led exercises TRADEWINDS and PANAMAX designed to train participants to respond to natural disasters and maritime threats in the Caribbean and defend the Panama Canal, respectively. Broader US led exercises outside North America that include CAF participation include RIMPAC, Exercise Sea Breeze, Exercise Spartan Warrior, Exercise SABER GUARDIAN, and exercise KEY RESOLVE, among others.[506]

The CAF works closely with the US military, and through NORAD, has been involved in ongoing operations, such as Operation Noble Eagle.[507] The Canadians often deploy alongside the US; however, this is generally through NATO supported operations (or operations that the two other members of the so-called P3, i.e., France and the UK, also endorse). Most significantly, Canada

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500 Chapnick and Stone, "From Policy and Strategic Outcomes," loc. 2238.

501 Massie and Vucetic, "Canadian Strategic Cultures: From Confederation to Trump," loc. 984.

502 National Defence and Canadian Armed Forces, "Military exercises."

503 CAE, "NATO Flying Training in Canada (NFTC)," *CAE,* accessed 10 February 2019, https://www.cae.com/defence-security/how-we-deliver-training/training-centres/nato-flying-training-in-canada-nftc/.

504 NORAD ensures coordination across training, command and control, infrastructure, air-to-air refuelers, ground based radars, airborne early warning platforms, among other systems and platforms. Fuhr, "Canada and Defence of North America: NORAD and Aerial Readiness."

505 Clemente Lynch, "Bi-national exercise, Vigilant Shield 19, enhances readiness to defend the homelands," *North American Aerospace Defense Command,* 1 November 2018, https://www.norad.mil/Newsroom/Article/1678922/bi-national-exercise-vigilant-shield-19-enhances-readiness-to-defend-the-homela/.

506 National Defence and Canadian Armed Forces, "Military exercises."

507 Operation Noble Eagle is an ongoing air patrol mission to defend the US against terrorism. Operation Noble Eagle began in the aftermath of 11 September 2001. For more information, see: Office of the Command Historian, "A Brief History of NORAD," *North American Aerospace Command,* 13 May 2016.

refused to participate in the Anglo-American invasion of Iraq in 2003, despite considerable US pressure to join the coalition.

The CAF also leads a series of exercises each year with allies and partners. Perhaps the best-known of the annual CAF exercises is exercise Maple Flag, established in 1978. Maple Flag takes place each year at the Cold Lake Air Weapons Range and provides realistic pilot training to the RCAF and key select partners and allies.[508] Canada's participation in international exercises—particularly with the US and NATO—seeks to rectify challenges associated with differing command styles, doctrine, equipment, and technologies. Ensuring interoperability with the US and NATO (and especially with the US via NORAD) has been a key argument employed by Canada's Department of National Defence to help secure defense funds in periods of fiscal austerity since 11 September 2001.

Yet, more so than the exercises, the alliances themselves dictate, in part, Canada's technological and doctrinal adoption choices. Indeed, Canadian governments—whether liberal or conservative—tend to view the CAF as a tool of alliance politics.[509] As Ben Lombardi and Bill Ansell note,

> *Canada's membership in NATO not only provides formal structures for the integration of a national military contribution both in peace and war. It also acts as a force multiplier by facilitating Canada's ability to project power and influence—an important consideration for a country with a relatively small armed force.*[510]

The importance Canada attaches to NATO is reflected in the government's decision to participate in every NATO operation in history. Likewise, NORAD helps to buttress the US Canadian alliance, while also ensuring the defense and security of Canada and North America. Canada's participation in NATO and NORAD operations is reflective of a uniquely Canadian form of "contribution" warfare. In essence, the government's contribution of forces to a coalition is a goal in and of itself.[511] The need to effectively "contribute" to a coalition, in practice, should drive interoperability. After all, when making procurement decisions, interoperability with allies is often one of the top priorities when selecting platforms.

Canada's focus on "contribution warfare," has, in some respects, undermined its capacity to fight as a joint force. Historically, Canada has reacted to requirements dictated by allies and struggled to devise the means of fulfilling those requirements—whether in manpower or technology.[512] Deployed Canadian task forces are often single service; thereby focusing on interoperability with allied sister services over interoperability across their own services. When the CAF does deploy

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[508] David Pugliese, "Maple Flag exercise postponed so improvements can be made to Cold Lake base and range," *Ottawa Citizen,* 12 December 2018, https://ottawacitizen.com/news/national/defence-watch/maple-flag-exercise-postponed-so-improvements-can-be-made-to-cold-lake-base-and-range.
[509] Chapnick and Stone, "From Policy and Strategic Outcomes," loc. 2238.
[510] Lombardi and Ansell, "Military Planning, Canada's Strategic Interests and the Maritime Domain," 9.
[511] Juneau et. al., *Canadian Defence Policy in Theory and Practice,* loc. 30.
[512] This issue was highlighted as far back as 1963 by John Gellner during the Sauvé Committee on defense. For more, see: John Gellner in 26th Parliament of Canada, "Minutes and Proceedings," *House of Commons, Special Committee on Defence* No 16 (24 October 1963): 561.

as a joint task force, they are employed by others. The focus on single services, when combined with the CAF's reliance on the broader coalition, has generated little impetus to develop joint processes and enablers across the force.[513] As a result, the joint force in Canada has often been viewed as an "adjunct" to core service capabilities.[514]

Interestingly, however, when specifically assessing Canada's adoption of synthetic training technologies to date, it is the FVEY intelligence grouping—US, UK, Australia, and Canada— that has had the most influence on its adoption decisions. Starting with JANUS in 1988, a US combat simulation, the Canadian military has drawn on its allies capabilities when procuring its own simulation tools.[515] In the 1990s, according to one interview, as the Canadian Navy was trying to identify how best to train its service members without ships, former embedded Canadian officers within the Royal Australian Navy stepped forward and shared lessons learned from their experiences using simulators with the Australians abroad, helping to drive simulator adoption within the RCN.[516] This statement, however, could not be confirmed by other secondary sources. In 2004, the Canadian Army's Operational Research and Analysis (CORA) program looked abroad for a tool to support their analytics needs. They landed on the UK Defence Science and Technology Laboratory's Close Action Environment (CAEn) model and employed that capability until the Canadian Army's research combat simulation capability was quietly shut down in 2015. More recently, as the Canadian Army seeks to upgrade and acquire new capabilities, an incentive exists to revive their simulation capability to aid in acquisition and analysis. As a result, the Canadian Army has been exploring potential tools based on their contact with FVEY allies as potential options:

- **US Army developed OneSAF:** The Canadian Army is exploring acquiring the US Army's developed constructive simulation tool, One-Semi-Automated-Forces or OneSAF. OneSAF is an evolution of Janus, featuring high-fidelity physics-based models. The simulation database associated with OneSAF allows users to represent soldiers, vehicles, and weapon systems in different types of conditions and over differing types of terrain for both training and analytics.
- **New Zealand developed Agent Based Modeling MANA**: Agent based models are non-interactive constructive simulation tools that seek to simplify simulation processes by abstracting away detailed physics models. New Zealand's Defence Technology Agency has developed the Map Aware Non-Uniform Automata (MANA) agent-based modeling tool that allow users to explore a range of differing combat outcomes quickly. The Canadian Army is presently conducting experiments with MANA for potential adoption.
- **Virtual Simulation with Virtual Battlespace:** Virtual Battlespace, now owned by BAE, a British company, is used by militaries throughout the world for training and mission rehearsal. Due to Canadian Army participation in a UK-led Experiment Virtual Eagle, a large-scale experiment that included over 180 UK military personnel engaged in simulated battle via VBS, the Canadian Army is exploring how it can combine the Army's virtual training exercises with experimentation objectives.

[513] Canadian Joint Operations Command, "How We Fight: V8 Final," 7.
[514] Rouleau, "How We Fight: Commander, CJOC's Thoughts."
[515] Nikolakakos and Amyot-Bourgeois, "Combat Simulation: How the Army is revitalizing a critical experimentation capability," 70.
[516] Conversation with 7 CAN, former Lt. Col in Royal Canadian Navy, 14 February 2022.

- **Commercial off the Shelf Tools**: Finally, while not specific to Canadian allies, the Canadian Army is also assessing various commercial off the shelf simulation tools, like Command Professional Edition (CommandPE) published by Matrix Games. Allied militaries, like the UK and the US already use CommandPE for select training needs. [517]

Even when the services seek to implement a new approach to simulation, like LVC, the Canadian military has looked afield. For instance, when the army has sought to implement LVC, they reached out to allied nations to better understand how the CAF could prevent itself from procuring the same piece of technology multiple times.[518] For these reasons, military-to-military contact would appear to pass the hoop test—it is a clear factor when explaining the CAF's synthetic training adoption to date. The CAF's low adoption of a multi-domain synthetic training environment could then partially be explained by the state of adoption among partners and allies. Indeed, a multi-domain synthetic training environment is early in the diffusion S-curve. Few countries have adopted such a training environment. As the adoption of these capabilities change, particularly among FVEY member states, it is possible that one could witness an uptick in adoption. However, that is likely also dependent on other variables such as the presence of champions and Canada's geopolitical threat perceptions.

Hypothesis Five: States will select synthetic training adoption strategies that mirror the adoption strategies of states they feel culturally aligned with.

The Hofstede and GLOBE studies identify cross-cultural similarities via a range of qualitative attributes that are then compiled into quantitative scores.[519] These scores serve as a useful basis for cross-cultural comparison, allowing scholars to identify whether cross-cultural similarity acts as a driver for adoption decisions. Canada's results, and those countries that were identified as "culturally similar" to Canada are found below (see table eleven).

Study	Attribute	Score	Cultural Similarity	Findings
Hofstede	Power Distance Index	39	US and Netherlands	Indicates that Canada is broadly a pluralistic country with decently high levels of equality. [520]
Hofstede	Uncertainty Avoidance Index	48 (55 when controlling for age)	Indonesia, USA, New Zealand, South Africa	Indicative of an older, more developed democracy.
Hofstede	Individualism Index	80	UK, Netherlands, New Zealand	Greater premium is placed on

[517] Nikolakakos and Amyot-Bourgeois, "Combat Simulation: How the Army is revitalizing a critical experimentation capability, 72.
[518] Bray, "From the road to the simulator: Combat vehicle training in a virtual environment."
[519] Hofstede, *Culture, Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations* and House et. al., *Culture, Leadership, and Organizations: The GLOBE Study of 62 Societies.*
[520] It is possible Canada's score has changed since the 1970s, as many immigrants have arrived from higher power distance index (PDI) states, thereby driving the score up. Moreover, the Canadian government also has placed a greater premium on social equality, this could theoretically drive the PDI down. As a result, it is unclear where Canada may fall today.

				individualism over collective responsibility within the state.
Hofstede	Masculinity and Femininity	52 (53 when controlling for gender)	Arab Countries and Belgium	Indicates that Canadians occasionally struggle to adjudicate in-between work and quality of life decisions and likewise, over societal gender differences.[521]
Hofstede	Long Versus Short Term Orientation	52	Zimbabwe and the Philippines	Characteristics of "persistence and thrift" are equally valued against characteristics of "personal stability and respect for tradition."
GLOBE	Performance Orientation Indicator	4.49	USA and South Korea	Premium is placed on encouraging and rewarding innovation.
GLOBE	Future Orientation	4.44	Denmark and Austria	Prioritization of longer-term policymaking (i.e. saving for future).
GLOBE	Gender Egalitarianism	3.7	Singapore and Albania	Women and men equally (or nearly) hold positions of power.
GLOBE	Assertiveness	4.05	Poland and Iran	Society has mixed feelings on assertiveness.
GLOBE	Individualism versus Collectivism	4.38	South Africa and India	Greater collectivism within society, but some prioritization towards individualism.

Table 12: Canada Cultural Similarity Expectations from Hofstede and GLOBE Studies[522]

[521] This score may be different today. The Canadian government established an agency Status of Women Canada in 1976, which evolved into the Department for Women and Gender Equality in 2019. Canada has also championed gender issues in its foreign policy, most recently releasing a *Feminist International Assistance Policy.* Maryam Monsef, "Department Plan," *Department for Women and Gender Equality, Canada* SW1-10E-PDF (2019) and Government of Canada, *Canada's Feminist International Assistance Policy* (20 January 2020).

[522] Hofstede, *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations,* 87, 150, 215, 285 and House et. al., *Culture, Leadership, and Organizations: the GLOBE Study of 62 Societies,* 250, 304, 365, 410, and 468.

Quantitative indicators of culture, as outlined in the Hodstede and GLOBE studies seem to have little to no bearing on CAF adoption decisions. Indeed, the countries that Canada were identified as quantitatively "culturally" similar to were diverse, ranging from the US to Iran. The range of countries seems to indicate how little credibility these studies have when attempting to understand country level adoption decisions. However, two trends are worth noting. The first is the repeated presence of Anglophone countries in the list—most notably the USA, UK, and New Zealand. Indeed, Canada's synthetic training adoption strategies do at times mirror those of the UK, New Zealand, and the US as discussed in hypothesis four. The second is the absence of France.

Scholars argue that since Canada's founding (and even before during pre-confederation Canada), Canadian defense has been driven by three strategic mindsets: imperialism, continentalism, and Atlanticism.[523] Canada's "imperialist" strategic mindset is linked to the former British empire. Canada is a former British colony and, as such, its defense was inextricably linked to London. In exchange for the empire's protection of its Dominion in North America, Canadians contributed to the empire's protection overseas. Even when Canada became a sovereign state, many Canadian citizens felt (and still feel) culturally British. Canada remains in the British commonwealth and the Canadian government is formed in King Charles' name. Canada's continentalist mindset was born out of what has been called the Ogdensburg Agreement, a military mutual assurance declaration in between the US and Canada during WWII.[524] Since that time, Canadian and US defense has been linked, through NORAD, military exchanges, technology acquisitions, and joint training, among other military interoperability initiatives. Finally, Canada's Atlanticist strategic mindset is a function of its other "maternal" state—France. Canada actively buttresses transatlantic military, political, and economic relations, while also balancing against Anglo-American unilateralism, through the inclusion and close cooperation of France.[525] Espousing a core tenet of Atlanticism, Secretary of States for External Affairs, Louis St. Laurent noted in 1948,

> *The best guarantee of peace today is the creation and preservation by the nations of the Free World, under the leadership of Great Britain, the United States and France, of an overwhelming preponderance of force over any adversary or possible combination of adversaries. This force must not be only military, it must be economic; it must be moral.*[526]

Canada's strategic mindsets—imperialism, continentalism, and Atlanticism—while at times differently weighted and prioritized, have driven Ottawa's military alliance choices. The FVEY alliance is based on shared normative values and is a function of Canada's imperialist mindset. Canada's involvement in NATO is a function of its Atlanticist mindset. However, while NATO does, in some ways, promote and protect liberal democracies, it is difficult to identify key shared normative or cultural traits across all 29 member states. Finally, participation in NORAD is a function of continentalism.

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523 Massie and Vucetic, "Canadian Strategic Cultures: From Confederation to Trump" loc. 806.
524 For more see: Desmond Morton, *A Military History of Canada* 5th ed. (Toronto, Ontario: McClelland & Stewart, 2007) and Desmond Morton, *A Short History of Canada* 7th ed. (Toronto, Ontario: McClelland & Stewart, 2008).
525 This may also be a function of the preferences of Canada's French speaking population. Massie and Vucetic, "Canadian Strategic Cultures: From Confederation to Trump" 984 and "Franco-Canadian Affairs," *Encyclopedia Britannica,* accessed 18 May 2020, https://www.britannica.com/place/Canada/Franco-Canadian-affairs.
526 As quoted in R.A. MacKay, *Canadian Foreign Policy 1945-1954: Selected Speeches and Documents* (Toronto, Canada: McClelland and Stewart, 1971): 184-185.

Canada has not yet adopted a multi-domain synthetic training environment. However, to the extent that the CAF makes adoption decisions that mirror states it is "culturally" similar to, it is likely it will choose to adopt synthetic training technologies that mirror those states whose geopolitical outlook resemble its own distinct strategic mindset. In the case of Canada, given Canada's alliances and partnerships are a function of shared normative and cultural traits, particularly in the case of the it FVEY grouping, it seems likely that shared norms via alliances are relevant when assessing diffusion. As a result, hypothesis five, appears to pass the straw-in-the-wind test.

Studying in Process Diffusion: The CAF and Future Multi-Domain Synthetic Training Adoption?

What explains the CAF's non-adoption of a multi-domain synthetic training environment? The CAF's non-adoption of a multi-domain synthetic training environment can primarily be explained by two overarching factors—its secure geostrategic environment and a lack of civilian champions for a multi-domain synthetic training environment (and more broadly defense). Indeed, both alternative hypotheses appear to be necessary factors—passing the hoop test—in the CAF's non-adoption.

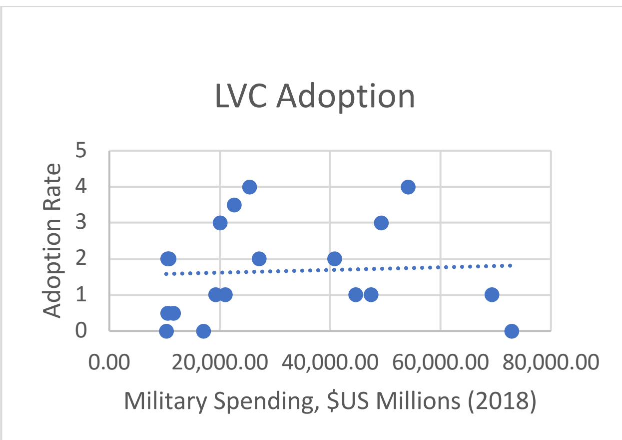
A multi-domain synthetic training environment, however, is early in the diffusion S-curve. It is plausible that the CAF could become an adopter. When the CAF has adopted synthetic training, even if it is not for a multi-domain synthetic training environment, it has primarily been the result of two factors—the presence of high-level military champions and ongoing military-to-military contact. It is plausible that continued military engagement with partners and allies, particularly the US and Canadian FVEY partners could create an impetus for military champions to emerge for these technologies. Whether those two factors together can drive adoption, however, in the absence of a changing geostrategic environment and civilian champions remains to be seen.

SECTION FOUR: EXPLAINING DIVERGENCES IN ADOPTION

Figure 37: US 2nd Armored Brigade team test out prototype for the Reconfigurable Virtual Training at the Synthetic Training Environment Cross Functional Team's User Assessment at Fort Riley. Image, Google Image, Creative Commons

CHAPTER EIGHT: CONCLUSION

This dissertation sought to answer the following question: what is driving the adoption of select synthetic training applications—in particular, LVC and a multi-domain synthetic training environment—among US partners and allies? A widely cited theory of diffusion, adoption capacity theory, made this question puzzling. Adoption capacity theory posits that the diffusion of complex technical tools can be explained by two overarching factors—a country's financial and organizational capital.[527] Yet, when assessing the adoption rates of LVC and a multi-domain synthetic training environment among US partners and allies this did not appear to be the case. After selecting for countries that possess a defense budget over $10 billion, which was deemed a baseline budgetary level to adopt complex training capabilities, the adoption results among countries were noticeably mixed. Indeed, financial capital seemed to have little to no bearing on adoption decisions (see figures thirty-seven and thirty-eight below).



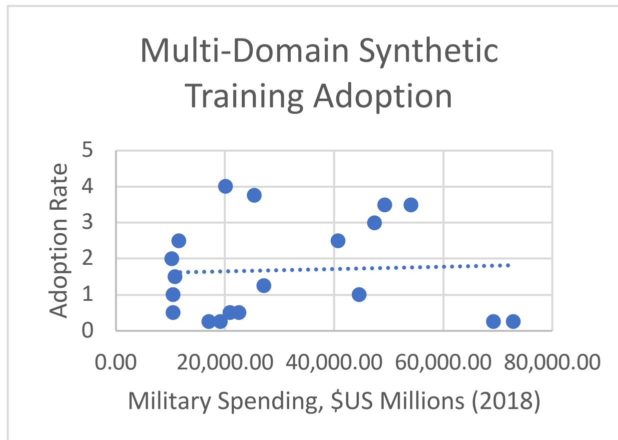


Figure 38: LVC Adoption Rates and Defense Budget

Figure 39: Multi-Domain Synthetic Training Environment Adoption and Defense Budget

As a result, if aspects of adoption capacity theory did not explain the diffusion of LVC and a multi-domain synthetic training environment, what did?

Research Approach

To answer my research question, this dissertation systematically tested five alternative hypotheses across two comparative case studies—Australia & Japan and Israel & Canada. As political theorists have noted, if one wants to study the causative variables that lead to adoption, one cannot solely select cases based on the dependent variable and study only high adopters.[528] Instead, cases must be selected that demonstrate the full range of adoption outcomes, both high and low. In each comparative case, a high (Australia and Israel) and low (Japan and Canada) adopter were selected.[529] Each group of cases have similar defense budget budgets but have significantly different adoption results.

[527] Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics*.
[528] Shively, *The Craft of Political Research,* 109.
[529] For a full overview of country level adoption rates, see appendix two.

Exploring why a state chooses to adopt each type of synthetic training requires the consistent and coherent measurement of the variable of interest—adoption. I do this by tracking state level variation across five alternative hypotheses: 1) the intensity and presence of local geostrategic competition, 2) the propensity for organizational reform, 3) the existence of bureaucratic civilian and military champions, 4) military-to-military contact, and 5) cultural similarity. For each alternative hypothesis a series of qualitative indicator questions were asked to aid in assessment throughout the case studies.

By tracking adoption across five alternative hypotheses, this dissertation comports with what Stephen Van Evera describes as a "theory testing" dissertation. It uses empirical evidence to evaluate existing theories via case studies.[530] To test each hypothesis, this dissertation relied on two tests within the process tracing literature— "straw in the wind tests" and "hoop tests."[531] Straw in the wind tests affirm the relevance of a hypothesis but do not confirm it. Likewise, they do not eliminate a hypothesis, but do weaken them. While in a single case, a straw in the wind test is not compelling, when a hypothesis passes multiple straw in the wind tests across a series of case studies, according to David Collier, it can be deemed that it does "add up to important affirmative evidence."[532] Hoop tests set a more demanding threshold than straw-in-the-wind tests, the hypothesis must "jump through the hoop" to remain under consideration, therefore the hypothesis, while not sufficient, becomes a necessary factor when exploring causality. When an alternative hypothesis passes a hoop test, it weakens the plausibility of other alternative hypothesis, while not discounting the possibility that they may be relevant.

Case Study Results

	Hypothesis 1: Presence of Geo-Strategic Competition	Hypothesis 2: Organizational Agility	Hypothesis 3: Presence of High-Level Champions	Hypothesis 4: Military-to-Military Contact	Hypothesis 5: Cultural Similarity
Australia	Hoop test	Straw-in-the wind	Hoop test (initial investments champions; Straw-in-the-wind (later investments)	Hoop test	Straw-in-the-wind (normative alliance groupings)
Japan	Hoop test (counterintuitively driving non-adoption)	Does not pass evidentiary threshold	Hoop test (lack champions, lack adoption)	Hoop test (LVC assets in Japan are US assets and may drive non-adoption)	Does not pass evidentiary threshold
Israel	Hoop test	Straw in the wind	Straw-in-the-wind (military), does not pass evidentiary threshold (civilian)	Straw-in-the-wind	Does not pass evidentiary threshold (quantitative indicators of culture and normative alliances), straw-

530 Van Evera, *Guide to Methods for Students of Political Science*, 90.
531 Waldner, "What makes process tracing good? Causal mechanisms, causal inference, and the completeness standard in comparative politics," 128.
532 Collier, "Understanding Process Tracing," 826.

					in-the-wind (religion)
Canada	Hoop test	Straw-in-the-wind	Hoop test (no civilian champions, low adoption); synthetic training adoption to date, but not multi-domain (mil champions)	Hoop test (military-to-military contact appear to influence synthetic training adoption to date, but has not yet influenced multi-domain)	Does not pass evidentiary threshold (quantitative indicators of culture); straw-in-the-wind (alliance based on shared norms)

Table 13: Country Case Study Results Across Five Alternative Hypotheses

When assessing results across all the country case studies, several trends become abundantly clear. First, the perceived presence of geostrategic competition consistently acts as the greatest explanatory factor when assessing whether a country chooses to adopt synthetic training. This is closely followed by the presence of champions and ongoing military-to-military contact. An organizational propensity for reform passes the straw-in-the-wind test in most cases, except for Japan, and is therefore relevant. Culture, particularly quantitative indicators of culture, does not pass the evidentiary threshold. However, when assessing alliance groupings based on shared norms it does pass the straw-in-the-wind test in two of the four cases and is therefore worthy of careful and nuanced consideration.

Hypothesis One: States that live in regions of intense geo-strategic competition will adopt synthetic training at a higher rate.

Perhaps the most compelling explanatory factor throughout the four case studies is hypothesis one—states that live in regions of intense geo-strategic competition will adopt synthetic training at higher rates. This is notable when comparing Israel and Canada's multi-domain synthetic training adoption rate. Indeed, it is difficult to understate Israel's perilous geographic position. Threats to the state range from the strategic to the sub-conventional. For Israel, adopting military capabilities to ensure its defense is not a choice, but a necessity. Conversely, Canada is blessed by its strategic geography. No state in over a century has presented an existential threat to Canada. The lack of a clear geostrategic threat to Canada's homeland has had some important implications for Canada's defense strategy and acquisitions policy. Canadians are often characterized by defense analysts as "easy riders;" they elect governments that devote as little funding as possible to defense. When funding is allocated, it is, first and primarily, directed to those areas in which the military must "go alone," such as the protection of borders or search and rescue. Adopting a multi-domain synthetic training environment does not fit within this category.

The comparison of Australia and Japan when viewed through the lens of hypothesis one is particularly interesting. Australia and Japan are both located in an area of intensified geostrategic competition—the Indo-Pacific, and, for Japan, the particularly rivalrous sub-region of Northeast Asia.[533] Japan is located far closer to potential geo-strategic threats

[533] See: Aaron Friedberg, *A Contest for Supremacy: China, America, and the Struggle for Mastery in Asia* (New York, NY: WW Norton & Company, 2011).

than Australia, yet Australia is a far greater adopter of LVC.[534] Japan's LVC adoption choices are greatly influenced by its threat perceptions, but somewhat counterintuitively, its threat perceptions may be driving what is called in the diffusion literature "re-invention" or, even a conscious choice for non-adoption.[535] Japan has demonstrated a preference for live exercises, over synthetic training options like LVC, partially because they want to alert potential adversaries, ranging from China to North Korea, to their own ongoing military developments. Live training and exercises may help bolster potential adversaries' perceptions of Japanese capabilities, and thereby serve deterrence purposes.

Finally, the extant diffusion literature on external threats does differ in some respects from this dissertation's findings. Indeed, neo-realists, like Waltz and Resende-Santos, view competition in the international system as a powerful driver of *emulation*. Competition, they assert, creates homogeneity, particularly with first movers, in adoption practices.[536] However, this dissertation shows that while competition may drive adoption (in most cases), it doesn't drive emulation. States will choose to adopt technologies or military practices that meet their geostrategic requirements, culture, or unique historic context. Indeed, Australia's recent adoption decisions, particularly its agreement with Lockheed Martin under its JP-9711 contract, differs significantly from LVC adoption decisions globally to date. It represents the first services-based distributed missions simulation environment to support joint coalition and allied training in the Asia Pacific. For that reason, it may also represent in the future an instance where an adoption practice originates in the periphery (i.e., Australia) and diffuses to the core (i.e., the US).[537]

Hypothesis Two: States that have a propensity for organizational reform within their defense bureaucracies will have higher synthetic training adoption rates.

Scholars that study organizational innovation point to four models that typically guide organizational reform—the interservice model, instraservice model, organizational culture model, and civil-military model (the last of which is covered in alterative hypothesis three). Organizational agility passed the straw-in-the-wind test in three of the four cases, which, when combined, does amount to important explanatory evidence.

In the case of Australia, the first two theories of innovation do not seem valid, not because Australia lacks organizational agility, but because adoption—or acquisition—decisions for LVC are inherently joint. JP-9711 is not occurring at the service level, but within a joint organizational framework. This represents a first-of-its-kind acquisition globally and differs from other LVC programs that are occurring at the service level, like the US Army's STE. To create the foundation to support LVC at the joint and enterprise level, the ADF has undergone a significant period of structural reform. In some ways, this change has aided adoption, but in other respects, changes have been implemented in name only.

[534] An exception to this rule may be Australia's concern of Islamic terrorism radiating from Indonesia into Australia.
[535] Rogers, *Diffusion of Innovations*, 174.
[536] Waltz, *Theory of International Politics,* 128 and Resende-Santos, *Neorealism, States, and the Modern Mass Army.*
[537] Timothy Hoyt, "Revolution and Counter-Revolution: The Role of the Periphery in Technological and Conceptual Innovation," in Emily Goldman and Leslie Eliason, *The Diffusion of Military Technology and Ideas* (Stanford, CA: Stanford University Press, 2003): 179- 201.

In the case of Japan and its choice to not adopt LVC, there seems to be a tenuous link, if any, between Japan's adoption decisions and these models of organizational reform. It appears that organizational agility—whether in the form of interservice rivalry, intraservice rivalry, or organizational culture—has little weight when exploring Japan's adoption of LVC. While some interservice rivalry does exist, there is little information that would causatively link LVC adoption decisions to competition among the services. Intraservice rivalry and organizational culture, similarly, do not seem to be acting as a barrier to LVC adoption decisions. As a result, it does not meet an evidentiary threshold.

No evidence presently exists that interservice rivalry is having a bearing on multi-domain synthetic training adoption decisions. Like Australia, the IDF's "multi-dimensional joint training environment" is occurring at the joint level. Intraservice rivalry is a fundamental aspect of the IDF's organizational culture and some constituencies within the services have argued for greater investment in cyber over other traditional forces. How these debates are adjudicated could have implications for future multi-domain synthetic training adoption, but at present, no explicit information exists that confirms this may be the case. As a result, it appears that intraservice rivalry is relevant, but not a necessary factor.

Canada is unique among Western countries when assessing models of organizational innovation since its armed forces have been unified under one command structure. The unification of the Canadian armed forces, even if short-lived, impacted CAF interservice rivalry, organizational culture, and to a degree intraservice rivalry. For instance, while interservice rivalry is considered an innovation driver in the US, in Canada, it has been pinpointed as an attribute that holds the force back—particularly when combined with a more bureaucratic and administrative culture within the CAF. These attributes have been highlighted as factors that hold the CAF back from reform and innovation. While no explicit evidence exists, it is possible that this may hamper adoption and it is therefore a relevant, but not necessary factor.

Hypothesis Three: States that have high-level "champions" for synthetic training either at the Chief of Service level or at the upper tiers of the defense bureaucracy will choose to adopt synthetic training at a higher level.

Scholars that assess internal causes of diffusion—both within an organization or a geographic location—highlight the importance of internal advocates who lobby on behalf of an innovation. In short, for adoption to occur, an innovation must find a champion.[538] When examining Australia and Japan's LVC adoption, hypothesis two appears to be quite explanatory. Australia possesses high-level champions for LVC within each of its military services and the defense bureaucracy. The presence of these service-level and civilian champions has acted as a driver for synthetic training use across the ADF, resulting in far higher rates of LVC adoption. Conversely, Japan, which lacks service-level and civilian champions, has not adopted LVC.

[538] Schön, "Champions for Radical New Inventions," 84.

The extent to which hypothesis three is explanatory with regard to the adoption of a multi-domain synthetic training environment becomes somewhat more complicated in the case of Israel and Canada. Israel and Canada both possess, to a degree, some service-level champions for a multi-domain synthetic training environment, but lack civilian champions.[539] Yet notwithstanding these similarities, Israel is a high-level adopter of a multi-domain synthetic training environment, while Canada is a low adopter. This divergence in adoption rates is likely a function of broader civil-military relations within each given country.[540] Indeed, historically, Israeli civilians have given the IDF greater latitude with regards to their budget and acquisitions, as the military was largely considered sacrosanct. Institutionally, within Israel, the civilian defense bureaucracy is somewhat marginalized. The security system is dominated by the uniformed military. As a result, should the military decide that a certain path is the right way forward, it is unlikely that the civilian leadership will seek to chart a different path.[541] Conversely, civilian officials within Canada, while also somewhat "hands-off", have not empowered military officials—through policy or budget—to pursue larger-scale programs or acquisitions that they may prove transformative. Canadian defense decisions have always fallen behind social and economic issues, in order of priority. As a result, Canadian defense spending, and force modernization, has largely been an afterthought. For a program as complex as a multi-domain synthetic training environment, some civilian interest would likely be required to empower implementation.[542]

It seems, based on this dissertation's findings, that while the military can empower the adoption of synthetic training more broadly, it requires civilian champions (except for states like Israel that empower military officials over civilians) to drive adoption of more complex collective training regimes, like LVC or a multi-domain training environment.

Hypothesis Four: States that have frequent military-to-military contact will have progressively convergent synthetic adoption rates and strategies

Ongoing military-to-military contact proved to be an explanatory factor with the hypothesis passing the hoop test in three of the four cases. In the case of Israel, it passed the straw-in-the-wind test. What makes hypothesis four interesting is that all four states have a unique, and close, relationship with the US, but adoption decisions differ.

Dating back to the 2006 JP-2098 program, Canberra's desire to better interoperate with the US has acted as a driver for the ADF's synthetic training choices. Given the complexity associated with adopting LVC, ADF officials have acknowledged that the services will closely follow the US' lead when it comes to the adoption of synthetic training. While

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[539] In the Canadian case, the military champions are for the use of synthetic training broadly and future multi-domain operational concepts versus the acquisition of multi-domain synthetic training environment.

[540] Posen, *The Sources of Military Doctrine: France, Britain, and Germany between the World Wars,* Deborah D. Avant, "The Institutional Sources of Military Doctrine: Hegemons in Peripheral Wars," *International Studies Quarterly* 37.4 (1993): 409-430, and Kristen A. Harkness and Michael Hunzeker, "Military Maladaptation: Counterinsurgency and the Politics of Failure," *Journal of Strategic Studies* 38.6 (2015): 777-800.

[541] Cohen, Eisenstadt, and Bacevich, "Knives, Tanks, and Missiles: Israel's Security Revolution," 78 and Weinraub, "The Evolution of Israeli Civil-Military Relations: Domestic Enablers and the Quest for Security."

[542] Email correspondence with Lt. Gen. (ret.) Yvan Blondin, 26 January 2020.

Australia may lead the global pack in LVC adoption, their decisions for how their training environment may manifest are influenced by their desire to train alongside the US. Conversely, the unusual nature of the US and Japanese defense relationship may have paradoxically acted as a broader *barrier* to the JSDF's adoption of LVC. The 1952 military alliance signed between Tokyo and Washington provides the US long-term access to military bases on Japanese soil, with over fifty thousand troops stationed there today under the aegis of US Forces Japan. This has significant implications for the deployment of LVC training on Japan's sovereign territory. Japan does host some cutting-edge synthetic training capabilities within its borders, to include LVC, but those capabilities are *US capabilities*. For this reason, such intimate military-to-military contact may act as a barrier, rather than a driver. The JSDF can get access to these capabilities, particularly the LVC capabilities at Misawa Air Base, without having to independently invest resources.

Ongoing military-to-military contact through exercises and exchanges with various countries, such as in Europe or the Middle East, seems to have little to no impact on the IDF's multi-domain synthetic training adoption decisions. Instead, it appears that Israeli adoption decisions might be partially influenced by the US as Israel's superpower patron. Deep bilateral ties exist between Israeli and US bureaucratic institutions—from the Department of Defense to the Joint Staff, and Central Command. Perhaps more significantly, the US provides Israel $3.3 billion in foreign military financing per year. Yet, Israel still possesses a significant amount of agency. While ongoing contact may be relevant, no explicit evidence exists that suggests the US, and military contact with the US, has acted as a driver.

Canada, for its part, often views its military as a tool of alliance politics and diplomacy, so the ability to interoperate with partners and allies acts a powerful factor when assessing decision-making. Even in periods of fiscal austerity, the need to maintain interoperability with allies has been an argument employed by the CAF to help ensure continued defense funding and future procurements. While Ottawa sees interoperability with NATO and NORAD as essential, when assessing synthetic training adoption, the FVEY intelligence alliance has proved to be the most influential. Ongoing military-to-military contacts with FVEY member states have driven the adoption of tools, like JANUS. While the CAF possesses a close relationship with the US, it appears that the CAF, based on past synthetic training adoption decisions, equally assesses capabilities developed by all FVEY member states.

The results show that military-to-military contact can act as a necessary, and relevant, factor when assessing synthetic training adoption decisions. However, how that can manifest, particularly when it comes to each state's relationship with the US differs. Australia-US military-to-military contact is acting as a driver for greater adoption. Japan US military-to-military contact may conversely be acting be a necessary factor in their non-adoption decisions. Israeli military-to-military contact with the US is relevant, but not necessary, as they work to maintain agency. And finally, in the case of the CAF, their relationship with the US matters, but their adoption decisions seem to be equally based on their ongoing relationships with all FVEY member states. These findings demonstrate that military-to-military contact can cause a multiplicity of adoption decisions, to include non-adoption. Diffusion scholarship that assesses military-to-military contact as a casual factor could benefit from deeper analysis of adoption decisions, beyond decisions solely to adopt. This is something that *in-process* diffusion studies are uniquely suited to provide.

Hypothesis Five: States will select synthetic training adoptions that mirror the adoption strategies of states they feel culturally aligned with.

This dissertation also demonstrates that when utilizing quantitative indicators of culture, hypothesis five lacks explanatory power. Indeed, when comparing indicators across the Hofstede and GLOBE study indexes, each country explored in this dissertation was identified as "culturally similar" to a wide range of countries. In each case—and especially with Israel and Japan—the identified "culturally similar" countries were so varied that it was difficult to pin down how quantitative measures of culture may be informative of adoption rates at all. Instead, this dissertation demonstrates that theories of diffusion that attribute adoption practices to cultural homogeneity are notoriously tricky to prove. Culture does not lend itself to easily quantifiable attributes.

When putting aside quantitative indicators of culture and assessing alliance groupings based on shared normative values, cultural alignment does seem to be partially explanatory.[543] Both Canada and Australia are part of the FVEY alliance grouping, which also happens to be a security compact of Anglospheric nations. Explicit evidence exists that members of the FVEY grouping have looked to other member states when making adoption decisions, like the Australian decision to adopt DATE or Canada's present consideration of OneSAF, MANA, and Virtual Battlespace. Given LVC and a multi-domain training environment are early in the diffusion S-curve, tracking FVEY adoption decisions over time could be revealing for future scholarly inquiry, particularly because the group of member states currently possess both high and low adopters.

Implications for Scholarship and Future Research

This dissertation addresses a puzzle based on adoption capacity theory. It shows that adoption capacity theory, in some circumstances, does not explain diffusion results. Instead, when assessing state technological adoption practices, particularly for technologies that draw heavily on software (or are software based), other causative explanations hold greater weight. By testing five alternative hypotheses across four case studies of both high and low adopters, this dissertation provides five overarching implications for scholarship and future research.

In-Process Studies of Diffusion Can Add Greater Nuance to the Field

This dissertation represents the only in-depth study within the political science literature that studies *in-process diffusion*.[544] While there has been a proliferation of scholarship across disciplines related to diffusion, significant limitations exist, the most prevalent of which is a "pro-innovation" bias within the literature. As Adam Grissom noted in his review of the military innovation literature, military innovation studies tend to be consequentialist, military practitioners

[543] Durell-Young, "Cooperative Diffusion through Cultural Similarity: The Postwar Anglo-Saxon Experience," 93-113.

[544] The one exception may be Michael Horowitz article on the diffusion of artificial intelligence. Horowitz, "Artificial Intelligence, International Competition, and the Balance of Power."

and scholars only study changes to practices that result in positive outcomes.[545] But, as history has shown, bad ideas can also diffuse. Moreover, due to the positive value-laden aspects of innovation studies, scholars often select rapidly diffusing innovations for study, thereby implicitly assuming that adopters are more agile. Yet, some actors may not benefit from adoption and some new ideas may not necessarily yield improvement. Due to this limitation in the scholarship, we know very little about technologies or ideas that diffuse slowly, about choices of rejection, or even the discontinuance of a new idea or technology. By studying two training applications in the diffusion process, this dissertation aims to fill that gap, helping to add further nuance to diffusion studies. By employing process tracing, it is possible to understand why some countries may, for real and rational reasons, choose *not* to adopt technologies that may seem, at first glance, beneficial. The JSDF's likely decision to not adopt LVC for geostrategic reasons, most notably deterrence reasons, is a strong example of this. More must be done to refine diffusion theories to better account for ideas that are re-invented or not adopted. This should be a rich area for future scholarly inquiry and theory refinement.

However, by studying in-process diffusion, this dissertation has had to grapple with some inherent challenges—there are no immediate "smoking guns" that indicate why a country made its adoption decision regarding LVC or a multi-domain synthetic training environment. For this reason, potential exists to continue to assess Australia, Japan, Israel, and Canada's synthetic training adoption decisions. Tracking adoption over time may provide more evidence about why adoptions occur, helping to bolster scholarship around technology re-invention and conscious decisions to reject technologies or innovation.

Adoption Capacity Theory and the Challenges of Explaining Software

This dissertation helps revise some widely accepted diffusion theories, like adoption capacity theory. Contrary to adoption capacity theory, a country's financial and organizational capital do not appear to be main factors driving the adoption of synthetic training. Given Horowitz' theory has wide applicability across a range of historical cases—from carrier warfare to the nuclear revolution, battlefleet warfare, and even suicide terrorism—it is worth asking why his theory does not seem to hold in the case of synthetic training. The simplest answer for this divergence in results, which is worthy of further study, is due to the type of technology under examination in the study. This study, unlike Horowitz's selected cases, studies the diffusion of *software* over *hardware.* Indeed, while synthetic training does partially rely on hardware via the user interface (i.e., a headset, laptop, or a simulator), most of the technology stack associated with synthetic training is software based—the visualization engine, content ecosystem, runtime infrastructure, and even aspects of networking and hosting can be managed via software.

Software development fundamentally differs from hardware development with key implications for financial capital. Software development is primarily dependent on *human capital*—it requires qualified software engineers, front-end and back-end developers, user experience and user interface designers, QA (quality assurance) and DevOps (developer operations) engineers that are accustomed to working through the software development lifecycle.[546] This lifecycle is an iterative

545 Grissom, "The Future of Military Innovation Studies," 350.
546 For some applications, like more sophisticated types of machine learning, some have argued that access to computational resources is also a factor. While this was true in the past, this trend appears to be changing in favor of

process that consists of structured brainstorming, design, programming, and integration that ensures that a software product meets the needs of the end-user. Hardware development—which will often employ system engineering methods—typically follows a somewhat similar process to ensure the product meets user requirements, but there is one key difference—physical material. While software simply requires qualified staff, hardware development also requires the acquisition of raw materials, physical space to house and assemble that material, and operations and maintenance funds to ensure the continued battle-worthiness of the procured platform. This likely has significant implications for overall cost, which is worthy of future scrutiny as it applies to diffusion.

Second, Horowitz argues that organizational capital also acts as a driver for the diffusion of innovations. According to Horowitz' theory, the extent to which a new technology dictates changes in warfighting paradigms—from operational concepts, to recruitment, and even training concepts—will also dictate its diffusion. Synthetic training is an enabler. It allows militaries to train for operational concepts that they may be unable to train for in a live environment, but it does not dictate that a new operational concept or recruitment and training regime must be created. Indeed, in many cases, militaries choose to adopt new operational concepts or technologies—like the US Joint All Domain and Control Concept or the F-35—and then seek to procure capabilities to facilitate them. Synthetic training, and many other types of software, typically fall into this category. They enable new warfighting paradigms, but they are not necessarily the cause for its adoption (like for instance carrier warfare).[547] However, this does not mean that organizational change does not need to take place for a software's acquisition—even if it is solely an enabler. As this dissertation has demonstrated, an organization's propensity for reform can help drive adoption, even if it is not the primary factor. Future research that looks specifically at the adoption of country level practices that ease software acquisition—such as continuous integration and continuous development (CI/CD) authorities, authorization to operate (ATO) processes for classified systems, and standards—may further refine research that explores the diffusion of software.[548] Even then, however, it is likely that countries are more apt to reform and adopt these practices in defense, when they face a perceived geostrategic threat, as this dissertation shows. Exploring this dynamic in more depth warrants future analysis.

The Primacy of Geostrategic Threat Perceptions When Explaining Diffusion

By systematically testing the five alternative hypotheses across four case studies, this dissertation highlights that geostrategic competition consistently acts as the *greatest explanatory factor* when assessing whether a country chooses to adopt, reject, or re-invent a technology. This has several implications for theory within both the innovation and diffusion literature. First, the findings run counter to the main research programs within technological innovation studies—comparative political economy, production regimes, and systems of innovation—that omit the geostrategic

more tailored and efficient applications and algorithms. Lohn and Musser, "AI and Compute: How Much Longer Can Computing Power Drive Artificial Intelligence Progress?"

[547] The exception to this rule may be AI, however, since AI has many applications and is also an enabler, this is debatable. Horowitz, "Artificial Intelligence, International Competition, and the Balance of Power."

[548] For more on CI/CD, see, "What is CI/CD," *Red Hat,* 11 May 2022, https://www.redhat.com/en/topics/devops/what-is-ci-cd.

threat environment as a variable in country innovation.[549] These research programs, while drawing on different methodological approaches, explore domestic variables of innovation, such as institutions and domestic policies as the primary attributes that determine technological progress. As Matthew Brummer notes in his review of the innovation literature, "whether one places emphasis on scientific determinism, randomness, or institutions, the end result is that international relations is assumed exogenous to technological progress."[550] This is problematic as technological innovation studies miss the distinct ways that a geopolitical environment can impact domestic policy and institutions—whether that is via indigenous technological development or diffusion.

This dissertation instead bolsters an emerging field of study that demonstrates that geopolitical competition acts as a determining factor when understanding state level technological change, by showing that state diffusion and adoption decisions mirror indigenous state innovation practices. Indeed, just as strong empirical findings are emerging that show that the international security environment impact national innovation rates, this dissertation's findings likewise show that a state's geostrategic environment impacts technology adoption decisions. [551] Given aspects of the diffusion literature in political science are closely tied to the innovation literature from economics and political economy, it is worth reassessing the literature to better understand the causal mechanisms by which technology diffuses.[552]

Second, when using neo-realist theories of diffusion, like geostrategic threats, to better understand adoption practices, this dissertation also demonstrates that theories should be both refined in scope to better address state adoption practices. First, a competitive international environment may drive the diffusion of technical innovations, but it will not necessarily drive emulation as Waltz and Resende-Santos asserts.[553] States will selectively adopt or re-invent innovations developed by other states—or they may simply choose to reject them, like in the case of Japan. Additionally, a state's assessment of its security environment is more indicative of adoption practices than the actual presence—or lack thereof—of competition. Indeed, while Japan arguably always lived in an intense area of geostrategic competition, it was only when that perception began to change among elites that reforms began to take place within their defense establishment.[554] A state's perception of its security environment, therefore, influences its strategic goals, the structure of its armed forces, and conception of future operations. This has down-stream effects on training and, more specifically, synthetic training adoption.[555]

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549 Porter, *The Competitive Advantage of Nations,* Breznitz, "National Institutions and the Globalized Political Economy of Technological Change: An Introduction," Hall and Soskice, *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*.
550 Brummer, "Innovation and Threats," 565.
551 See for instance recent studies that track the presence of geopolitical competition against indigenous innovation rates. Brummer, "Innovation and Threats," Schmid, Brummer, and Taylor, "Innovation and Alliances," and Taylor, "Toward and International Relations Theory of National Innovation Rates."
552 Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics*.
553 Waltz, *Theory of International Politics,* 128 and Resende-Santos, *Neorealism, States, and the Modern Mass Army*.
554 Geostrategic threats were not highlighted in high-level defense documents until the 2004 *National Defense Program Guidelines*. As some academics have noted, threat perception did not a driver of postwar military planning. Smith, *Japan Rearmed: The Politics of Military Power,* 108.
555 Fravel, *Active Defense: China's Military Strategy since 1949.*

The Need for Intellectual Humility: Theoretical Parsimony Can Only Go So Far

This dissertation argues for the importance of intellectual humility when engaging in theory development or theory testing, particularly when theoretical findings may have strong policy implications. While overarching trends may emerge that act as drivers for state adoption practices—like geostrategic competition—states often make decisions for a range of state-specific and idiosyncratic reasons. This dissertation's case studies illustrate the benefit of diving into a state's history and unique circumstances when attempting to understand synthetic training adoption—or likely many other types of technical acquisition adoption—decisions today. For instance, Australia's adoption of LVC, and synthetic training more broadly, cannot be understood without understanding the ongoing strategic debate within the country between those broadly characterized as "alliance maximalists" and "alliance minimalists" or those advocating for the exigencies of localized defense or more expeditionary strategies. Tokyo's defense related decision-making today, to include its decisions to not adopt LVC and other synthetic training applications, is best viewed through the lens of history, in particular its wartime legacy. Meanwhile, Israel's ongoing adoption of a multi-domain synthetic training environment can best be explained by its geopolitical threat environment, and various factors unique to Israel's history, culture, and even the predominance of Judaism; all of which seem to impact Israel's adoption decisions. Indeed, the IDF's emphasis on mission command and some of its leadership's skepticism towards simulation can largely be viewed through this prism, seeming to indicate that adoption may be more incremental than otherwise expected. Finally, Canada's adoption decisions regarding a multi-domain synthetic training environment cannot be disentangled from domestic politics. Indeed, domestic political decisions have always taken primacy over defense related decisions. In short, while theory can be a useful guiding tool when developing policy best practices, it is important to also dive into a state's unique history before choosing to apply or execute against those policy proposals.

Additional Avenues for Scholarly Inquiry Exists Related to Synthetic Environments

Finally, this dissertation also represents the first in-depth study of synthetic training within the field.[556] It draws extensively on literature from combat engineering and modeling and simulation to make technical topics accessible to a far wider audience. Synthetic training—to include LVC and a multi-domain synthetic environment—has ramifications beyond battlefield effectiveness and coalition interoperability. The technologies that undergird these training applications represent a rich area for future scholarly inquiry. For instance, the same technology stack that applies to synthetic training—the user interface, visualization, content ecosystem, runtime infrastructure, networking, and hosting—can also be used to create synthetic environments to support experimentation, test and evaluation, and decision support. Studies could explore how synthetic environments (particularly those that can be spun up as thousands of simultaneous simulations and run faster-than-real time) can aid in deterrence by denial, helping to theoretically identify vulnerabilities in faster-than-real time to aid in resilience measures. Other studies could look at how synthetic environments could be employed as organizational learning tools, bolstering literature on organizational innovation. Studies could also assess how synthetic environments may be changing aspects of the military planning process. Indeed, just as synthetic training has changed

[556] Scholars like Der Derian and Aggie Hirst have covered synthetic training in their work, but their examination of the topic has been limited. See, Der Derian, *Virtuous War: Mapping the Military-Industrial-Media-Entertainment Network* and Aggie Hirst, "Wargames Resurgent: The Hyperrealities of Military Gaming from Recruitment to Rehabilitation," *International Studies Quarterly* 66 (2022): 2-13.

traditional training paradigms, the ability to sift through mass amounts of data, generate synthetic data sets, and run multiple simulations in tandem opens new avenues for planning and force development.

Implications for Policy

Developing a deeper understanding of US allied and partner adoption choices with regard to LVC and a multi-domain synthetic training environment is critical from a policy standpoint. Indeed, the resurgence of great power competition—when combined with the erosion of the US' military edge, and the continued threat posed by regional revisionist actors—renders the international threat environment singularly challenging and ripe for conflict. In the future, the US may find itself drawn—whether willingly or not—into a great power war, alongside partners and allies. As a result, the battlefield effectiveness of a coalition becomes increasingly important, particularly when operating against a near-peer or peer adversary that may deny—through the scale and speed of combat—a coalition the time and opportunity to effectively experiment or adapt in the field.

Recent literature has demonstrated that while coalitions can, at times, be strategically beneficial, they can also incur heavy tactical and operational costs.[557] A coalition's effectiveness is often dependent on a host of factors, ranging from adequate and realistic multinational training, to a history of military cooperation, and the possession of equipment and technology that can effectively connect and communicate.[558] However, few opportunities exist for coalitions to rectify these challenge areas. As former CAE President, Gene Colabatistto observed, "You often hear that the first-time multi-service, joint, and coalition forces get to experience the battlefield environment is when they actually get on the battlefield together."[559] This is problematic, as coalition operations are often the most complex. Moreover, when training for a future contested and complex battlespace—saturated by adversary cyber, electronic, or information operations—the live environment, as previously discussed, will fall short.

The implementation of LVC and a multi-domain training environment by partners and allies, therefore, serves an invaluable warfighting purpose. When training for a high-end conflict, these select synthetic training applications provide the only environment, short of war, for allies and partners to build interoperability across the force. For this reason, synthetic training environments are now highlighted in various policy proposals as areas of potential defense cooperation between the US and allies and partners.[560] However, as this dissertation has demonstrated, US allies and partners may choose, for many reasons, to not adopt—or only partially adopt—LVC or a multi-domain synthetic training environment. As a result, when proposing initiatives that may deepen cooperation and interoperability via synthetic training environments, those policy proposals should be grounded not only in an understanding of the diffusion process, but also in each state's unique political context. Such an approach should better guide policymakers on what proposals may be

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[557] Schmitt, *Allies that Count: Junior Partners in Coalition Warfare* and Bensahel, "International Alliances and Military Effectiveness: Fighting Alongside Allies and Partners," 186-206.
[558] *Ibid.*
[559] As quoted in Pat Host, "USAF fighter pilots participate in 'Red Flag' Alaska missions form home base for the first time," *Jane's International Defence Review,* 7 November 2018.
[560] Paul McLeary, "Indo-Pacom Presses All Domain Ops; Sends Plan to Hill Soon," *Breaking Defense,* 24 March 2020, https://breakingdefense.com/2020/03/indo-pacom-presses-all-domain-ops-sends-plan-to-hill-soon/ and Tate Nurkin and Ryo Hinata-Yamaguchi, "Emerging technologies and the future of US-Japan defense collaboration," *The Atlantic Council* (17 April 2020).

more advantageous for each party and the most likely to be effectively implemented. Indeed, a one size fits all approach to synthetic training, as demonstrated in this dissertation, is hardly optimal, or indeed realistic.

APPENDIX ONE: Country Case Study Selection Data Set

Country	Military spending (US$ millions, 2018)	Percent GDP on Military Spending (2018)	Size of Military (Total- Active and Reserve)	Military Size, Per 1000 capita (total)	Size of country (land in km2)	4th or 5th Generation Platform Live to Sim Usage Ratio	Prioritization of LVC	LVC Exercises	Prioritization of Multi-Domain Operations (MDO)	Multi-Domain Training Events
Australia	25,391	1.86%	79,000	3.2	7,741,220	F-35 50/50	Published policy across three services; 2015 JP97-11 tender; *2016 Defence White Paper* prioritization on simulation.	Sole ADF LVC exercises and LVC allied exercises. Significant investments under JP97-11 in LVC.	High-level statements across service chiefs on need for MDO.	Acquisition under JP97-11 for multi-domain training for pilots; otherwise limited.
Canada	22,632	1.05%	94,000	2.6	9,984,670	Planned 5th generation platform (platform not yet decided) 40/60	Published *RCAF Simulation Strategy 2025*; *RCN Future Naval Training System Strategy*; *Canadian Army Simulation Strategy*	RCAF DMOC capability and LVC at service level; RCN DMOC under development; Canadian Army initial steps towards LVC.	Unknown, no high-level documents or statements found. Canadian Army doctrine, Adaptive Dispersed Operations, runs counter to MDO.	No mention of multi-domain training; cyber ops. defensive, passage of Bill C-51, 2015 provides opening for offensive operations.
France	49,304	1.91%	240,000	3.6	643,801	Rafale 70/30 Part of Future Combat Air System (FCAS)	FAF Synthetic Training Vision; *Army Master Plan for Simulation 2006-2015*; Naval policy on simulation; LVC seems to be service based, not joint.	DMOC in 2018 for tactical training; plans for virtual federation and virtual flags 2025; participating in allied exercises.	Forthcoming published virtual policy and planned exercises. Part of Tri-lateral Strategic Steering Group on multi-domain operations.	Training events are limited; goal is to extend to C2, front line operator, and joint training.
Germany	44,670	1.13%	208,000	2.5	357,022	Typhoon u.k. Part of Future Combat Air System (FCAS) German Navy, aircraft agnostic 30/70	*Reorientation of the German Army* emphasizes simulation; *Konzeption der Bundeswehr*	Helicopter Training Centre for German Army at Bückeburg; virtual applications	MDO is not mentioned in high-level statements or in doctrine/ strategy.	Germany participates in initial MDO exercises via NATO, like RAMSTEIN GUARD.

							higlights need to improve training, but LVC is not mentioned.	across services; little information on combined LVC.		Unlikely Germany conducts sole training.
India	69,285	2.15%	2,600,000	1.9	3,287,263	Saab Gripen u.k. Kiran aircraft (basic trainer) 70/30 5th gen. aircraft selection under review as MMRCA2.	*Annual Report 2017-2018* and *Technology Perspective and Capability Roadmap 2018* mentions procurement of simulators, however, does not appear to have any prioritization of LVC.	Simulator Development Division developed tactical VR training; Vayu Shakti exercise w/ live and simulated assets. Unclear LVC occurring (or aspirational).	MDO is not mentioned in high-level statements or in doctrine/ strategy.	No mention, and unlikely, multi-domain training; however, India is standing up an offensive cyber capability, the Defence Cyber Agency.
Israel	20,074	5.07%	635,000	72.8	20,770	Aircraft agnostic 40/60	Official Strategy of the Israeli Defense Force does not mention training or LVC; however, simulators are deployed across force.	Israel hosts Blue Flag, which includes LVC assets; emphasis on international exercises due to lack of airspace. Networking LVC in development.	Official Strategy of the Israeli Defense Force emphasizes multi-domain fire integrated across all combat forces; flexible C2 architecture based on campaign.	Unclear if Israel conducts multi-domain training, however, likely, as IDF at vanguard of MDO in 2007 in Syria.
Italy	27,122	1.19%	189,000	3.1	301,340	F-35 u.k.	Ministry of Defense, White Paper highlights the use of simulators and virtual systems for higher-fidelity training. LVC is not mentioned.	Italian Air Force partnering w/ industry to open LVC International Flight Training School in 2021 for 4th and 5th gen. fighters.	Ministry of Defense, White Paper highlights the increased importance of cyber domain and the need for integration across force. MDO not specifically mentioned.	Unclear, but unlikely, MDO exercises or training take place. Italian Cyber Operations Joint Command activated in 2017.

Japan	47,426	0.93%	303,000	2.4	377,915	F-16 90/10 F-35 under review, likely will follow US 50/50	*National Defense Program Guidelines for FY2019 and beyond* mentions the use of simulation, however, not LVC.	LVC limited, emphasis on live. Exception of Japanese Aerospace Ground Environment for ballistic missile defense operational training.	National Defense Program Guidelines for FY2019 and beyond calls for the creation of a Multi-Domain Defense Force.	Currently trying to map force structure for multi-domain forces; force structure complete by 2023; no plans for MDO exercises at present.
Netherlands	10,821	1.24%	40,000	2.3	41,543	F-35 classified	2018 Defence White paper highlights the importance of training and includes modernization activities for simulators. LVC is not mentioned.	Exercises do take place, however, according to RNAF, details are classified. Netherlands Aerospace Center provides LVC public and private sector capabilities.	2018 Defence White paper highlights importance of cyber domains and need to develop capabilities. MDO is not mentioned.	According to RNAF, details are classified. However, the Netherlands does participate in initial MDO exercises via NATO.
Pakistan	10,524	4.13%	944,800	3.1	796,095	F-16 u.k.	A Pakistan national security strategy is not available, so it is challenging to assess to what extent training or LVC is included in their strategic planning.	Unclear to what extent LVC is used. However, simulators are part of their military training.	As of April 2019, Pakistan did not have a cyber strategy or a strategy linked to MDO.	Unclear, but unlikely. As of April 2019, Pakistan did not have a cyber unit within the military. Pakistan does have a National Centre for Cyber Security and a CERT.
Poland	11,591	2.05%	196,700	3	312,685	F-16 u.k.	2020 National Security Strategy of the Republic of Poland highlights the need to adapt training	Unclear to what extent LVC is used. Simulators are part of military training. Briefings by Polish military	2020 National Security Strategy of the Republic of Poland highlights the need to adapt training	Unclear, but unlikely. As of April 2019, Poland did not have a cyber unit within the military. MDO is not explicitly

							programs for modern multi-domain environment, but LVC not clearly mentioned.	focused on live training challenges, to include pilot shortfall.	programs for modern multi-domain environment.	mentioned in any documents.
Saudi Arabia	72,918	10.77%	227,000	6.9	2,149,690	Typhoon u.k.	Saudi Defense Doctrine (SDD) under development. Secondary source recommends investments in training, however, no mention of simulation or LVC.	Saudi Arabia is using simulators in training, however, unclear to what extent training involves LVC.	MDO is not mentioned in high-level statements or in doctrine/ strategy.	SDD under development; secondary source recommends developing cyber and space capabilities. MDO not mentioned.
Singapore	10,524	3.17%	386,000	68.8	697	F-35 classified, likely will follow US 50/50	*Defending Singapore in the Twenty-First Century* highlights the use of greater simulation to meet training needs; especially with squeeze in training space. No mention LVC.	Live exercises are main methods of meeting standards; LVC remains aspiration. Virtual solution sets at service levels, to include RSN simulation centre.	MDO is not mentioned in high-level statements or in doctrine/ strategy. However, SAF publication does explore MDO integration challenge.	Multi-domain remains an aspiration, especially w/ 4th and 5th generation platforms.
South Korea	40,814	2.37%	3,725,000	72.4	99,720	F-35 u.k. F-15 u.k.	2016 Defense White Paper does not mention LVC or simulation; unclear 2018 Defense White Paper; Defense Reform 2.0 highlights	ROK does have simulation capabilities and as part of “smart air power” working to upgrade. Unclear on LVC exercises.	MDO is not mentioned in high-level statements of doctrine; 2016 Defense White Paper highlights creation of Cyber Defense Unit across three	Planning for network-centric joint operations. Some initial MDO training taking place via annual command post exercises w/ USFK.

							training & sim as key cap. themes.		branches of military.	
Spain	17024	1.05%	135,000	2.9	505,370	Typhoon u.k. Part of Future Combat Air System (FCAS), however, still interested in F-35 procurement	*National Security Strategy 2017* and *National Defence Directive 2012* do not mention military training, simulation, or LVC. Unclear on 2018 *Defense White Paper.*	Spain employs simulators across services; existence of NATO Spanish LVC interoperability model; unclear if deploys LVC within country.	MDO is not mentioned in high-level statements or in doctrine/ strategy.	Unclear, but unlikely, that Spain trains or participates in exercises with MDO. 2017 Spain's MoD earmarked $11.2M for Joint-Cyber Defence Command.
Taiwan	10,307	1.83%	1,820,000	7.7	35,980	F-16 u.k. New procurement of aircraft (F16 or F35) under review by US	Overall Defense Concept focuses on asymmetric tactics in conflict w/ China. Requires new training. Unclear LVC or simulation is part.	Presence of F-16 mission training centre. Nascent simulated training. Live exercises to counter Chinese aggression 2019/2020. Unclear LVC.	The *2017 National Defense Report* and *Quadrennial Defense Review* highlights strategic multi-domain deterrence.	Development of concepts to support multi-domain deterrence. Improving joint operations training. Unclear MDO training.
Turkey	19,225	1.11%	734,000	9.0	783,562	F-16 u.k. F-35 procurement under review by US Congress	*National Security Policy Document* is classified. *Strategic Plan for 2017-2021* highlights flight simulators as focus area.	Originally slated to host a F-35 training installation; Turkish defense industry focus in simulation; unclear on service level sim and LVC usage.	MDO is not mentioned in high-level statements or in doctrine/ strategy.	Unclear, but unlikely, that Turkey trains with MDO. Turkey established a cyber defence directorate, but mission primarily defensive.
UAE	20,974.66 (Jane's)	5.48%	63,000	6.7	83,600	F-16 80/20	There does not appear to be any high-level statements or	LVC Naval Training Centre opening in 2019;	MDO is not mentioned in high-level statements or in	Remains an ambition, but little, if any, ongoing training

							documents that highlight the use of LVC. Training is highlighted as an area of importance; acquisition of sims.	aspiration to achieve LVC for Air Force; live priority but increased constructive usage.	doctrine/ strategy.	in common synthetic environment
UK	54,123	2.00%	228,000	3.5	243,610	Platform agnostic, to include F-35 50/50	Published *Defence Policy for Simulation*; implemented Defence Operating Model; upcoming Defence Virtual Simulation program.	Implemented Defence Training Centre; LVC training tends to be service specific over joint/ combined. Significant investments in LVC.	Part of Tri-lateral Strategic Steering Group on MDO; *National Security Capability Review* mentions joint force must fight across all domains- including, cyber.	2018 UK announced modernization effort of joint forces, to include cyber. UK integrating some MDO via training through Cyber Electro-magnetic Activities Vision.

Table Acronyms

ADF – Australian Defense Force
C2 – command and control
IDF – Israeli Defense Force
LVC – live, virtual, constructive training
MDO – multi-domain operations
MMRCA – medium multi-role combat aircraft
MoD – Ministry of Defense

NATO – North Atlantic Treaty Organization
RCAF – Royal Canadian Air Force
RCN – Royal Canadian Navy
RNAF – Royal Netherlands Air Force
ROK – Republic of Korea
RSN - Royal Singaporean Navy
SAF – Singapore Armed Forces

SDD – Saudi Arabia Defense Doctrine
U.K. – unknown
USFK – US Forces Korea
SDD – Saudi Arabia Defense Doctrine
VR – Virtual Re

General Comparative Defense Figures:
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4th and 5th Generation Fighter Figures:
Information on 4th and 5th generation platform usage is from interviews with defense industry or military officials, conference findings, and secondary sources. Data from Australia, Canada, and UK are from "8th Annual Military Flight Training Conference," 9 October 2015, London, UK. France data from interview with French Air Force Colonel Olivier Le Bot, 15 March 2019. Germany data from Sebastian Sprenger, "German Navy leans heavy on simulation pilot training," *Defense News,* 22 May 2018. India data from Air Marshal Dhiraj Kukreja, "Simulation and Training: The IAF Perspective," *Indian Defence Review* 28.2 (2013). Israel data from Israeli Air Force Lt. Col. Ben Blustein, presentation 18th Annual Flight Training Conference, London, UK, 28 March 2019. Japan data from interview with member of Japanese Air Defense Force (asked for non-attribution), 17 February 2019. Royal Netherlands Air Force (RNAF) data from interview with RNAF Lkol, 10 May 2019. Data on UAE and Singapore from interview with training industry regional defense teams, 21 April 2019.

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APPENDIX TWO: Country Selection Likert Scale

Country	LVC Prioritization (0-4)	LVC Training and Exercises (0-4)	Total Score, LVC	Multi-Domain Operations Prioritization (0-5)	Multi-Domain Training and Exercises (0-5)	Total Score, Multi-Domain
Australia	4	4	4	3.5	4	3.75
Canada	4	3.5	3.75	1	0	0.5
France	3	3	3	3.5	3.5	3.5
Germany	1	2.5	1.75	0	2	1
India	1	1	1	0	.5	.25
Israel	3*	4	3.5	5**	3	4
Italy	2	4	3	1.5	.5	1.25
Japan	1	1	1	3	3	3
Netherlands	2	4	3	1	2	1.5
Pakistan	0	1	.5	0	1	1
Poland	0	1	.5	5	0	2.5
Saudi Arabia	0 ***	1	.5	0	.5	.25
Singapore	2	2	2	1	1	1
South Korea	2	2	2	1	4	2.5
Spain	0	1.5	.75	0	.5	.25
Taiwan	0	1.5	.75	2	2	2
Turkey	1	1.5	1.25	0	.5	.25
UAE	1	3	2	0	1	.5
UK	4	3.5	3.75	3.5	3.5	3.5

*Of note, many of Israel's defense documents are classified or not publicly released. However, the Israeli militaries current simulation capabilities when combined with ongoing tests of LVC indicates it is a priority, even if not in published documents.

** This is partially based on open source reporting among the cyber community that the Israeli Defense Force (IDF) combined conventional and non-kinetic (i.e. cyber) operations in Operation Orchard in 2007. However, it is unclear whether cyber capabilities were used and if they were, whether they are indicative of the use of multi-domain training prior to the operation itself.

*** Saudi Arabia does not have an official published defense policy. This is from secondary sources, so this also may be from a lack of information versus an indication of actual investment/ capability.

APPENDIX THREE: OVERVIEW OF 4th AND 5TH GENERATION FIGHTER PROCUREMENTS

	Country	4th or 5th Generation Fighter Status?	Budget $US, million (2018)
1	Afghanistan		188
2	Albania		175
3	Algeria	✓	9551 (uncertain)
4	Andorra		Not available
5	Angola	✓	1610
6	Antigua and Barbuda		Not available
7	Argentina	✓ (allocated funds)	3443 (uncertain)
8	Armenia	✓	523
9	Australia	✓	25391
10	Austria	✓	3263
11	Azerbaijan	✓	1716
12	Bahamas		Not available
13	Bahrain	✓	1543
14	Bangladesh	✓	3808
15	Barbados		Not available
16	Belarus	✓	730
17	Belgium	✓	4657
18	Belize		24.5
19	Benin		84.8
20	Bhutan		Not available
21	Bolivia		630
22	Bosnia and Herzegovina		164
23	Botswana	✓ (under consideration)	486
24	Brazil	✓	27074
25	Brunei		352
26	Bulgaria	✓	940
27	Burkina Faso		281
28	Burundi		62.87
29	Cabo Verde (Cape Verde)		10.3
30	Cambodia		553 (uncertain)
31	Cameroon		418
32	Canada	✓ (under consideration)	22632
33	Central African Republic		30
34	Chad		238
35	Chile	✓	5185
36	China	✓	229168
37	Colombia	✓ (under consideration)	9458

38	Comoros		Not available
39	Congo		283
40	Costa Rica		0.0
41	Cote d'Ivoire		570
42	Croatia	✓	923
43	Cuba	✓	Not available
44	Cyprus		428
45	Czech Republic	✓	2641
46	Democratic Republic of the Congo		283
47	Denmark	✓	4349
48	Djibouti		Not available
49	Dominica		Not available
50	Dominican Republic		583
51	Ecuador		2556
52	Egypt	✓	3762 (uncertain)
53	El Salvador		295
54	Equatorial Guinea		143.1
55	Eritrea	✓	Not available
56	Estonia	US 4th and 5th generation assets stationed in country.	597
57	Eswatini (former Swaziland)		90.2 (uncertain)
58	Ethiopia	✓	560
59	Fiji		80.3
60	Finland	✓ (under consideration)	3600
61	France	✓	49304
62	Gabon		254
63	Gambia		11.8
64	Georgia		315
65	Germany	✓	44670
66	Ghana		205
67	Greece	✓	5475
68	Grenada		Not available
69	Guatemala		277
70	Guinea		211
71	Guinea-Bissau		19.1
72	Guyana		62.8
73	Haiti		0.1
74	Honduras		392
75	Hungary	✓	1473
76	Iceland		0.0
77	India	✓	69285
78	Indonesia	✓	7835
79	Iran	✓	15257
80	Iraq	✓	6270 (uncertain)

81	Ireland		1060
82	Israel	✓	20074
83	Italy	✓	27122
84	Jamaica		210
85	Japan	✓	47426
86	Jordan	✓	1973
87	Kazakhstan	✓	1491
88	Kenya		1163
89	Kiribati		Not available
90	Kuwait	✓	7203
91	Kyrgyzstan		127
92	Laos	✓	Not available
93	Latvia		507
94	Lebanon		2861
95	Lesotho		49.3
96	Liberia		20.5
97	Libya	✓ (provided to Libyan mercenaries by Russia)	Not available
98	Liechtenstein		Not available
99	Lithuania	US 4th and 5th generation assets stationed in country.	852
100	Luxembourg		380 (uncertain)
101	Madagascar		70.9
102	Malawi		63.5
103	Malaysia	✓	3381
104	Maldives		Not available
105	Mali		449
106	Malta		64.5
107	Marshall Islands		Not available
108	Mauritania		160
109	Mauritius		22
110	Mexico		6051
111	Micronesia		Not available
112	Monaco		Not available
113	Mongolia	✓	97
114	Montenegro		75.1
115	Morocco	✓	3641
116	Mozambique		202
117	Myanmar	✓	2357
118	Namibia	✓	434
119	Nauru		Not available
120	Nepal		443
121	Netherlands	✓	10821
122	New Zealand		2456

123	Nicaragua		82.7
124	Niger		212
125	Nigeria	✓	2028
126	North Korea	✓	Uncertain
127	North Macedonia		114
128	Norway	✓	7128
129	Oman	✓	7575
130	Pakistan	✓	10524
131	Palau		Not available
132	Panama		0.0
133	Papua New Guinea		82
134	Paraguay		371
135	Peru	✓	2677
136	Philippines	✓	2965
140	Poland	✓	11591
141	Portugal	✓	4090
142	Qatar	✓	Not available
143	Republic of Korea	✓	40814
144	Republic of Moldova	✓	37.9
145	Romania	✓	4214
146	Russian Federation	✓	62404
147	Rwanda		117.9
148	Saint Kitts and Nevis		Not available
149	Saint Lucia		Not available
150	Saint Vincent and the Grenadines		Not available
151	Samoa		Not available
152	San Marino		Not available
153	Sao Tome and Principe		Not available
154	Saudi Arabia	✓	72918
155	Senegal		372
156	Serbia	✓	795
157	Seychelles		23.5
158	Sierra Leone		27.3
159	Singapore	✓	10524
160	Slovakia	✓	1262
161	Slovenia		510
162	Solomon Islands		Not available
163	Somalia		Not available
164	South Africa	✓	3458
165	South Sudan		245
166	Spain	✓	17024
167	Sri Lanka	✓	1543
168	Sudan	✓	799
169	Suriname		Not available

170	Sweden	✓	5365
171	Switzerland	✓	4596
172	Syrian Arab Republic	✓	Not available
173	Taiwan	✓	10307
174	Tajikistan		84
175	Thailand	✓	7141
176	Timor-Leste		20.8
177	Togo		99.7
178	Tonga		Not available
180	Trinidad and Tobago		168
181	Tunisia	✓ (competition underway)	814
182	Turkey	✓	19225
183	Turkmenistan	✓	Not available
184	Tuvalu		Not available
185	Uganda	✓	423
186	Ukraine	✓	4744
187	United Arab Emirates	✓	20974 (Jane's)
188	United Kingdom	✓	54163
190	United Republic of Tanzania	✓	612
191	United States of America	✓	694860
192	Uruguay		1196
193	Uzbekistan	✓	1507
194	Vanuatu		Not available
195	Venezuela	✓	0.5 (uncertain)
196	Vietnam	✓	5603 (uncertain)
197	Yemen	✓	Not available
198	Zambia	✓	334
199	Zimbabwe	✓	1101

List of countries based on UN General Assembly membership, plus Taiwan based on US treaty with Taiwan. UN General Assembly used because depending on the list, the Holy See and Palestine could also be included. See, United Nations, "Member States," accessed 7 March 2020, https://www.un.org/en/about-us/member-states.

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APPENDIX FOUR: Interviews, Correspondence, and Ethics

Australia

Coding	Interviewee	Role/ Rank	Status	Medium	Format	Length	Confidentiality	Consent
1, AUS	Group Captain Andrew Campbell	Co-lead of RAAF Project Jericho	11 August 2016 at Australia MoD, Canberra, Australia	In-person	Semi-structured	30-minutes	Not-for-attribution	Serendipitous, Potomac Institute for Policy Studies, cleared and published
2, AUS	Group Captain Bernie Grealy	Director of Simulation Services at the Australian Defence Simulation and Training Centre	11 August 2016 at Australian Defence Simulation and Training Centre, Canberra, Australia	In-person	Semi-structured	30 minutes	Not-for-attribution	Serendipitous, Potomac Institute for Policy Studies, cleared and published
3, AUS	Air Commodore Mike Kitcher	RAAF Air Combat Group Commander	11 August 2016 at Australian MoD, Canberra, Australia	In-person	Semi-structured	30 minutes	Not-for-attribution	Serendipitous, Potomac Institute for Policy Studies, cleared and published
4, AUS	Lieutenant Colonel Kane Mangin	Director Land Simulation, Army Headquarters	11 August 2016 at Australian MoD, Canberra, Australia	In-person	Semi-structured	30 minutes	Not-for-attribution	Serendipitous, Potomac Institute for Policy Studies, cleared and published
5, AUS	Lieutenant Commander Navy	Staff Officer, Modeling and Simulation Major Projects, Australian Navy	11 August 2016 at Australian MoD, Canberra, Australia	In-person	Semi-structured	30 minutes	Not for attribution	Serendipitous, Potomac Institute for Policy Studies, cleared and published

6, AUS	Air Marshall Geoff Browning	Former head of the Royal Australian Air Force	19 June 2018 via email.	E-mail	Structured	N/A	On-the-record	Via Email
7, AUS	Wing Commander Steve Laredo	RAAF Deputy Director Modelling and Simulation	11 August 2016 at Australian MoD, Canberra, Australia. Follow up via email 4 March 2020.	In-person and email	Semi-structured and structured	In-person: 1 hour; Email: N/A	On-the-record	Serendipitous, Potomac Institute for Policy Studies, cleared and published Follow-up via email
8, AUS	Canadian LVC research scientist	Australian Government, Defense Science and Technology; LVC team	5 March 2020 via email	Email	Structured	N/A	Off-the-record	Via email
9, AUS	Wing Commander, Mick Tully	Coalition Virtual Flag Exercise Director	8 April 2020 and 9 April 2020 via email correspondence.	E-mail	Structured	N/A	On-the-record	Via email

Canada

1, CAN	Lt. Gen Yvan Blondin	Former Commander of Royal Canadian Air Force	26 January 2020 via email correspondence.	E-mail	Structured	N/A	On-the-record	Via email
2, CAN	Gene Colabatistto	Former President of CAE (Canadian Aerospace Engineering) Defense and Security Group	4 February 2020 via phone	In-person	Semi-structured	1-hour	On-the-record	Via text and then confirmed via phone call
3, CAN	Brig. General David Anderson	Chief of Staff Readiness, Canadian Joint Operations Command	14 November 2020 in Tel Aviv	In-person	Semi-structured	2-hours	On-the-record	In-person; follow up via email

4, CAN	Major in Canadian Armed Forces, Lead for M&S and Experimentation	Joint Wargaming Experimentation and Simulation, Canadian Joint Warfare Centre	20 April 2021, via Zoom	In-person	Semi-structured	1-hour	Not-for-attribution	Via email
5, CAN	Senior Wargame Designer (pan-domain wargames w/ M&S)	Joint Warfighting Experimentation and Simulation Canadian Joint Warfare Centre	29 April 2021 via Zoom	In-person	Semi-structured	1 hour	Not-for-attribution	Via email
6, CAN	Program manager, Canadian simulation industry	Former combat systems engineer, Royal Canadian Navy- Canadian Forces Fleet School and program manager, Canadian simulation industry	11 February 2022 via Zoom	In-person	Semi-structured	30-minutes	Not-for-attribution	Via email
7, CAN	Lt. Colonel (ret.)	Chief of Staff to Commander, Royal Canadian Training System, Royal Canadian Navy	14 February 2022 via Zoom	In-person	Semi-structured	30-minutes	Not-for-attribution	Via email
8, CAN	Canadian Naval Subject Matter Expert	Former Naval Warfare and Training Development Officer; Royal Canadian Navy and simulation industry, Navy SME	14 February 2022 via Zoom	In-person	Semi-structured	45-minutes	Not-for-attribution	Via email
9, CAN	Royal Canadian Air Force Subject Matter Expert	Former RCAF pilot instructor, RCAF BD Canadian simulation industry	16 February 2022 via Teams	In-person	Semi-structured	30-minutes	Not-for-attribution	Via email

Israel

1, Israel	MG Motti Baruch	Commanding General, General Staff Corps and Commander, C2 School	13 November 2019 in Tel Aviv, Israel	In-person; International Summit Operational Simulation	Semi-structured	15-minutes	On-the-record	Questions asked during Q&A, posted online by IDF
2, Israel	MG Yacov Bengo	Head of Training and Doctrine Division (J7) & Commander of Northern Corps	13 November 2019 in Tel Aviv, Israel	In-person; International Summit Operational Simulation	Semi-structured	15-minutes	On-the-record	Questions asked during Q&A, posted online by IDF
3, Israel	MG Gershon Hacohen	IDF General Staff Exercise Director	12 November 2019 in Tel Aviv, Israel	In-person; International Summit Operational Simulation	Semi-structured	15-minutes	On-the-record	Questions asked during Q&A, posted online by IDF
4, Israel	Col (res.) Gideon Hoshen	Defense Systems Analyst and Architect	12 November 2019 in Tel Aviv, Israel	In-person; International Summit Operational Simulation	Semi-structured	15-minutes	On-the-record	Questions asked during Q&A, posted online by IDF
5, Israel	LTC (Res). Yaron Mizrachi	CEO Bagira Systems	26 January 2022 via Teams	Teams	Semi-structured	30 minutes	On-the-record	Via WhatsApp text conversation with his assistant and, again, verbally at the beginning of the interview
6, Israel	Col. Gabi Siboni	Chief Methodologist, IDF Concepts Laboratory	12 November 2019 in Tel Aviv, Israel	In-person; International Summit Operational Simulation	Semi-structured	30-minutes	On-the-record	Questions asked during Q&A, posted online by IDF
7, Israel	Alon Yair	Head of Training Systems Field, Rafael	13 November 2019, Tel Aviv, Israel	In-person; International Summit	Semi-structured	15-minutes	On-the-record	Questions asked during Q&A, posted online by IDF

				Operational Simulation				
8, Israel	IDF Civilian Employee	Head of Strategic Wargames, IDF J-3	13 November 2019, Tel Aviv, Israel	In-person	Semi-structured	30-minutes	Not-for-attribution	Via WhatsApp and again verbally
9, Israel	Israeli Air Force Officer	Air Attaché	19 September 2019 in Washington, DC.	In-person	Semi-structured	30-minutes	Not-for-attribution	Via email
10, Israel	High Ranking Military Officer	Former Head of IDF	19 September 2019 in Washington, DC.	In-person	Semi-structured	30-minutes	Not-for-attribution	Via email
11, Israel	IDF Spokesperson for National Training Center	Israeli Defense Force officer (active), lead for foreign interviews on training	14 November 2019 at the National Training Center in the Negev.	In-person	Semi-structured	1 hour	Not-for-attribution	Via WhatsApp

Japan

1, JAP	JASD Fighter Pilot	JASDF officer tasked with simulation training answered questions alongside team	Email correspondence 17 February 2019 and 13 June 2019.	Email	Structured	N/A	Not-for-attribution	Via email
2, Japan // USA	Brig. Gen. Barry Barksdale (US)	(Ret.) Vice Commander, 12th Air Force; 7th Air Force Senior Air Controller; oversaw training exercises in Korea and Japan	Conducted 23 April 2020 via phone.	Phone	Semi-structured	1 hour	On-the-record	Via email
3, Japan // USA	Mr. Brent Johnson	Senior Systems Engineer; American training provider for the JSDF for over 20 years.	Conducted 20 April 2020 via phone.	Phone	Semi-structured	1 hour	On-the-record	Via email

4, Japan // USA	Mr. Ronald (Scott) Hamman	Air Force Agency Modeling and Simulation Training Toolkit Warfighter advocate, former C2 officer, American training provider for the JSDF for over 20 years.	Conducted 16 April 2020 via phone.	Phone	Semi-structured	1 hour	On-the-record	Via email
5, Japan // USA	American training provider	American training provider for the JSDF for over 20 Years. Korea Air Simulation Center, Chief of Simulations	Conducted 28 April 2020 via phone.	Phone	Semi-structured	1 hour	Not-for-attribution	Via email
6, Japan // USA	US Navy Military Officer, F-16 pilot	Previously stationed in Japan, flew in LVC training events.	17 May 2020 via email correspondence.	E-mail	Structured	N/A	Not-for-attribution	Via email
7, Japan // USA	US Pacific Air Forces training provider for JSDF	Lead for JTLS simulation	Conducted 20 April 2020 by phone.	Phone	Semi-structured	15-minutes	Not-for-attribution	Via email

1, France	Colonel Olivier Le Bot	Chief of Staff, Director of French Air Warfare; Former Deputy Director Operational Test and Evaluation	MoD. Follow up email correspondence 15 March 2019 and 1 April 2019.	In-person March 2016; Email 15 May 2019 and 1 April 2019.	In person: Semi-structured Email: Structured	In person: 1 hour Email: N/A	On-the-record	Serendipitous, Potomac Institute for Policy Studies, cleared and published Via email
1, Netherlands	Lt Colonel Air Force official	Royal Netherlands Air Force	Conducted 10 May 2019 via email.	E-mail	Structured	N/A	Not-for-attribution	Via email

		Simulation and Training Official						
1, UAE	Simulation industry official	Asia and Middle East Manager	21 April 2019 via email.	E-mail	Structured	N/A	Not-for-attribution	Via email
1, UK	Julie Tilson	Jane's Defence, Senior Simulation Analyst	Conducted 21 April 2019 via email.	E-mail	Structured	N/A	On-the-record	Via email
1, USA	Col Robert Epstein	Commander of the US Air Force Agency for Modeling and Simulation	Conducted 15 November 2019 via email.	E-mail	Structured	N/A	On-the-record	Via email
2, USA	Barry McArdle	Former lead engineer for the US Air Force AWSIM program (constructive simulation used in many command post exercises)	Conducted 19 August 2021.	Phone	Semi-structued	30 minutes	On-the-record	Via email
3, USA	Brig. Gen. Bruce McClintock	Led the review of the Air Force Space Command LVC Operational Training Fight Plan	Conducted 11 October 2017 by phone	Phone	Semi-structured.	30 minutes	On-the-record	Via email; previously published by CSBA
4, USA	Col Doug "Cinco" DeMaio	Vice Commander of the Curtis LeMay Center for Doctrine Development	Conducted 23 January 2018 at Maxwell Air Force Base.	In-person	Semi-structured	1-hour	On-the-record	Verbal consent and via email
5, USA	Lt. Col Peter Garretson	Instructor at Air University, Air Command and Staff College	Conducted 23 January 2018 at Maxwell Air Force Base.	In-person	Semi-structured	1 hour	Not-for-attribution	Verbal consent
6, USA	US Air Force Major	Air Force Major charged with cyber	29 March 2018.	Phone	Semi-structured	30 minutes	Not-for-attribution	Via email and verbal consent

		operations in the Middle East against ISIS						

APPENDIX FIVE: DEFINITIONS OF GAMING, AUGMENTED REALITY, AND MIXED REALITY

- *Gaming: Video Games as Training Tools*

The US military has experimented with retrofitting popular commercial video games to meet their training needs since the 1980s, when Atari released its groundbreaking *Battlezone.* Following on *Battlezone*'s success, the US Army requested Atari's assistance in generating a unique Army version of *Battlezone* that could train soldiers to operate the Bradley infantry vehicle. *Army Battlezone*, also known as the *Bradley Trainer*, while produced, was never used. However, since that time, a slew of military video games has built on the burgeoning popularity of the commercial video game industry. From first-person shooter games, like *Marine Doom* to *UrbanSim,* which teaches warfighters the complexity of counterinsurgency operations, the military has sought to blend "work" and "play," using one of their young recruits' preferred recreational activities as a heuristic device. Military video games—at times referred to as "serious games"—have now been utilized by the armed forces for training, recruitment, and the psychological well-being of troops, to include sexual harassment training and the treatment of post-traumatic stress disorder.

- *Augmented Reality: Combining the Physical World with a Virtual Overlay*

Augmented reality combines elements of both the physical and virtual environments in one setting. Typically, augmented reality applications overlay virtual images on the physical world, much like Google Glass or Pokémon Go. Military leaders are incorporating augmented reality technologies on training sites, such as the Marine Corps Base at Camp Pendleton in California. Camp Pendleton has indoor and outdoor training facilities, which include mock villages. Actors are employed to act as adversaries during training scenarios in the mock villages. Under law, however, child actors cannot be employed. Augmented reality allows for virtual children to be superimposed onto the physical environment, providing a higher level of realism in training for certain counterinsurgency or urban warfare scenarios.

- *Mixed Reality: Mixing the Physical World with Artificial Sensory Triggers*

In the past, the term mixed reality was often employed interchangeably with augmented reality. However, new training platforms are creating a "mixed reality" market that is distinct from augmented reality applications. Indeed, mixed reality employs technologies that trigger trainee responses across their senses—to include visuals, haptic feedback, spatial sound, and smell. For example, simulated imagery of a pine forest would act as a catalyst for the injection of pine aroma, while the pull of a trigger during gunnery training would generate a recoil and muzzle flashes. Mixed reality strives to move beyond mere visual displays to better simulate the physical sensations of combat.

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