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14. ABSTRACT

This research examines the intersection of future AI-infused machine-learning systems and human adaption through an organizational learning lens to identify conceptual lessons and key actionable issues for senior Service, Joint Staff, and Department of Defense leaders in order to prevent catastrophic failure following rapid technological fielding in the future. The study uses contextual-phenomenon analysis of historic responses when innovative and disruptive technology is fielded rapidly to warfighters and assesses results through an organizational learning and change management lens. The application of multi-looping organizational learning theory demonstrates parallels with the elegant simplicity of John Boyd's OODA loop model that emphasizes agility and innovation through faster situational awareness and feedback. It provides a pragmatic methodology to fill a gap between formal training and formal education with self-directed learning and a collective training crucible to improve organizational warfighter mental agility .While two conceptual next-step intervention solutions are presented to preempt future disruption as the military looks towards the rapid fielding of AI-infused weapon systems, the research may be applied to prevent organizational failure from an inability to learn, anticipate, or adapt during any disruptive or catastrophic event.

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Robots and Rogue Thinkers: Leveraging Organizational Learning Theory to Prevent Catastrophic Failure After Rapid Fielding of Disruptive Technology

by

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A paper submitted to the Faculty of the United States Naval War College Newport, RI in partial satisfaction of the requirements for the degree of Master of Arts in National Security and Strategic Studies.

Table of Contents

List of Figures

Abstract

This research examines the intersection of future AI-infused machine-learning systems and human adaption through an organizational learning lens to identify conceptual lessons and key actionable issues for senior Service, Joint Staff, and Department of Defense leaders in order to prevent catastrophic failure following rapid technological fielding in the future. The study uses contextual-phenomenon analysis of historic responses when innovative and disruptive technology is fielded rapidly to warfighters and assesses results through an organizational learning and change management lens. The application of multi-looping organizational learning theory demonstrates parallels with the elegant simplicity of John Boyd's OODA loop model that emphasizes agility and innovation through faster situational awareness and feedback. While two conceptual next-step intervention solutions are presented to preempt future disruption as the military looks towards the rapid fielding of AI-infused weapon systems, the research may be applied to prevent organizational failure from an inability to learn, anticipate, or adapt during any disruptive or catastrophic event.

Introduction

The U.S. Navy operates in an environment constantly subject to change… [and] is expected to adapt quickly and operate effectively.[1]

The United States has enjoyed unrivaled military preeminence since the 1991 Persian Gulf War, but it cannot assume that it will keep that edge. Speaking in 2018, Dr. Timothy Grayson, the director of DARPA's Strategic Technologies Office, noted that the United States' military dominance is "eroding as other nations modernize their militaries at a pace accelerated by globally available advanced commercially technology." The country that modernizes faster and can get inside an adversary's *observe-orient-decide-act* (OODA) loop, he argues, will win.[2] Speed is an imperative and the military plans to use autonomy, advanced sensors, and weapon systems with machine-to-machine interoperability and artificial intelligence to network manned and unmanned systems together to act faster than competitors.

The advent of artificial intelligence (AI) promises a future of robotic and autonomous systems that think and decide for themselves. Surges in computing power are rapidly leading the world towards algorithmic warfare, where autonomy and human-machine teaming are used at scale to transform military operations. Today, this machine learning technology is used for non-lethal applications of improving maintenance schedules, scanning through hundreds of hours of surveillance video, or testing self-driving vehicles. Weapon systems will have artificial intelligence programmed to act autonomously on the battlefield. Command and control systems

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[1] US Navy, "Comprehensive Review of Recent Surface Force Incidents, October 2017, 20; hereinafter USFF.
[2] Timothy Grayson, "Mosaic Warfare and Multi-Domain Battle," DARPA 60th Anniversary Symposium (Gaylord National Harbor, Oxon Hill, Md., September 7, 2018).

will have intelligent agents that work with humans to improve decision making speed and accuracy. Across government and industry, leaders are encouraging people to think out of the box, find innovative solutions, and get new, effective technologies quickly into the hands of warfighters. Fielding these highly autonomous systems will require high levels of trust based on a process to validate and verify machine decisions. More importantly, it will require assertive consideration for the human side of advanced technology. The challenge is to have a military capable of constant adaptation to whatever situation arises faster than its opponent to maintain an edge.

Warfighter understanding must evolve at least as fast as the technology. Without changing to stay ahead of an adversary's innovation and adaptation cycle, the military operates at a disadvantage and may not be able to assure national survival. Military-technical revolutions have shown the power to change the character of warfare, but only if organizations can adapt to take advantage of opportunities provided by new technology before their adversaries. If technology advances faster than the organization can understand it, it creates an environment for suboptimal results. In business, failing to adapt can mean lower profits and the potential of bankruptcy. In the military, failing to adapt can mean losing the battle and squandering American blood and treasure. Any gap between fielding the technology and the warfighter's ability to employ it effectively surrenders initiative.

Battlefields are littered with the remains of armies that could not perceive, learn, and adapt to change. In volatile, complex, uncertain, and ambiguous environments—especially in the extremes of warfare where Clausewitzian friction impedes decision making—fielding new technology rapidly requires an organization to absorb change and manage uncertainty.

Simultaneously, it must align its processes and cultural values while building trust so the organization evolves at least as fast as the technology is introduced. A transformational learning approach is the most effective method to evolve the Navy into an agile next-generation learning organization capable of rapid and continual adaption that is vital to winning future wars.

The rest of this research paper is organized into five sections. The first examines historic responses when innovative and disruptive technology is fielded rapidly to warfighters. The potential of organizational learning theory is analyzed in Section 2. Section 3 applies learning and change management theories to innovation disruption as the military looks towards the rapid fielding of artificial intelligence-infused weapon systems. Two conceptual next-step solutions are presented to preempt future disruption as the military looks towards the rapid fielding of AI-infused weapon systems in Section 4. Finally, conclusions are presented in Section 5.

1. Innovation and Disruption

In a war, you've got to try to keep at least one punch ahead of the other guy all the time.[3]

Technological optimism is widespread. Every industry and most nations are constantly innovating to maintain a competitive edge and constantly looking for disruptive technology to give it an unmatched advantage. At a press conference in 2017, Russian President Vladimir Putin announced his intention to increase research and development funding on artificial intelligence (AI) research. The country that leads in AI, he said, "will become the ruler of the world."[4] At the same time, China is leveraging its national champion companies in a "digital triangle" of direct

[3] General Curtis LeMay, March 10, 1945, quoted in Richard Rhodes, "The General and World War III," *The New Yorker*, June 12, 1995, https://www.newyorker.com/magazine/1995/06/19/the-general-and-world-war-iii.
[4] Quoted in James Vincent, "Putin Says the Nation That Leads in AI 'Will Be the Ruler of the World,'" *Verge*, September 4, 2017, https://www.theverge.com/2017/9/4/16251226/russia-ai-putin-rule-the-world.

government funding and grants, generous lines of credit from state-owned banks, and staff and assistance from research institutes to gain a dominant global advantage in artificial intelligence. China's strategic roadmap for national science and technology development makes its intent to combine military capabilities and civilian production clear.[5]

The Defense Intelligence Agency (DIA) commissioned a recent study looking at technological optimism and warfare. "Conventional wisdom," the authors write, "presumes that the new technology is categorically different, delivers a devastating effect, and will be decisive in warfare, especially if its introduction on the battlefield is a surprise."[6] The "seductive appeal of technological optimism"[7] can be seen in historical and contemporary calls to get innovations into the hands of the warfighter rapidly. The DoD's *Third Offset* strategy was intended to speed development and fielding of cutting-edge technologies, especially in the areas of autonomous systems, robotics, and advanced manufacturing. The 2018 *National Defense Strategy* makes it clear that these new technologies are how the nation will "fight and win the wars of the future."[8]

In arguing that genuine transformational innovations that disrupt the strategic status quo are extremely rare, the most "game-changing" innovations, the DIA study's authors continue,

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[5] Evan Medeiros et al., *A New Direction for China's Defense Industry* (Arlington, VA: RAND Corporation, 2005), 205; For further discussion see PRC Medium- and Long-Term SandT Program Guidelines for 2006-2020" (Xinhua Domestic Service, February 9, 2006) cited in Bryan Krekel, Patton Adams, and George Bakos, *Occupying the Information High Ground: Chinese Capabilities for Computer Network Operations and Cyber Espionage,"* Northrop Grumman Corp, March 7, 2012, https://nsarchive2.gwu.edu//NSAEBB/NSAEBB424/docs/Cyber-066.pdf; Sydney J. Freeberg, Jr., "Joint Artificial Intelligence Center Created Under DoD CIO," *Breaking Defense*, June 29, 2018, https://breakingdefense.com/2018/06/joint-artificial-intelligence-center-created-under-dod-cio/.

[6] James L. Regens, Matthew R.H. Uttley, and Charles B. Vandepeer, "Technological Optimism and the Imagined Future: Implications for Warfare," (DIA Grant# HHM402-19-1-0005), *The Strategy Bridge*, February 18, 2020, https://thestrategybridge.org/the-bridge/2020/2/18/technological-optimism-and-the-imagined-future-implications-for-warfare

[7] Ibid.

[8] Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge*, 3, https://www.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf

will likely be limited to disrupting the "operational or tactical status quo." Innovations in weapons, they contend, lack a "linear relationship between the technological development of weapons and application in warfare." They conclude, somewhat cryptically, that the "imagined future" of war's character is "a necessary precondition for military innovation."[9] There are several problems with this view, not the least of which is an over-reliance on the work of Sir Basil H. Liddell Hart, where military innovation is concerned. The prolific and influential theorist was wrong more often than he was right as his disdain for land warfare overshadowed sound analytical thinking.[10] The most egregious fault, however, is in failing to account for the human side of innovation in assuming the effect of an imagined future on society's view of warfare.

What then, influences society's vision of the character of warfare? Clausewitz called it the spirit of the age. Social and political norms, laws, technology, evolving cultural morality, and ethics all play a role. The stories we tell ourselves influence these factors and shape the future character of warfare. In the history of science fiction, dark dystopian futures have outnumbered utopian visions. This has created a deep cultural undercurrent of fear as society catches up with fiction. This is especially true for autonomous AI applications, which is reinforced through negative media portrayal of *robopocalypse* images of terminators, Cylons, and other killer robots that were introduced a century ago. In a play written in 1920, Karel Capek introduced both the word "robot" (roboti) and the inevitability of world domination and human extinction by

[9] James L. Regens, Matthew R.H. Uttley, and Charles B. Vandepeer, "Technological Optimism and the Imagined Future: Implications for Warfare."
[10] For a robust discussion on Liddell Hart's merits, see John J. Mearsheimer, *Liddell Hart and the Weight of History,* (Ithaca, NY: Cornell University Press, 1988).

robots.[11] In 1927, Fritz Lang's film *Metropolis* warned of technology as a fulcrum of power and corruption. It was not until 1950 when Isaac Asimov's "Three Laws of Robotics" began an argument that properly programmed and regulated AI robots would benefit humanity.[12] Arthur C. Clark's *2001: A Space Odyssey* then showed the consequence of adding human bias and lies to AI programming.

The United States intends to maintain its status as the world leader in artificial intelligence research and development.[13] On the military side, the Department of Defense created the Joint Artificial Intelligence Center to synchronize and accelerate the delivery of artificial intelligence-enabled capabilities into the hands of warfighters.[14] "The real challenge now, both in the United States and abroad, is going beyond the hype and getting the right people, organizations, processes, and safeguards in place."[15] Achieving faster technical development, experts agree, is only part of the problem. Rapid fielding of innovative technology is not in itself revolutionary and cannot, by itself, compel an adversary to act in desired ways. Disruptive innovations, from AI-enabled, networked, and autonomous weapons to nanomaterials and on-demand 3-D printing, and human enhancement, are, however, part of a long history of providing the raw materials for military revolutions. Of these, the AI-infused machine-learning systems

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[11] R.U.R. (Rossum's Universal Robots). The first human death by robot was an industrial accident in 25 January 1979 at the Ford Motor Company casting plant in Flat Rock, Michigan

[12] Cf. Brooks Landon, *Science Fiction After 1900: From Steam Man to the Stars or* Robert A. Heinlein, *On the writing of speculative fiction,"* 1947; Kevin L Young and Charli Carpenter, "Does Science Fiction Affect Political Fact? Yes and No: A Survey Experiment on 'Killer Robots,'" *International Studies Quarterly,* Vol 62, No. 3, September 2018, pp. 562-576.

[13] Executive Order 13859, "Maintaining American Leadership in Artificial Intelligence," Executive Office of the President, February 14, 2019, https://www.govinfo.gov/content/pkg/FR-2019-02-14/pdf/2019-02544.pdf.

[14] "Vision: Transform the DoD Through Artificial Intelligence," Department of Defense, nd., https://dodcio.defense.gov/About-DoD-CIO/Organization/JAIC/.

[15] Michael Horowitz and Casey Mahoney, "Artificial Intelligence and the Military: Technology is Only Half the Battle," *War on the Rocks,* December 25, 2018, https://warontherocks.com/2018/12/artificial-intelligence-and-the-military-technology-is-only-half-the-battle/

have the greatest potential for revolutionary change and the greatest challenge for human adaptation. In *Forecasting Change in Military Technology, 2020-2040*, Michael O'Hanlon, notes that these "revolutions must ultimately be sparked by entrepreneurship and organizational adaptation."[16] Military-technical revolutions have shown the power to change the character of warfare, but only if the organizations that can quickly adapt their processes to absorb change, manage uncertainty, and take advantage of opportunities provided by new technology.

Archaeologists suggest that weapon innovation can be seen going back to the Paleolithic era. In written accounts, the Greek historian Thucydides documented the use of an emerging and disruptive technology, a proto flamethrower, used by the Boetians in 424 BC as a fearful psychological weapon used to burn defensive wooden walls and end the siege of Delium during the Peloponnesian War.[17] These innovations can include a single disruptive technology, like this, or the longbow, poison gas, artillery, the airplane, the submarine, or nuclear weapons; or the novel use of several known technologies in a new architecture, like the German *Blitzkrieg,* ballistic missile submarines, or the space-enabled precision warfare of the 1991 Gulf War. The commonality in each of these examples suggests that those organizations capable of rapid adaptation to change had success while those not capable of adapting suffered failure. Adaptation requires change. The military, however, has a history of promoting rapid fielding of innovations while simultaneously resisting change.

Innovation diffusion describes the degree of adaptation an idea, new product, or new practice has across a given population. Research has shown that individuals adapt to innovation

[16] Michael O'Hanlon, Forecasting Change in Military Technology, 2020-2040, (Washington DC: Brookings, September 2018), https://www.brookings.edu/wp-content/uploads/2018/09/FP_20181218_defense_advances_pt2.pdf, 4
[17] Thucydides, *The Peloponnesian War,* Bk. IV.100.

across time and that they can be categorized by their propensity to adopt relative to the rest of the group. Viewed as a normal, if asymmetric, distribution in Figure 1, approximately 70 percent of individuals fall in the early and late majority when the innovation is adopted into common use. The early majority tend to adopt just ahead of the average of their social group. Late majority adopters are skeptics who wait to see how the innovation works before adopting. Two percent are categorized as innovators who are eager, perhaps obsessively so, to try new ideas. Early adopters are influencers who are tied tightly into social networks. Laggards tend to be the least trusting and the last to adopt an innovation. They cling to 'old traditional ways,' and by the time they adopt the innovation, it may already be obsolete.[18] Late adopters and laggards placed into a role that demands adaption because of rapidly fielded technology or a disruptive innovation will reject adaptation. The time lag, however, between early adopters and late majority indicates an organization that is slow to adapt.

[18] Rogers, *Communication of Innovation*.

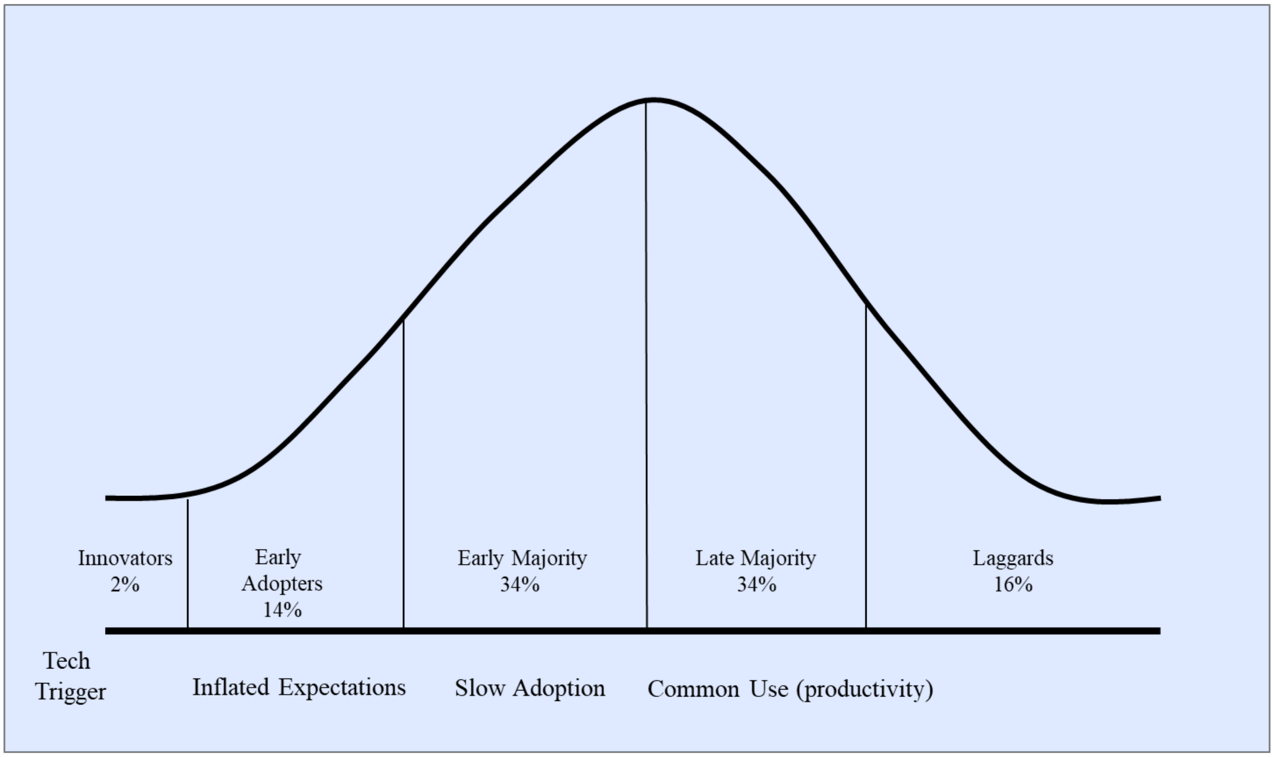

Figure 1. Innovation adopter's curve. Adapted from Everett. M. Rogers, Communication of Innovation. (New York: The Free Press, 1995), 257-62.

Given the potential disaster of being slow to adapt, the positive impact of fast adapters has been studied extensively. Allowing the adopter's curve to run its course is counterproductive. Organizations need to flatten the curve by shifting left. By moving half of early majority adopters to early adopters and half of later majority adopters into the early majority, organizations can gain a substantial advantage. Scholarship in the past twenty years has focused on accomplishing this shift through bottom-up, top-down, and horizontal innovation models.[19] Harvard professor Clayton Christensen, who coined the term disruptive innovation, has written extensively on business aspects of innovation and disruptive technologies. In *The Innovator's*

[19] Stuart Griffin (2017) Military Innovation Studies: Multidisciplinary or Lacking Discipline?1, Journal of Strategic Studies, 40:1-2, 196-224, DOI: 10.1080/01402390.2016.1196358

Dilemma, he contends there are two types of innovation. The first is sustaining innovations that are generally linear in nature. These linear changes have, historically, returned the greatest profits by continuously improving product lines. Using market research focused on continuous product improvement will frequently support the idea that customers are demanding ever-increasing high-tech solutions. This approach creates a circular reinforcement for corporate profit-seeking and results in a tendency to innovate faster than customers can adapt.

Eventually, Christensen argues, this results in goods or services that are too complicated, sophisticated, or expensive for the market. Established and mature corporations are unwilling to risk sustaining profits for radical innovation. Make better products for better profits wins the argument in corporate boardrooms. Once this happens, disruptive competitors enter at the bottom of the market with new and simpler technology that rapidly take over the market because the customers wanted technology they could understand and use.[20] Startup companies tend to be the leaders in introducing disruptive technology, which is the second type of innovation. The ability of an organization to manage change is challenged for both linear change and exponential innovation.

[20] Clayton Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail,* (Brighton, MA: Harvard Business Review Press, 1997).

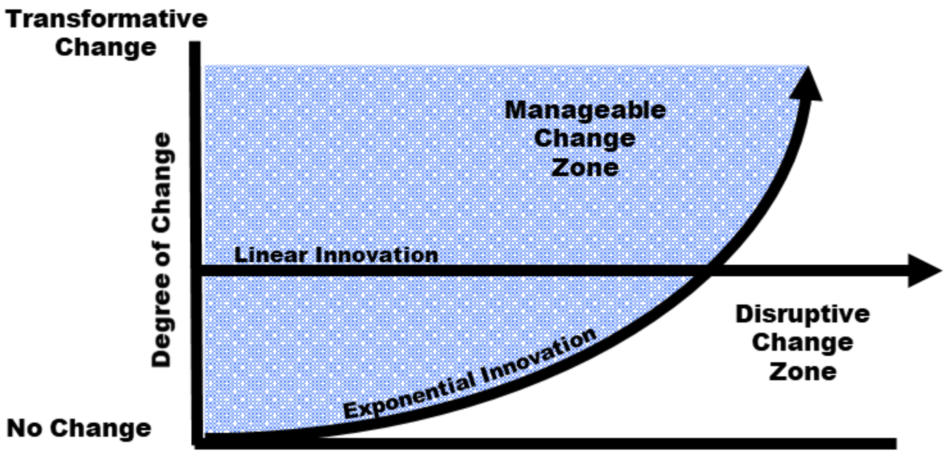

Figure 2. Exponential Change Inflection Points. Adapted from Daniel Burrus, The Anticipatory Organization: Turn Disruption and Change into Opportunity and Advantage, (Austin, TX: Greenleaf Book Group Press, 2017), 36.

Managing the two types of innovation suggest that organizations, like the military, must encourage desired incremental innovation while preventing profit-seeking innovation that simply adds unnecessary complication to existing systems without a substantial improvement in effectiveness. Likewise, the military must adapt quickly to the introduction of disruptive technology from either a single, radical technology or the novel combination of existing technologies by building flexible training programs for warfighters. Consideration should be given to identifying, training, and promoting capable *Early Adopters* in each organization. Since these individuals are influential in their social networks, they will speed innovation adoption across the organization. While Rogers notes that older adults are generally less likely to be early adopters,[21] his definition of 'older' is generally outside of the age range for military service. However, training for senior operational leaders that command organizations that are using innovative or disruptive technology must occur to build organization-wide competency and trust

[21] Everett. M. Rogers, *Communication of Innovation.* (New York: The Free Press, 1995).

in the new technology. Additionally, it is important to provide enough training and practice time so crews can find creative and unexpected ways of using the new technology to take advantage of opportunities in gaining a combat edge.

Innovation and Failure

Studying adaptation to innovation and disruption requires a multidisciplinary approach. In the fast-changing information age, organizational studies using multiple perspectives, including management and operations, history and sociology, economics, computing, and education, are more apt to produce viable results. A multitude of factors contributes to success or failure, with the most prominent of these falling within leadership and decision-making categories that are deeply embedded in how the organization learns. Emerging technology, whether it disrupts at the tactical or operational levels of warfare or is truly transformative in that it revolutionizes warfare at the strategic level, benefits the side that adapts fastest. Simply put, new technology will not deliver a decisive edge if the warfighter, as an organization, cannot learn to use it effectively.

In *Military Misfortunes: The Anatomy of Failure in War*, Eliot Cohen and John Gooch found military failure could be categorized into one of three types of misfortune related to innovation: inability to learn, inability to anticipate, and inability to adapt.[22] Each of these is deeply embedded in complex processes and interconnections between humans, systems, and organizations. An organization with inabilities in two categories is likely to fail. An organization with all three is likely to fail catastrophically. In *On Flexibility,* Meir Finkel discusses ways for a military organization to recover from the actions of an adversary's innovation but can be equally

[22] Eliot Cohen and John Gooch, *Military misfortunes: the anatomy of failure in war,* New York: Vintage, 1991).

applied to adapting rapidly to disruptive innovation. Success, he argues, is in four ‘strata.’ These include doctrinal flexibility, organizational and technological diversity, leaders with mental agility, and a process to share lessons learned quickly.[23]

Encountering lessons is relatively easy.[24] Unless organizations can learn from these lessons, they run the risk of failing. Unfortunately, few organizations have mastered this skill, and even fewer have sustained it over time. In *Learning from the Long War*, Frank Hoffman and G. Alexander Crowther noted that learning from history is “an arduous task under any circumstances.”[25] Others, they note, have made the same observation. Instances where the military has failed to learn from hard-earned lessons “echo throughout the ages.”[26] This is complicated by the inherent difficulty in scaling learning by experience from an individual to an organization. A single individual can live through an experience and apply lessons learned from it to subsequent experiences. These lessons may influence a small group around that individual, but unless there is a process to save institutional information and a process to retrieve it and apply it with contextual knowledge to prevent misapplication, failure is likely. Levitt and March conclude that “organizations are seen as learning by encoding inferences from history into routines that guide behavior.” These routines make the lessons “accessible to organizations and organizational members who have not themselves experienced the history.”[27]

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[23] Meir Finkel, *On Flexibility: Recovery from Technological and Doctrinal Surprise on the Battlefield,* (Stanford, CA: Stanford Security Studies, 2011).
[24] Joseph J. Collins, “Desert Storm and the Lessons of Learning,” Parameters (Autumn 1992), 83–92.
[25] Lessons Encountered: Learning from the Long War, Frank G. Hoffman and G. Alexander Crowther, Eds., (Washington DC: National Defense University Press, 2015), 3.
[26] Ibid, 6.
[27] Barbara Levitt and James G. March, “Organizational Learning,” Annual Review of Sociology 14 (1988): 319-340.

Rapid fielding of new technology to the military at the outset of the Second World War created a failure gap between the warfighter's intellectual understanding of how to employ new technology in combat. Historian James Hornfischer noted, "the unfamiliar power of a new technology was seldom a match for a complacent human mind bent on ignoring it."[28] Following the introduction of surface-search radar, "the attitudes of most line officers towards this fledging technology spanned the full range of know-nothingdom, from raw ignorance to well-considered dismissal."[29]

On December 7, 1941, Army radar operators on Oahu warned of approaching aircraft, which proved to be the Japanese attack force heading to Pearl Harbor, but they were ignored with catastrophic results. The enlisted operators were trained and proficient, but not the officer of the watch. Neither were the intelligence officers charged with analysis. At the First Battle of Savo Sea in August 1942, the destroyers USS *Blue* and USS *Ralph Talbot* in Task Force 62.2 were equipped with the latest radar and best-trained radar operators in the fleet, but senior leaders (ship captains and fleet admirals) were never trained on the new technology's capabilities and did not understand nor trust the system, again with catastrophic results. Despite the known effective range of about seven miles, the ship's screening course west of Savo Island placed them fourteen miles apart. This allowed the Japanese 8th Fleet to slip undetected between the destroyers. After ravaging the Allied Southern Cruiser Group, the Japanese turned north towards the Northern Cruiser Group. On the heavy cruiser USS *Astoria,* the surface-search radar operator reported contacts approaching. However, he was ignored by leadership, who believed the blips to be shadows of the southern group. When he became insistent, the officer of the deck threatened

[28] James Hornfischer, *Neptune's Inferno*, (New York: Bantam Books, 2012). 63.
[29] Ibid, 103.

to throw him in the brig. With the warnings ignored, the Japanese Navy took the northern group by surprise. In less than an hour, they sank four heavy cruisers killing more than 1,023 American sailors and leaving more than 700 wounded.

Like Pearl Harbor, there was a multitude of causal factors. The equipment worked and trained operators reliably reported accurate information, but the lack of understanding by leaders, and their subsequent complacency, had strategic consequences. The leadership of Task Force 62.2 overestimated the ability of radar to prevent tactical surprise while failing to listen to the advice and warnings of its radar operators. Leaders had an anchoring bias empowered by a lack of mental agility that created resistance to the new technology. The doctrine was inflexible, and the strict cultural hierarchy of the organization prevented diversity of thought. The inability to learn, inability to anticipate the advantages of the new technology, and inability to adapt in the face of an enemy, who did learn and adapt, were significant contributions to what naval historians widely consider as the worst open-sea defeat in the history of the US Navy.

Training in the Fleet

Multi-causal failure to learn, anticipate, and adapt is frequently blamed on a multitude of reasons, but the fix is almost always targeted at training gaps. US Navy surface warfare officers are trained to be generalists. After completing Surface Warfare Officer training, officers receive on-the-job-training at their first assignment. Rotations, and later responsibilities as ship department heads, take the officer through engineering, communications, weapons, deck, and bridge operations. Those who do well as the ship's executive officer attend short prospective command and surface command courses. As with most Navy training, individual proficiency is stressed through linear course progression broken up with significant gaps between training programs.

A 2001 Executive Review of Naval Training, which was used as the basis for the Chief of Naval Operations' *Revolution in Training*, blamed the training and called for modernization through instructional technology. The review noted that sailors were reporting to their ships without the basic knowledge of surface warfare. To correct this, the Navy shifted training from instructor-led to computer-based training over the next decade. Instructional design developed under a behaviorist learning theory requires fewer resources than those developed from constructivist learning theory. Shrinking resources and increasing demand leads to institutions converting pre-existing instructional material into a digital medium, colloquially called "shovel-ware,"[30] that provides content in the same manner for everyone.

Standards of performance eroded under computer-based instruction with an assumption that on-the-job apprentice training would build the required levels of proficiency. This shifted the training burden to unit-level training creating gaps between curriculum-driven deliberate learning and shipboard learning by happenstance. However, without the benefit of an accessible instructor, or adaption to make the information learner-centric, this method places an unsustainable burden of responsibility on learners while diluting the nature of the instruction. Navy leaders are aware of this training gap. Almost a decade after the revolution in training, two reports, one on training and one on readiness, indicated "a growing sense of frustration in the fleet that the 'revolution in training' had not occurred."[31] The Navy's emphasis on the value of

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[30] Sandoe, 2005.
[31] Richard E. Brooks, Gary R. Jones, and Bryan McGrath, "BALANCING ACT," *Proceedings.* US Naval Institute, Vol. 138, no. 2, February 2012, 34-39.

technology, however, has continued without evaluating shortcomings with the underlying learning theory or the larger impact on organizational learning.

Once sailors are sent out to the fleet, the Navy conducts surface warfare training through a combination of single-ship unit training and integrated Composite Training Unit Exercises. Finding deficiencies with crews transitioning from single-ship operations to operating as part of a naval group or task force, the Navy recently created the Surface Warfare Advanced Tactical Training course to provide four weeks of just-in-time pre-deployment training. The remedial course begins with shore-based (or onboard pier-side) refreshers on basic tactics and progresses through crawl, walk, run training iterations to more advanced tactics, and seamanship training requirements conducted underway as part of multi-ship exercises. These training events, while necessary to evaluate ship performance and close the gap between expectation and outcome, are expensive. Steady pressure to reduce costs by cutting the number of dedicated unit training days through reliance on continuous self-training and local assessment is likely to depress standards. Likewise, apprentice-style training provides sailors limited learning opportunities and results in inconsistent standards because the quality of underway training varies widely.

From a macro perspective, this training paradigm is not significantly different today than it was seventy years ago. Theories proposed by behavioral psychologists Thorndike, Hull, and Skinner contended that learners were passive receivers who needed either positive or negative stimuli to achieve the desired response.[32] These theories were first applied to training during World War II, where the necessity of quickly training large numbers of military personnel cemented standardized instructional methods where classes and students moved at a measured

[32] B. F. Skinner, *About Behaviorism*. (New York: Alfred A. Knopf, 1974).

pace. By the mid-1950s, government and industry trainers were well versed and comfortable with these training methods.[33] These ubiquitous behaviorist learning methods remain a significant part of the military's instructional culture.

Behaviorist learning drives a rigid accountability culture that is highly averse to error risk. Leadership focuses on control by authority, punishing mistakes that should be leveraged as learning events. Internal organizational politics are inward-facing seeking to assign blame instead of attempting to understand and adapt to current and future needs. Leaders will promote technological "silver bullet" shortcuts but underestimate the human side of technological innovation leading to the organization's slow adaption to the new technology. A 2017 article in *The Hill* questioned readiness issues where extended deployments "cannibalized time for pre-deployment training" compounding "long-standing factors that have left the surface fleet's officer corps…lacking in skill as professional mariners." Citing fiscal necessity, the Navy cut the time surface warfare officers spent in school and shifted to "on-the-job" experience. This resulted in the best trained and experienced US Navy warfare officer being the equivalent of "a comparative amateur" when held against the higher standard of a Royal Navy junior surface warfare officer.[34] Depending on computer-based training that incorporated instructional materials but not the instruction provided by instructors and inconsistent apprentice-style training was a poor choice for the US Navy.

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[33] Glen E. Snelbecker, *Learning theory, instructional theory, and psychoeducational design* (New York: McGraw-Hill, 1974).
[34] Steven Stashwick, "The Navy's surface fleet warfighters unfortunately aren't mariners," *The Hill,* September 8, 2017, https://thehill.com/blogs/pundits-blog/international/349673-the-navys-surface-fleet-warfighters-unfortunately-arent; Cf. Mich McGuffie, "A Rude Awakening," *Proceedings*, January 2009, Vol. 135, No. 1, https://www.usni.org/magazines/proceedings/2009/january/rude-awakening.

Retraining the Fleet

The outcome of inadequate training was disastrous. In 2017, the Navy suffered two ship collisions and a ship grounding. In the worst of these, the collision between the USS *John S. McCain* and a Liberian-flagged tanker, the National Transportation Safety Board (NTSB) report noted the bridge crew had lost situational awareness while struggling with newly fielded technology. As a result of the collision, ten *John S McCain* sailors died, 48 were injured, and the vessel sustained more than $100 million in damage.[35]

When viewed through a multi-disciplinary lens, the *McCain's* mishap suggests all three types of misfortune led to catastrophic results. First, organizational inability to anticipate problems caused by newly upgraded bridge systems; second, inability to learn from known lessons regarding significant bridge system differences given the crew swap; and third, inability to adapt to change as a crew. Behaviorist-style rote learning failed when the crew was presented with different system errors leading to the bridge crew's cognitive overload. The bridge system itself, having all the hallmarks of corporate profit-seeking in adding unnecessary complications to existing systems to preserve market share, contributed to the crew's failure.

The Integrated Bridge and Navigation System (IBNS), built by Northrop Grumman Maritime Systems, was part of the Navy's modernization program to "automate collection, processing, control, and display of ship control and navigation sensor data" to improve bridge watch efficiency and ship control safety.[36] The system was installed in the *McCain* in 2016,

[35] National Transportation Safety Board, *Collision between US Navy Destroyer John S McCain and Tanker Alnic MC Singapore Strait, 5 Miles Northeast of Horsburgh Lighthouse August 21, 2017,* June 19, 2019, viii. https://dms.ntsb.gov/public/62500-62999/62649/626695.pdf
[36] Northrop Grumman Maritime Systems https://news.northropgrumman.com/news/releases/northrop-grumman-to-provide-integrated-bridge-navigation-and-steering-gear-systems-for-arleigh-burke-class-guided-missile-destroyers

where it was used to control the ship's propulsion and steering. Using the IBNS multiple-menu touch-screen system, the ship could be controlled from any of four different positions on the bridge or from the ship's aft steering compartment. Despite its known flaws, the Navy considered the system a "triumph of technology and thrift."[37] Investigative reporters challenge that the IBNS was no technical marvel, writing that it is a "welter of buttons, gauges and software…poorly understood and not surprisingly misused."[38]

The ship's captain did not trust the system citing its tendency for "multiple and cascading failures."[39] The failures were likely the result of operator error caused by not understanding the overly complicated system. About an hour before the collision, one of these failures led him to order the IBNS system switched from computer-assisted manual to manual backup mode. Unknowingly, this disabled several safeguards without alerting the crew. The system lacked a common graphic user interface scheme of colors, icons, and menu functionality. The NTSB report found that the design of the touchscreen steering and thrust control system increased the likelihood of operator errors that led to the collision.[40] The NTSB also found that fielding of the IBNS had inadequate training. The system had many controls and data options that were not in training documents nor understood by operators.[41] Even the person responsible for training sailors had less than an hour of training on the complex system.

[37] T. Christian Miller, Megan Rose, Robert Faturechi and Agnes Chang, "Collision Course
When the USS *John S. McCain* crashed in the Pacific, the Navy blamed the destroyer's crew for the loss of 10 sailors. The truth is the Navy's flawed technology set the McCain up for disaster," *ProPublica*, December 20, 2019, https://features.propublica.org/navy-uss-mccain-crash/navy-installed-touch-screen-steering-ten-sailors-paid-with-their-lives/
[38] Collision Course.
[39] Collision Course.
[40] NTSB, 38-40.
[41] NTSB, 38.

As an organization, the most significant contributing factor for the mishaps was likely a lack of organizational agility. The events demonstrate at least two of the three inabilities of misfortune: not learning from its lessons learned and a failure to anticipate. Since then, the Navy's efforts to adapt have fallen short by only calling for incremental change when more in-depth analysis is needed: "The Navy has experienced at least one major shiphandling mishap nearly every year since 2000, when the USS La Moure County ran aground off Chile because its officers didn't understand how their GPS worked. In many of these incidents the ships' captains were on the bridge, not just junior officers."[42]

The Navy's own reporting confirms the lack of agility, stating that "reviews found the surface force was under great strain" from heavy demand from combatant commanders. The Navy had been "forced to push out ships that still had material readiness deficiencies and crews that weren't fully certified." The strain is exasperated by the Navy's practice of rotating crews to forward-deployed ships, which will be further complicated by the adoption of Blue/Gold crew rotations. This effectively derails its training tradition of shore-based and underway training by prohibiting crews from training on the ships they will operate. As with the Pearl Harbor attack and the Battle of Savo Sea, the collisions had a multitude of causal factors including a lack of trust in new technology that led to cognitive overload, Navy efforts to reduce costs by leveraging new technology to reduce ship staffing while reducing, for a multitude of reasons, the time ships spend at sea, and the potential for an organizational culture where ship captains and senior leaders are always right and not to be questioned that effectively restricts feedback loops.

[42] Stashwick.

Reviewing feedback from the fleet after the 2017 collisions, Rear Admiral Bill Galinis explained:

> *…it was really eye-opening. As a result of innovation and a desire to incorporate new technology, we got away from the physical throttles, and that was probably the number-one feedback from the fleet. They said just give us the throttles that we can use. [It goes in the] 'just because you can doesn't mean you should' category. We really made the helm control system, specifically on the 51 class [destroyers], just overly complex, with the touch screens under glass and all this kind of stuff.*[43]

Shortly before the Navy's comprehensive internal report on the 2017 mishaps was released to the public in October 2018, Vice Admiral Richard Brown, the commander of Naval Surface Forces, wrote an op-ed in *Surface Warfare Magazine* arguing that surface warfare leaders must demand "thoughtful compliance with exacting standards, continuous improvement of processes, and brutally honest self-assessment."[44] He outlined three "waypoints" in a running fix to systemic problems in the surface fleet. First, improve surface warfare officer training by extending the duration of formal training courses and sea duty requirements while reinforcing command principles of "authority, responsibility, accountability, and expertise."[45] Second, the creation of maritime skills training centers in Norfolk and San Diego, a disciplined process for shipboard training drills, and a series of fleet advisories on ship steering systems. Third, improving fleet certification, assessing fleet readiness, and restoring scheduling predictability.

Since the report's release, the Navy is contracting with Northrop Grumman to modify the IBNS with more straightforward touch screen menus and add physical throttles beginning in

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[43] Rear Admiral Bill Galinis quoted in Megan Eckstein, "Navy Reverting DDGs Back to Physical Throttles, After Fleet Rejects Touchscreen Controls," *OSNI News*, August 19, 2019, https://news.usni.org/2019/08/09/navy-reverting-ddgs-back-to-physical-throttles-after-fleet-rejects-touchscreen-controls
[44] Richard Brown, "Surface Warfare a Running Fix," Surface Warfare Magazine, Summer 2018, No. 59.
[45] Ibid.

mid-2020. There is, however, no indication that Northrop Grumman has involved surface warfare operators in the redesign, standardization across the fleet in graphical user interface controls and menus, nor a requirement to include simulator hardware and software with each installation. At the same time, the Navy is taking another look at how it conducts training to establish a twenty-year "coherent tactical training continuum to prepare individual officers" for command.[46]

In February 2020, Thomas Modly, the Acting Secretary of the Navy, argued that the Navy must increase the level of capability and skill in the fleet. Attracting and retaining the right people, he noted, would influence everything from ship design to the investment in education. "[We're] going to ask these people to do a lot more and to be a lot more adaptable in the jobs that . . . we're asking them to do."[47] With personnel costs rising faster than inflation, defense budgets declining in real growth, training and readiness issues, and a mandate to grow the number of ships, the Navy is in a quandary. With a per-hull operating cost of roughly $2 billion, the Secretary suggests that the Navy's force structure will shift to a "more distributed" model.[48] Historically this indicates reducing the crew per ship and augmenting with technology (like the IBNS) to automate systems and, presumably, additional training programs that focus on individual functional proficiency but do not support collective training in multidomain operations.

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[46] Eckstein, Megan, "Naval Surface Forces Looking Closely at Warfare Training for Individuals, Watch Teams," *USNI News*, January 13, 2020, https://news.usni.org/2020/01/13/naval-surface-forces-looking-closely-at-warfare-training-for-individuals-watch-teams
[47] Quoted in Christopher Woody, "The military's 'war for talent' is affecting what the Navy's future ships will look like," *Business Insider*, February 23, 2020, https://www.businessinsider.com/military-recruiting-efforts-affecting-future-navy-ship-designs-2020-2.
[48] Quoted in Ben Werner, "Navy $40 Billion Savings Effort Linked to Force Structure Assessment," *USNI*, February 21, 2020, https://news.usni.org/2020/02/21/navy-40-billion-savings-effort-linked-to-force-structure-assessment.

These running fixes emphasize technology, group conformity, and compliance, and sequential, task-based instructional methodology without evaluating shortcomings with the underlying learning theory or the larger impact on the organization. Viewed through an organizational learning lens, these solutions pose significant problems. The continued fixation on new technology and closing training gaps through incremental changes indicate a mechanistic effort to gain better results by doing more of the same while sidestepping two decades of systemic training issues.

All three of the waypoint objectives are typical of a reactive organization unable, or unwilling, to question its assumptions. Small errors went undetected, building a causal chain to the catastrophic failure event. These ACTION - REACTION, ACTION - REACTION behaviors focus on narrow and short-term, incremental solutions that demonstrate the limited agility found in classic single-loop learning organization behavior. An organization that is only capable of single-loop learning will not be able to learn, anticipate, or adapt quickly to disruptive innovation. In most cases, this organization will not even be able to see the leap it must take to adapt because of excessive cultural resistance, and leaders who lack mental agility. This painful lesson is repeated throughout history. Evolving the Navy into an adaptive, next-generation learning organization capable of rapid and continual adaptation will require a new paradigm.

2. Organizational Learning Theory

Industrial Age Learning

Depending on individual learning is a legacy of behaviorist methods refined to improve assembly line efficiency. Educational experts describe two learning models typical of outdated industrial-age organizations. Both models demonstrate the processes of detecting and correcting error. These are generally bottom-up ways to identify performance gaps and recommend changes to existing tactics, techniques, and procedures. Formal business processes filter selective recommendations into doctrine (the how-to manual in an organization's collective memory) and training curriculum to improve performance or efficiency through individual training.

The first learning model is a maintenance learning model where an organization strives implicitly to improve what it already does. Maintenance learning is used to gain incremental improvement and reinforce the correct manner to accomplish a task. For example, the Air Force is already good at generating combat air patrol sorties. Continuous process improvement experts at each wing look at the processes to eliminate waste. The Air Force Doctrine Center collects and publishes several reports each year that identify issues and offer potential solutions. Likewise, the Center for Army Lessons Learned collects and codifies issues and best practices to share lessons across the service. Doctrine, however, is a lagging indicator of institutional learning and lacks a robust distribution process.[49]

[49] John Nagl, *Counterinsurgency Lessons from Malaya and Vietnam: Learning to Eat Soup with a Knife,* (Westport, CT: Praeger, 2002).

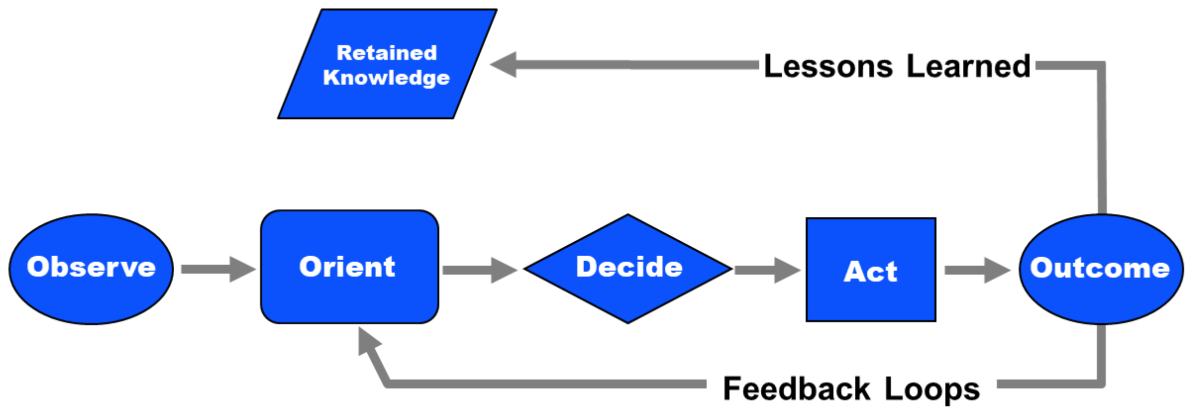

Figure 3. Classic Observe-Orient-Decide-Act (OODA) Loop. Adapted from John R. Boyd, The Essence of Winning and Losing, Unpublished briefing, January 1996.

The second learning model is shock learning, where an organization reacts to an unanticipated short-term crisis. The Navy's response to the 2017 ship handling crisis is a good example. This model forces organizations into rigid top-down command and control structures that limit the organization's ability to learn and inhibits long-term success by centralizing decisions at the highest level. The priority is identifying and solving the closest problem first. This model assumes the truism that once in a crisis no one saw it coming. When faced with a short-term crisis, the first solution industrial-age management attempt is to find an individual expert to lead the response. Seen in the classic *Observe, Orient, Decide, Act* (OODA) loop first proposed by Colonel John Boyd, assigning an experienced individual can abbreviate the ***observe*** and ***orient*** steps to decide and act faster in the short-term. For example, when Operation ODYSSEY DAWN shifted suddenly from humanitarian airlift and a blockade of Libyan ports to the creation of a no-fly zone and an air campaign against Muammar al-Gaddafi's forces, two senior general officers with recent air combat experience were sent to mentor the Joint Force Air Component Commander. After the operation, the task force dutifully pushed lessons learned into maintenance learning, and the organization went back to its status quo without adaptation.

Knowledge Age Learning

Single loop learning organizations depend on waiting for individuals to experience success and failure. It is slow to gather and recirculate feedback to the organization, and it stifles innovation. The difficult task of codifying lessons and experiences into institutional memory is often accomplished through haphazard processes to gather collective experiences. The often stated idea that these experiences morph over time into an institutional memory passed from one generation to another demonstrates an incomplete understanding of the extraordinarily perishable nature of individual memory.[50] Additionally, information is lost because of organizational silos, frequent turnover, skip-generational knowledge needs, and the difference between collective memory and institutional knowledge. If the information was not retained or cannot be found easily, the organization will become dependent on its collective memory of rituals, symbols, and culture. Characterized by the phrase "we've always done it that way," collective memory becomes a myth that distorts information, dilutes or sublimates facts, and unduly influence decisions.

For nearly half a century, scholars and practitioners have defined organizational learning in a variety of ways from interdependence of individual learning to linking learning to adaptation through experience. Most theories suggest that organizations are polities requiring that learning is understood within the context of their political and cultural hierarchy as an intra-organizational phenomenon.[51] Single-loop organizational learning is characterized by incremental change

[50] Kathleen M. Carley, "Organizational Learning and Personnel Turnover," *Organization Science*, Vol. 3, 1992, 20–46.
[51] Chris Argyris and Donald A. Schön, "What is an organization that it may learn?" In Organizational Learning II: Theory, Method, and Practice (Menlo Park, CA: Addison-Wesley Publishing Co, 1996); Anthony DiBella, Edwin

within an existing framework. This method falls short in the complexity of today's environment where the joint force is expected to win across multiple domains without significant loss of national blood and treasure or disruption to the American way of life. The challenges facing the military are heavily intertwined and cannot be solved by depending on individual learning alone to enable longitudinal improvement. It also requires deliberate processes to question assumptions and promote rapid, actionable feedback intended to improve the organization's effectiveness.

Generations of leaders have agreed the military must be a learning organization.[52] Often this sentiment is followed by a call for more effective training and for units to identify and share lessons. What they mean is that learning must occur within the organization. Learning in an organization, however important to future success, does not equal change or rapid adaptation of the organization. This is especially true when the focus is on individual skill proficiency in environments where collective proficiency and agility is required. According to Garvin, learning organizations are skilled at five main activities: systematic problem solving and experimentation with new approaches to build the ability to anticipate, learning from their own experience and from the experiences and best practices of others to build the ability to learn, and transferring knowledge quickly and efficiently throughout the organization to build the ability to adapt.[53]

Nevis and Janet Gould, "Understanding Organizational Learning Capability," *Journal of Management Studies*, vol. 33, no. 3 (May 1996); Edwin C., Nevis, Anthony J. DiBella, and Janet M. Gould, "Understanding Organizations as Learning Systems." *Sloan Management Review* 36,2 (Winter 1995): 73-86.

[52] Petraeus, David H., remarks to the Business Executives for National Security Eisenhower Award Dinner, New York, NY, November 19, 2008; DiBella, Anthony J., "Can the Army Become a Learning Organization? A Question Reexamined," *Joint Forces Quarterly,* 56(1QTR 2010), 117-122, accessed at https://www.army.mil/article/36320/can_the_army_become_a_learning_organization_a_question_reexamined)).

[53] David A. Garvin, "Building a Learning Organization," *Harvard Business Review,* July-August 1993, https://hbr.org/1993/07/building-a-learning-organization.

Single-loop learning is similar to the function of a traditional thermostat. When set to 72 degrees (a strategy taken for granted – “we’ve always done it that way”), it will appropriately turn the heat on and off as it receives information (the room’s temperature) and takes corrective action to maintain that temperature. The thermostat has low freedom of choice and its setting is defended as being clearly correct. This provides the organization with greater control of both tasks and the environment while reducing risk. Double-loop learning occurs when an error is detected (the room’s temperature falling) and corrects it in ways that scrutinize and challenge the organization’s reason for creating the 72-degree rule. For example, the rule was created when the organization used radiators fed by an oil-fueled boiler that took hours to raise the ambient temperature in a room. Maintaining a constant temperature was efficient. However, that system was replaced several years ago with a high efficiency forced air system capable of raising the ambient temperature efficiently in minutes. The 72-degrees rule is outdated, but the need for change will not be identified unless the underlying assumptions are challenged. Challenging assumptions result in a new energy-efficient rule of 68 degrees when the room is occupied and 64 degrees when it is empty by replacing the thermostat with a programmable version that allows for a greater error range before taking corrective action. This thermostat has a higher freedom of choice.[54]

[54] Christopher Argyris and Donald Schön, *Organizational learning: A theory of action perspective*, (Reading, MA: Addison Wesley, 1978), 2-3.

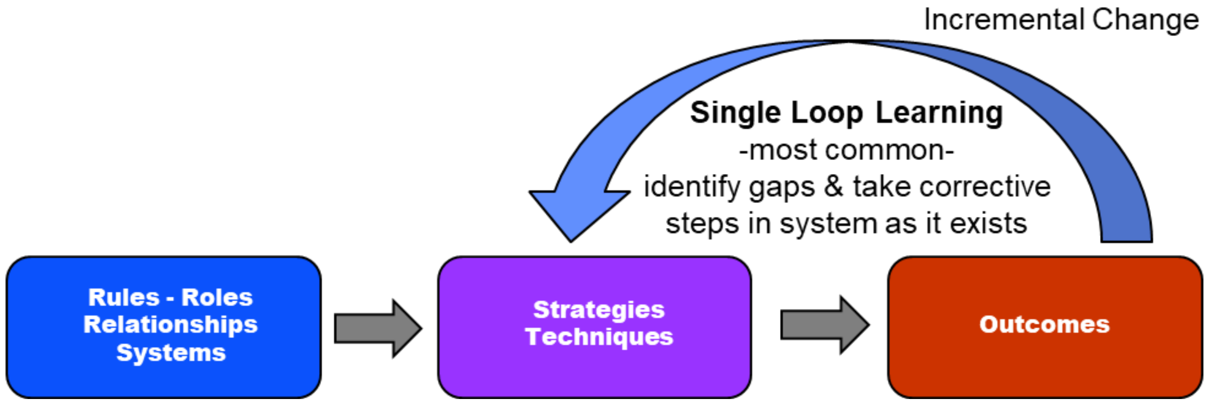

Figure 4. Single Loop Learning Model. Adapted from Christopher Argyris, "Double Loop Learning in Organizations," Harvard Business Review, (September 1977).

Double-loop learning characterizes the anticipatory learning model. It begins with a more comprehensive inquiry that challenges the status quo by questioning the organization's underlying assumptions, doctrine, policies, and objectives.[55] The role of acquiring, storing, interpreting, and distributing information becomes an explicit process that is vital for organizational learning. This goes beyond the single-loop paradigm of identifying gaps and corrective steps and codifying lessons. Anticipatory learning tears down information silos and builds a network across the organization where information is shared, and every member is empowered to execute as the organization actively scans the environment for clues (expectations or predictions) to anticipate future events.[56]

Learning organization theory is the most effective path to both improving organizational processes and linking learning and change. Unfortunately, the theory is frequently misunderstood and often conscripted to give gravitas to otherwise empty premises that fail to account for the

[55] Christopher Argyris, "Double Loop Learning in Organizations," Harvard Business Review, (September 1977).
[56] Cf. Witkowski.

process of assimilating learning within an organization. In *Winning the Next War*, Stephen Rosen argues social science in general (and Argyris' work on organizational learning in particular) has been unable to explain innovation. Innovation, he argues, is not just having a new idea but "actually doing something different" in one of three categories: operational behavior in peacetime, operational behavior during war, and technological innovation.[57] The effectiveness of wartime technological innovation, he concludes, is limited by "the difficulties connected with wartime learning and organizational change, especially with regard to time constraints."[58] He suggests part of the solution is for the United States "to be prepared to innovate rapidly" to meet emerging threats.[59] "Actually doing something different" is the purpose of learning organization theory to understand and improve organizational behavior in both peacetime and war. Rosen's criticism is likely due to most theories lacking a pragmatic application, and many not able to scale to large organizations well.

Peter Senge, who studied under Professor Chris Argyris, worked to bridge the gap between academic theory and practical applications. In *The Fifth Discipline*, he inspired a wave of corporate and government organizations to rewrite their vision statements to advocate agile thinking in order to manage uncertainty in volatile environments. Senge considers a learning organization as a community where people continually expand their capacity to achieve desired results.[60] In this community, individual learning is the only way an organization learns, and learning is best achieved through experience. Without it, he argues, organizational learning

[57] Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military*, (Ithaca, NY: Cornell University Press, 1991), 4.
[58] Rosen, 251.
[59] Rosen, 260-1.
[60] Peter Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization* (New York: Doubleday, 1990), 3.

cannot occur. Yet, individuals are often blind to the organizational consequences of their actions, and the theory does not detail the social process of learning transfer within an organization. The fusion of his five component technologies (systems thinking, personal mastery, mental models, shared vision, and team learning) is more art than practice leaving three immediate challenges for organizations.

First, individual learning does not always result in the organization learning. Training may target the wrong skill or the wrong population. There is truth in the African proverb, "when an old man dies, a library burns down."[61] Personnel churn creates a knowledge vacuum. There are efforts to mitigate the knowledge vacuum with 'smartbooks,' but every time an experienced person departs, the organization blinks. Individual knowledge only benefits the organization when it is replicated to become organizational knowledge. This requires pragmatic and robust processes to acquire, retain, and disseminate institutional knowledge, so it is embedded in the organization's structure. The most common failure to become a learning organization is the inability to close this knowledge loop.

Second, actions taken with the best intentions may result in unforeseen second- and third-order effects. This includes the acquisition of new, highly complex weapon systems without a comparable program to adapt all levels of the organization; force strength decisions based on budgetary forecasts instead of strategic needs; and decades of counterinsurgency expertise unsuited to the resurgence of Great Power competition and the potential for high-intensity combat.

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[61] Attributed to Amadou Hampâté Bâ at UNESCO, 1960; see Abdourahman A. Waberi, "A Missive for Youth," *The UNESCO Courier*, No. 2, 2018, https://en.unesco.org/courier/2018-2/missive-youth

Third, anticipatory learning only occurs in an environment that favors risk taking, and military services are increasingly risk adverse. Organizational members must see a cost-benefit to encourage them to actively integrate new ideas as part of a team. Psychological safety cannot be sustained in an institution if the culture is dominated by short-term hierarchical thinking. Leaders must be open to criticism. In environments of rapid change, the organizations must reinforce both member commitment and the capacity to learn to remain flexible, adaptive, and productive.[62] Anticipatory organizational learning defines an organization that takes learning from prior events and combines it with contextual information from the present and information indicating future needs discovered through active environmental scanning. This means that a next-generation learning organization will be able to switch between incremental (single loop) and transformational (double loop) to choose the most effective model.

Anticipatory Learning

When there is a disconnect between intention and outcome in single-loop learning, organizations will seek to improve strategy or techniques within the organization's inherent values and rules. In a double loop learning model, the organization will critically evaluate the organization's baseline assumptions, established doctrine, and policies leading to modification or shift that opens the path to new strategies.[63] Organizational learning is a collective phenomenon. The best solution to managing uncertainty in a high tempo, high threat environment is a robust learning process capable of absorbing rapid change through successive

[62] Senge, 1990, 4.
[63] Chris Argyris and Donald Schön, *Theory in Practice. Increasing professional effectiveness*, (San Francisco: Jossey-Bass, 1974); Chris Argyris, "Double Loop Learning in Organizations," *Harvard Business Review*, (September 1977).

feedback loops. Where single-loop learning is characterized by incremental change, double-loop learning theory guides anticipatory learning.

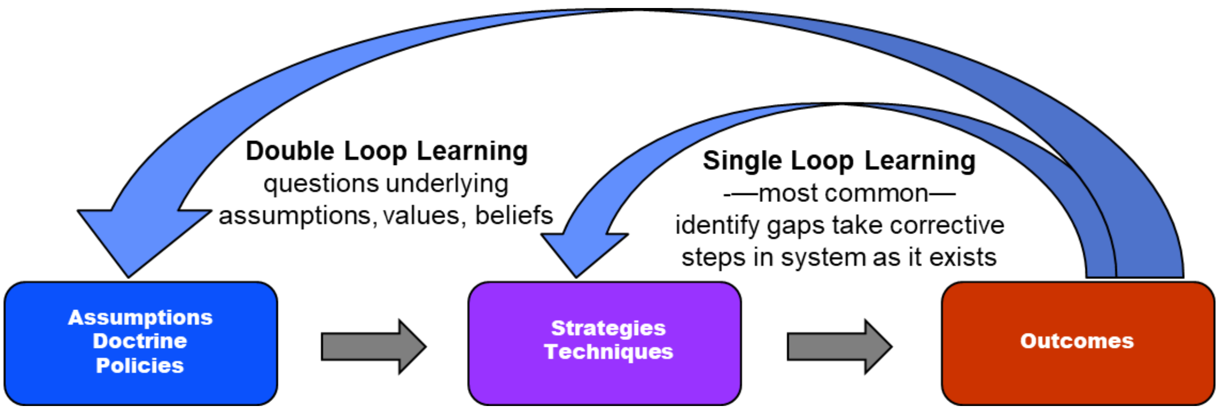

Figure 5. Single and Double Loop Learning Model. Adapted from Argyris (1977).

In the simplest terms, an anticipatory learning organization is capable of three general behaviors: taking action independent from future predictions, taking action dependent on future predictions, and taking action by detecting unpredicted events through active scanning. These behaviors can be viewed conceptually as a contextual analysis within a decision-making OODA loop model. This can also be overlaid with change management theory and double-loop learning. Based on years of empirical research, Argyris contends that double loop learning is critical for organizations to make informed decisions in volatile and uncertain environments.[64] Double-loop learning requires an ongoing process to acquire, retain (preserve) information, and disseminate knowledge (defined as information with context) at the correct point in the decision cycle to improve effectiveness. With double-loop learning processes, organizations do not have to wait

[64] Ibid; Christopher Argyris, *Knowledge for Action. A guide to overcoming barriers to organizational change*, (San Francisco: Jossey Bass, 1993).

for an error. They can adapt proactively by building actionable knowledge and actively scanning the environment to anticipate the change or errors.

Collectively, facilitative factors (acquisition, retention, and dissemination of institutional knowledge), which Finkel listed as the flexibility factor of sharing institutional memory, comprise knowledge management. This term requires clarification because there are multiple uses of the term, which can lead to confusion. Seeking quantitative rather than qualitative measures, military and corporate use of the term knowledge management and knowledge operations management have incorrectly defined it to describe information systems or network technology help desks, and control of document and publication lifecycles. This has severed it from facilitative factors, including lessons learned and preservation of institutional memory outside of legal records act requirements. A more precise definition is a "process or practice of creating, acquiring, capturing, sharing, and using knowledge, wherever it resides, to enhance learning and performance in organizations."[65] Whatever methods are used, they must be pragmatic and deeply embedded in organizational processes. For anticipatory learning organizations, they must include active scanning of the current, near, and future environment with an ability to proactively create a fusion of multiple information sources to create accurate, consistent, and actionable knowledge to improve decision making.

[65] Henry Scarborough, Jacky Swan, and John Preston, *Knowledge Management: A Literature Review,* (London: Institute of Personnel and Development, 1999), 1.

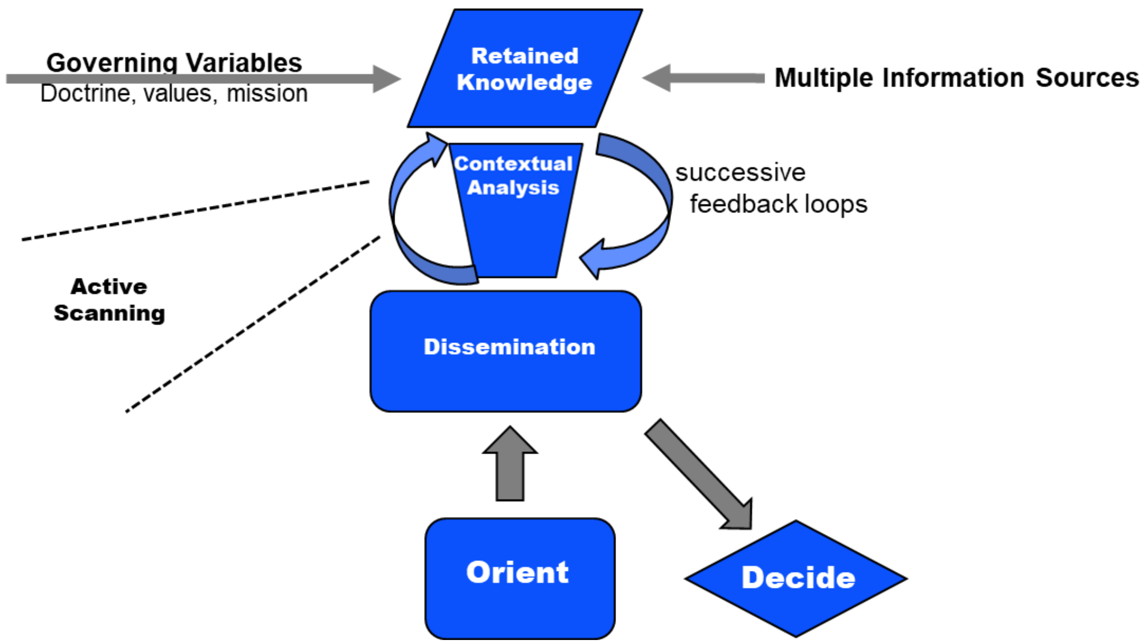

Figure 6. Information Fusion conceptualized within the first steps of an OODA Loop.

3. Learning Theory Applied to Innovation Disruption

The Navy must improve our processes in order for our people to meet future challenges.[66]

For an organization to be successful, it must change to balance its internal processes and structures to the external conditions. When those external conditions change, the organization must learn and adapt to survive. The faster the rate of external change, the faster an organization must adjust. Contemporary management concepts can help inform the discussion on adaptation to exponential innovation and help answer why agility is needed to manage the increasing pace of disruption and change. In *The Anticipatory Organization,* Daniel Burrus divides all

[66] SecNAV, initial guidance to the fleet, June 2019.

organizations into two categories, the disruptor and the disrupted. He explains that change becomes disruptive when it exceeds the organization's ability to manage it. Organizations, he argues, should decide to be a disruptor because the future is only uncertain to those with the wrong mindset. This requires an organization to learn the competency of anticipatory thinking and agility through anticipation. These skills provide the ability to predict and pre-solve problems.[67] Like many of the mass market business books that leaders look to for inspiration, the *Anticipatory Organization* model will not succeed without a learning organization foundation and someone to champion change.

Reframing and Rogue Thinkers

The Navy, like most organizations, is good at solving problems. Also, like most organizations, it is poor at identifying indicators of future problems before they become urgent. Once they reach a crisis stage, the problems with high visibility tend to get prompt attention and leadership focus for a speedy solution. Most organizations struggle with figuring out what are the right problems to solve. There are several excellent tools developed for this purpose, including Lean, Six Sigma, Total Quality Management, Business Process Re-engineering, or TRIZ (a Russian acronym for "theory of inventor's problem solving"—a framework for solving technical innovation problems[68]). However, many organizations are unwilling to devote the resources needed for complicated and time-consuming diagnostic processes. More straightforward problem-diagnosis tools (e.g., root cause analysis through creating fishbone charts or '5 Whys' exercises) are easy to facilitate in small group settings with pre-determined problems. However,

[67] Daniel Burrus, *The Anticipatory Organization: Turn Disruption and Change into Opportunity and Advantage,* (Austin, TX: Greenleaf Book Group Press, 2017).
[68] Developed by Genrikh Altshuller in the mid-1940s; Cf. Kari Lippert and Robert Cloutier, "TRIZ for Digital Systems Engineering: New Characteristics and Principles Redefined," *Systems*. Vol. 7, no. 3:39 (2019).

since these tools are less useful in diagnosing and framing the understanding of problems to find creative solutions, they tend to provide the results that were expected and wanted.

The concept of a learning organization has been part of the business community's lexicon since the 1990s when *The Fifth Discipline* was published. Senge advocated agile thinking to manage uncertainty in a volatile environment. A learning organization can be recognized by its agility by how it adapts to the external world. From within the organization, leaders have the mental agility to champion diversity of thought. In turn, this creates an organizational ethos where everyone is encouraged to challenge doctrinal assumptions, rules, values, and the status quo to find new solutions. Learning comes from mistakes, and everyone learns from everyone else's mistakes. Likewise, everyone embraces transitional change and innovation as a dynamic and never-ending process in building agility.

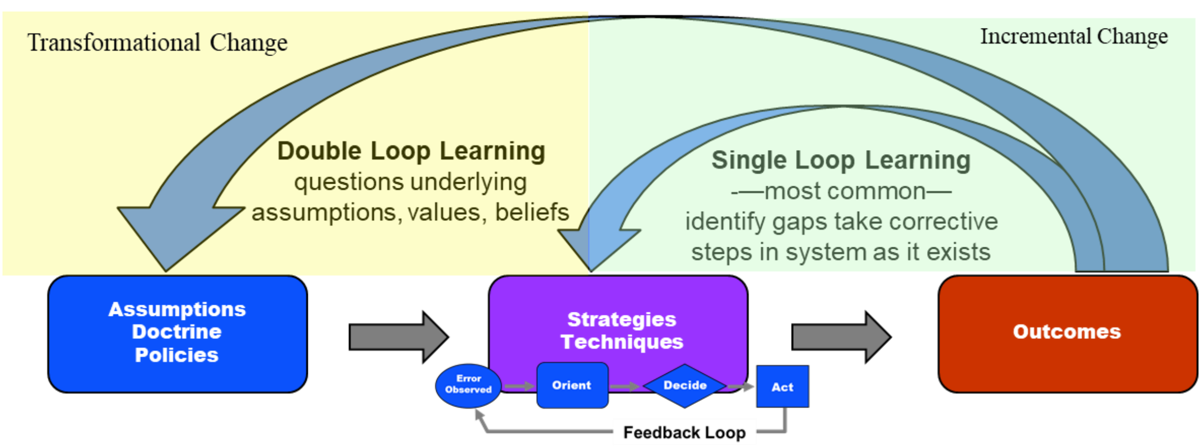

Figure 7. Relationship of Learning, Change, and OODA Loop Models.

Success will result in an organization capable of learning, anticipating change, and rapidly adapting. These anticipatory learning organization traits are the inverse of factors Cohen and Gooch describe as leading to military misfortune.[69] Argyris maintains that single-loop learning methods are most appropriate for routine issues that help "get the everyday job done."[70] A double-loop learning model is best suited for complex issues. A next-generation learning organization is one that can move between the two models as needed to remain competitive through both continuous and transformational changes.

The largest challenge of any learning theory is in proving its value in tangible, quantitative results. Organizations spend millions of dollars and devote thousands of hours to learning programs, reengineering, reorganizing, and continuous process improvement. For a theory that has existed in the literature for more than 40 years, and in the mainstream business world since the early 1990s, there are few long-term success stories. This is primarily the result of a mindset that believes organizational learning happens in isolation from organizational culture. Many corporate leaders subscribed to the idea without critical analysis or the commitment to champion invasive change. Practitioners and academics have compounded the confusion because they interchanged the terms *organizational learning* and *learning organization* without clarifying assumptions or intent. Worse, learning organization became anthropomorphized, which Peter Senge pushed back on by insisting that individual learning and sharing is the only way an organization learns.[71]

Hierarchical organizations, those with specialization of work, unity of command, centralization of power, and information flow that runs parallel to the power structure have higher rates of transformational change failure. A 2008 research study looking at leadership

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[69] Cohen and Gooch, *Military misfortunes;* Cf. Finkel, *On Flexibility.*
[70] Chris Argyris, 1999, 69.
[71] Senge, 1990.

effectiveness in implementing change and driving innovation confirmed the critical role of a leader-champion. By an overwhelming percentage, employees believe that leadership is frequently the most significant source of resistance to change.[72] Despite the overuse of the word 'revolution,' sustainable organizational change can only occur by corporate fiat or unilateral imposition. Even then, especially when an organization's core competencies, socialization structure, traditions, and culture are challenged, change has a high failure rate.

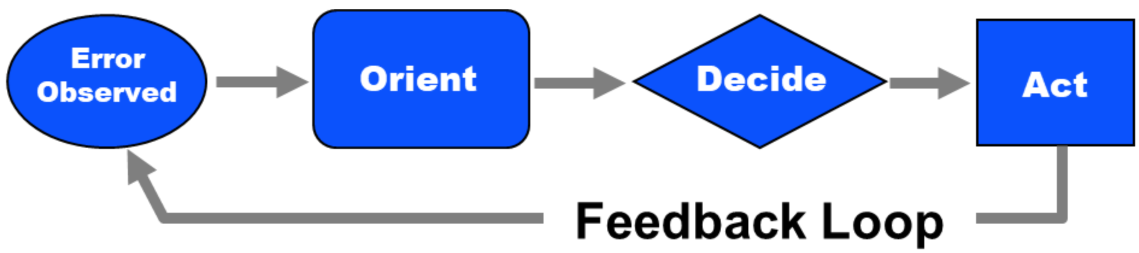

Figure 8. Single-Loop Learning conceptualized in an OODA Loop

Information moving through the organization is vague and inconsistent, creating narrative fallacies. This results in higher error rates from confused and dissatisfied employees who now think the problems are unsolvable and, ultimately, lead to chaos. Leaders respond by seeking more unilateral control over *disloyal* employees, which increases the penalties for discussing the undiscussable, and the undiscussability is itself an undiscussable organizational taboo.[73] This correlates with organizational inflexibility and high rates of failure in sustaining change. Some studies suggest that the failure rate for sustainable change reaches 80-90 percent.[74] These failures

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72 Ann Gilley, Pamela Dixon, Jerry W. Gilley, "Characteristics of Leadership Effectiveness: Implementing Change and Driving Innovation in Organizations," *Human Resource Development Quarterly, Vol. 19, No. 2, Summer 2008. DOI: 10.1002/hrdq.*
73 Argyris, 1999, 84-86.
74 Cope 2003

stem from a lack of flexibility and inability to adjust to dynamic market environments, which are remarkably similar to Cohen and Gooch's three types of drivers for military misfortune: inability to learn, inability to anticipate, and inability to adapt.[75]

In *Mars Learning,* Keith Bickel discusses the processes the Marine Corps used to develop and publish its small wars doctrine in 1940. These included informal methods where officers wrote articles in professional journals and formal methods where the Marine Corps published manuals and training material. He contends that identifying lessons learned is straightforward but difficult to implement because developing doctrine is an amorphous process relying on the subjective judgment of the senior officer who champions the change.[76] This suggests that doctrine development theory is consistent with both organizational learning theory and change theory. In practice, however, it is limited to the influence of a senior leader willing to champion change and results in inconsistent knowledge transfer and, at best, change that lags the organization's need to adapt, anticipate, and learn. Without a sustained process, experience and knowledge will be lost leading to inefficient performance and failure. It falls to senior leaders to create and maintain a process that also matches an organization's culture.

Over the past decade, the Air Force has evolved its traditional history program into an operational program focused on improving operational effectiveness. In 2018, the Secretary of the Air Force directed the historian corps to "document and preserve the Air Force's operational and institutional memory to provide commanders and decision makers informed perspectives based on accurate and factual information in support of operational and national strategic

[75] Eliot Cohen and John Gooch, *Military misfortunes: the anatomy of failure in war,* New York: Vintage, 1991).
[76] Keith B. Bickel, *Mars Learning: The Marine Corps' Development of Smalls Wars Doctrine, 1915-1940,* (New York, Routledge, 2018).

objectives."[77] Historians assigned at the wing, numbered air force, and major commands are integrated into the commander's staff where their understanding of aerospace history and specific knowledge of their organizations past activities, decisions, and outcomes is used to improve the quality of information available to decision makers. This process overlays the OODA loop with historians *observing* at the same time as the commander and staff, using the *orient* stage to research institutional memory and fuse historical information with contemporary context and provide that information to decision makers. Remaining "in the room," historians capture the decision-making process (including courses of action not taken) and factually document actions and outcomes, which are incorporated into the service's institutional memory.[78] Having only one historian at the vast majority of units, along with the rotational and permanent change of station demands typical of military organizations, creates a single point of failure in the process.

There is an assumption held by many in the military that organizational adaptation to change is accomplished through members carrying their experiences into new positions where they can influence doctrine development. In practice, this may be partially true for a few people whose experience and abilities are noticed by senior leadership and appropriately mentored. However, without a robust system to transfer experience and knowledge from those who experienced it to those who did not, the lessons learned are likely to be lost through the turnover of personnel.[79] Institutional memory needs a champion if it is to become embedded in an organization's culture.

[77] US Air Force, *Air Force Policy Directive 84-1: History and Heritage Management, July 6, 2018, 2.*
[78] US Air Force, *Air Force Instruction 84-101: Aerospace Historian Responsibilities and Management,* December 13, 2018.
[79] Levitt and March, 328

Champions and Visionary Leaders

"The challenges of today's organizations require the objective perspective of managers as well as the brilliant flashes of vision that wise leadership provides."[80] Transformational success depends on a senior leader with vision to champion the change and competent managers to execute the changes in ethical and legal processes. Most change management models start with identifying a champion to lead the change process. Depending on the model, there can be as few as three "steps" or as many as ten. Steps will include creating a strategy, building and growing a coalition, developing and communicating a vision, establishing a sense of urgency, removing obstacles, and seeking early wins to build momentum.[81] Often, the best champions are visionary leaders.

Visionary leaders are essential to shepherd organizations through disruptive change and are often credited with creating and adapting organizations to persistent innovation. In *Business @ the Speed of Thought,* Microsoft's Bill Gates writes that, "Corporate IQ involves sharing both history and current knowledge. Corporate IQ comes from individual learning and from cross-pollination."[82] Everyone benefits from sharing knowledge. In *Team of Teams*, General Stanley McChrystal describes this as an empowered network or shared consciousness. In the midst of combat in Iraq, McChrystal and his team learned to adapt proactively through a network of transparent communication and decentralized decision-making.[83] This transitional change, inspired by evaluating how Al Qaeda functioned, required trust, based on an organization-wide

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[80] Bolman and Deal, x.
[81] For example, see John Kotter, *Leading Change,*((Brighton, MA: Harvard Business Review Press, 2012).
[82] William H. Gates, *Business @ the Speed of Thought: Succeeding in the Digital Economy,* (New York: Warner Books, 1999), 238-9.
[83] Stanley McChrystal, Tantum Collins, David Silverman, and Chris Fussell, *Team of Teams: New Rules of Engagement for a Complex World,* (New York: Penguin, 2015).

understanding of the mission, to permeate the organization, which leads to, in McChrystal's words, a shared consciousness.

Team of Teams demonstrates the rogue characteristics of a next-generation learning organization that can deliberately flex between the two types of learning modes. Facilitative and trust factors inherent in the double loop learning model are visible in creating and empowering teams through improved acquisition, retention, and dissemination of institutional knowledge, as well as shared attitudes, values, and behaviors. In this model, leaders stress adaptation and creativity. In comparison, the faster single-loop learning model is seen in processes that seek to control both the environment and tasks through continuous incremental improvement to streamline processes. In this model, leaders stress winning and faith in their own views as obviously correct irrespective of facts.[84] Adaptation is, at best, slowed significantly.

Additionally, the organizational structure itself sets limitations on its ability to learn, anticipate, and adapt. Lee Bolman and Terrence Deal write in *Reframing Organizations,* that groups "operate on two levels: an overt, conscious level focused on *task* and a more implicit level of *process,"* created by the organization's structure.[85] Implicit processes are complex and deeply embedded in the structure through interconnections between humans and systems. Team building activities are highly effective in aligning the explicit *task* and implicit *process* levels. Without team building, they argue, outcomes can be catastrophic. They cite an example where an Airborne Warning and Control System (AWACS) team, well trained in the technical aspects of their work, played a significant role in the 1994 friendly fire shootdown of two US Army *Black*

[84] Chris Argyris, Robert Putnam, and Diana McLain Smith, Action Science, (San Francisco, CA: Jossey-Bass, 1985), 89.
[85] Lee Bolman and Terrence Deal, *Reframing Organizations: Artistry, Choice, and Leadership,* 5th ed., (San Francisco, CA: Jossey-Bass, 2013), 175.

Hawk helicopters. The team had never worked together, so they were to attend two planned full mission simulations as a team-building activity. However, only one simulation occurred, and three of the four key leaders were absent. “Some *individuals* got half of the prescribed “spin-up” training. The *team as a whole* got none.”[86] The failure demonstrates a perfect example of the multicausal chain of events when implicit processes are ignored, and a feedback loop to identify faults in structural processes is missing. The organization did not recognize a nearly two-year error in Identify Friend or Foe (IFF) recognition codes or the system of issuing multiple, and sometimes conflicting, air tasking orders. The F-15 fighter pilots did not question the AWACS assumptions. Without a process to question underlying assumptions, the organization in general, and both the AWACS team and fighter pilots in particular, failed to learn, anticipate, and adapt, which resulted in the death of 26 military and civilian personnel.[87]

Team of Teams illustrates two important points on the change to implicit processes and organizational structure. First, double-loop learning is best suited to environments where rapid adaption is critically important. Without it, the organization will remain oblivious to the pace of environmental change and error rates because of its myopic focus on explicit *tasks.* Second, because it is difficult to scale up from teams, or groups, to an enterprise-level, a double loop learning model requires a visionary champion who encourages testing assumptions, freedom of choice, and information sharing.[88] This is especially true for transformational change.

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[86] Ibid, 177.
[87] Cf. General Accounting Office (GAO), "Operation Provide Comfort: Review of U.S. Air Force Investigation of Black Hawk Fratricide Incident,” (November, 1997), https://www.gao.gov/assets/160/156037.pdf.
[88] Empirical research on learning transfer across teams is sparse; Cf. Kathryn S., Roloff, Anita W. Woolley, and Amy C. Edmondson. "The Contribution of Teams to Organizational Learning." In *Handbook of Organizational Learning and Knowledge Management*. 2nd ed. Eds. M. Easterby-Smith and M. Lyles, 249–272 (London: John Wiley and Sons, 2011).

In *The Fourth Age*, Byron Reese contends that humanity is at the doorstep of a technological revolution where artificial intelligence and robots will fundamentally change the world. With disruptive innovation, the nation that can learn and adapt fastest will gain a significant global advantage.[89] With this change underway, the US Navy is poised on the most significant institutional and identity change since its strategic awakening in the latter part of the nineteenth century. During the period between 1870 and 1900, the Navy changed from the age of sail to an age of steam, transformed from a tradition of single-ship patrols based on foreign stations to protect American commerce into squadrons and fleet operations that could project American power globally and defeat an adversary's navy. In the half-century between the US Civil War and the outbreak of the First World War, the Navy anticipated and adapted to change by modernizing and replaced its "imperial constabulary tradition with a new focus on warfighting."[90] Even though it predates anticipatory learning theory development, the Navy's successful transformational change demonstrates that it was, in fact, a next-generation learning organization.

Some have argued that the Navy's education system in the 1930s (where 98 percent of flag officers were Naval War College graduates) produced officers with a shared strategic and operational vision that enabled the navy's success in the war. In fact, the new Navy educational strategy attempts to mirror this by placing great emphasis on educating officers who can outthink adversaries.[91] Admirals Ernest King, Chester Nimitz, and Bill Halsey, all graduates of the Naval

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[89] Byron Reese, *The Fourth Age: Smart Robots, Conscious Computers, and the Future of Humanity*, (New York: So,pm and Schuster, 2018).
[90] Cited in Pier Beckman, "The US Navy's Strategtical Awakening with Scott Mobley" *The Strategy Bridge*, October 13, 2019, http://stitcher.com/podcast/the-strategy-bridge/e/64624627; Cf. Scott Mobley, *Progressives in Navy Blue: Maritime Strategy, American Empire, and the Transformation of US Naval Identity, 1873-1898*, (Annapolis, MD: Naval Institute Press, 2018).
[91] Notes, John Kroger, US Navy Chief Learning Officer, speaking to the Navy War College, February 27, 2020.

Academy and War College, are studies in effective strategic leadership and visionary thinking.[92] Leadership at the operational and tactical level, however, was considerably less effective because it was limited by the implicit structural processes deeply embedded in Navy culture.

Education onshore, if the nation's entry into World War II is an example, left the Navy unprepared for combat at sea and operational leaders unwilling, or unable, to overcome the paralysis of peacetime routine. In many cases, subordinates were well trained in the technical aspects of their work, but leaders, like those at the First Battle of Savo Sea, for example, lacked the mental models to understand the new and disruptive technology that would have given them the ability to use it effectively. While this can, and should, be seen as a sweeping generalization, history shows that if senior operational officers—to be specific ship's captains and admirals—lose touch with tactical innovations and warfighter training; they will make intuitive decisions based on incorrect pattern recognition and outdated implicit processes that constrain the organization's ability to learn, anticipate, and adapt.

Even several months after Savo Sea, leadership's inability to learn the technology effectively had significant repercussions. Rear Admiral Norman Scott is widely regarded as a role model for warfighters. Scott had assumed command of Task Force 64 not long after the debacle at Savo. He immediately instituted a tough training regime and found time to run night fighting drills between escort missions. Daily lessons learned bulletins were distributed fleetwide to share knowledge. However, because Scott did not trust the new technology of radar, his ability to fight was constrained. At the Battle of Cape Esperance in October 1942, this distrust limited his situational awareness and prevented him from exploiting an advantage. During the same

[92] Cf. Walter R. Borneman, *The Admirals: Nimitz, Halsey, Leahy, and King – The Five-Star Admirals Who Won the War at Sea*, (New York: Little, Brown, and Company, 2012).

battle, the captain of the USS *Helena* used radar to detect and deliver devastating blows to the enemy fleet. In November, Rear Admiral Daniel Callaghan, who was promoted over Scott, fumbled an ambush because he disregarded radar contact reports and relied on traditional visual lookouts. Several US ships were sunk, and both Callaghan and Scott were killed. Two days later, Rear Admiral Willis Lee, who had spent time learning the capabilities of the new radar systems, leveraged radar-directed gunfire, like the *Helena* had used, to achieve a tactical win. This was repeated in mid-November.[93] Navy historians have identified a clear lesson learned: "Effectively using an emerging and still rapidly evolving technology (radar) required commanders and their staffs to fully understand the technology and the means to utilize it in combat to provide an advantage over the Japanese."[94]

The essence of a learning organization is its willingness to foster learning through a climate of intellectual openness and perpetually challenging the status quo.[95] The most influential "idea challenging" occurred at the newly established Naval War College. In a *Strategy Bridge* podcast, Scott Mobley describes the progressive accomplishments during this time while comparing the similarities in technological change, globalization, and great power competition as the country came out of the Gilded Age to those of today. Rear Admiral Stephen B. Luce described the Naval War College as "a place of original research on all questions relating to war and the statesmanship connected with war, or the prevention of war." Visionary leaders Admirals Hyman G. Rickover and William F. Raborn championed the innovations of nuclear submarines

[93] Hornfischer; Curtis Utz, Nicholas Roland, and Guy Hasuti, "What the Navy Learned from Guadalcanal," *Learning from History*, Naval History and Heritage Command, November 13, 2018, https://usnhistory.navylive.dodlive.mil/2018/11/13/what-the-navy-learned-from-guadalcanal/.
[94] Utz, et.al.
[95] Richard M. Burr, "Leading Change: The Military as a Learning Organization." Unpublished Paper, US Marine Corps Command and Staff College, Quantico, VA, 1998.

and ballistic missiles that combined to create a "truly disruptive technology of nuclear deterrence from the sea."[96] Both leaders used transformational double-loop methods to overcome structural resistance to build a strategic navy within the Navy.

Overcoming Resistance

Any study on how organizations adapt (or fail to adapt) to "game-changing" innovations must consider resistance to change. Organizations resist change by focusing on activities with immediate impact rather than the long-term. Despite the proliferation of long-range planning guidance, the military tends toward a fixation on short-term and crisis events. This ACTION - REACTION cycle is driven by shock learning and forced reaction to world events, adversary actions, and the ever-present budgetary uncertainty from the proliferation of continuing resolutions. Additionally, implicit organizational structures limit their ability to anticipate and adapt. This can be seen clearly if organizational resistance increases if the change adaptation to technology innovation threatens core processes or the organization's identity.

There are countless management books on identifying and reducing resistance. Most agree that culture is resistant to change. Renowned sociologist Morris Janowitz argues that the military, in particular, "have a long record of resistance to technological change."[97] Cultural biases in the military may be evident through customs and traditions, but there are implicit values and assumptions that are difficult to quantify methodologically. Additionally, variables of time, space, and force join differences in institutional processes, command climate and efficacy, and intangible factors of fate and chance. Viewed in isolation, each of these aspects will present only

[96] William Bundy, *Visionary Technology Leadership from Admiral Hyman G. Rickover to Masters of the Information Age.* Unpublished PhD Diss, Salve Regina University, Newport, RI, 2005.
[97] Morris Janowitz (1960), *The Professional Soldier*, (New York: The Free Press), 22.

a facet of the problem. If used as the basis for intervention, the solution can not only fail to solve the problem but set the conditions for cascading organizational failure.

Organizational learning theory is closely related to change theory, and the two should be matched to create an effective anticipatory learning organization. The most common form of change is developmental change. Developmental change is closely related to single-loop learning organizations. This type of change is characterized by incremental improvements or corrections within an existing structure to close gaps in processes or skills to keep the machine running. Constant change can lead to dissatisfaction and reduced effectiveness while the organization is trapped in the past and unable to see a new vision of the future. Leaders that do have a new vision tend to lead change using the *unfreeze – change – refreeze* method, which is a transitional model. This change will result in a period of disarray, which could turn into chaos if not managed well as the organization reacts to urgent, though not necessarily important, stimuli or bounces from crisis to crisis in a cycle of leadership indecision. Transformational change is the most radical in that it challenges organizational assumptions and may recreate the organization's very identity.[98] Like true transformational innovations, this change results in a fundamentally different state of being. The rapid feedback in double-loop learning theory supports a continuous adaptive environment that improves both transitional and transformational change outcomes.

25 Bloodless Battles

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[98] Cf. Robert J. Marshak, "Managing the Metaphors of Change," *Organizational Dynamics*, Vol. 22, Summer 1993; Linda Ackerman, "Development, Transition, or Transformation: The Question of Change in Organizations," in *Organizational Development Classics*, eds. Donald Van Eynde, Judith Hoy, and Dixie Cody Van Eynde (San Francisco: Jossey-Bass, 1997).

In 2008, the Secretary of Defense created the *Close Combat Lethality Task Force* to right a generational wrong in training. The effort is focused on questioning the Army's governing variables and testing assumptions to find new ways of thinking about ground warfare from the human side of recruiting, selecting, training, and acculturating Infantrymen. It also characterizes a double loop learning model by questioning fundamental assumptions with a rapid feedback loop. The bloodless battles theory suggests that Infantry soldiers should fight 25 bloodless battles to provide stress inoculation before they ever face real-life-or-death combat. This includes a commitment to "train like the pros" with constant repetition while monitoring physical and cognitive performance and adding virtual training through simulators so any soldier downtime can be used on training across a wide variety of scenarios. The idea resonated with Congress, which directed the Secretary to consider building a Top Gun for small-unit infantry leadership.[99]

Simulators provide participants high engagement and deep learning in a safe environment. There are three basic types of simulators. Procedural simulators focus on learning a specific procedure step by step. Process simulators focus on learning a sequence of events. Causal simulators focus on learning through cause and effect relationships. Beginning in 1959, NASA required astronauts to spend hundreds of hours, one-third or more of their total training time, in high fidelity procedure and process simulators to prepare astronauts for every potential contingency.[100] Aircraft pilot training and continuing proficiency, in commercial airlines, military, and private pilot programs, have used simulators since the beginning of heavier than air flight. Commercial mariner training programs use ship handling and navigation simulators. The

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[99] Sydney Freedberg, Jr., "HASC Endorses Mattis Infantry Task Force – With Some Suggestions," *Breaking Defense,* May 10, 2018. https://breakingdefense.com/2018/05/hasc-endorses-mattis-infantry-task-force-with-some-suggestions/.
[100] James Tomayko, *Computers in Spaceflight: The NASA Experience*, (Washington DC: NASA, 1988), 269-70, https://history.nasa.gov/computers/Ch9-2.html.

largest growth in the use of causal simulators is in medical and law enforcement training, but growth is occurring across multiple industries.

Figure 9. Firing on an interactive shooting simulator. US Navy photo, Mass Communication Specialist 2nd Class Tyler R. Fraser. Yokosuka, Japan

Simulators have been used for more than a century to train hand-eye coordination and muscle memory while exposing trainees, from student drivers to student pilots, to potential situations until they demonstrate an appropriate level of mastery. This uses the same instruction through repetition and practice and linear course sequencing that influenced early computer-based training.[101] The idea behind a simulator is to provide a learner the ability to learn from experience. However, the growing trend of using heterogeneous computer simulators, from low-fidelity dual-screen desktop computers to virtual-reality augmented versions, to emulate

[101] Clark and Salomon, 1986.

shipboard systems and controls has limited value unless the instructional programs are designed using experiential and constructivist learning theory.

Experiential Learning and Interaction

Kolb and Fry theorized experiential learning occurs when a learner conducts a particular action and then discovers the effect on a given situation. As individuals gain experience, they are then able to anticipate the results of the action in similar situations. For example, practice with simulators exposes students to situations with varying levels of complexity and supported by an instructor to coach the student through scenarios to gain this experience, which then can be transferred to similar situations in real life.[102] Simulations have three instructional design elements: a scenario that recreates a real-life situation, a model that contains rules or causal relationships that govern the situation, and an instructional overlay, which optimizes learning and motivation.[103] Unlike the lock-step training structure of computer-based training, simulators provide a heuristic approach where organizational members learn through discovery and support constructivist learning theory and learner-centric paradigms.

Simulators have deep support within the Navy's surface warfare community, and it has accelerated fielding of mobile low-fidelity training simulators for crew training. A 2009 Navy Inspector General report on computer-based training, while critical of an overreliance, a lack of standardization, and underfunding, noted that simulators "are an excellent asset to the Fleet as training aids" and able to "offset the need to train at sea and reduce the training budget." The

[102] David Kolb and Ronald Fry. "Toward an applied theory of experiential learning," in C. Cooper (Ed.), Studies of group process, (New York: Wiley, 1975), 33-57.
[103] Charles.M. Reigeluth and Ellen Schwartz, (1989). An instructional theory for the design of computer-based simulations. *Journal of Computer-Based Instruction*, 16(1) 1989, 1–10.

Navy operates several types of surface simulators. These range from simple system emulators, virtual reality, and immersive simulators. With few exceptions, simulators are used solely for individual training courses. Desktop simulators, Class B console simulators, and Class A full mission simulators provide the repetition needed for rote instruction appropriate for building specific low-cognition skills. However, it is not well suited to building the mental agility needed for rapid adaptation. Frequent criticism from within the fleet suggests that most see all forms of "virtual training as sub-optimal substitutes for fewer days underway." [104] This question, however, fails to challenge the status quo.

From a learning theory perspective, educators agree that training in simulators has validity. With most computer-based training, "learners are often denied opportunities to develop the decision-making, self-monitoring, and attention-checking skills necessary to optimize learning experiences."[105] One solution is adopting a constructivist approach that supports an active process of constructing, rather than communicating knowledge without regard to the interaction between the learner and external instructional stimuli (like CBTs),[106] and offer the best support in designing instruction for technology-rich learning media.[107] Learning should be based on activities and problems with "real-world relevance and utility, [then] integrate those tasks across the curriculum, [to] provide appropriate levels of complexity, and…allow students to select appropriate levels of difficulty or involvement."[108] Constructivist learning theory

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[104] Richard E. Brooks, Gary R. Jones, and Bryan McGrath, "BALANCING ACT," *Proceedings.* US Naval Institute, Vol. 138, no. 2, February 2012, 34-39.
[105] Perkins 1993, 12.
[106] Duffy and Cunningham (1996).
[107] S. Kirkley and J. Kirkley, 2005).
[108] Jonassen (1996), 271.

requires content that is much more facilitative than prescriptive in nature, which fits well into simulation.

Figure 10. Fleet warfare tactics training in a portable On-Demand Trainer. US Navy photo, Petty Officer 2nd Class Joseph Millar, USS *Paul Hamilton*.

The Navy has used a variety of high physical and psychological fidelity simulators in technical training programs to create realistic training evolutions in controlled environments for trainees. The value of experiential learning through simulators is well documented. A 2009 Navy Inspector General report noted that "sophisticated computer programs are an excellent asset to the Fleet as training aids. They offset the need to train at sea and reduce the training budget."[109]

[109] Ibid.

The Surface Warfare Officer School has a number of engineering simulators. The Littoral Combat Ship has high-fidelity simulator trainers used for crew training, which the Navy partially credits for the high quality of officers coming up through the LCS program.[110] Other simulators provide practice in interpersonal communication skills through the Immersive Naval Officer Training System or introduce recruits to the basics of fighting shipboard flooding and fires through the Damage Control Trainer.

At a panel discussion at West 2019 on improving Navy combat training, Vice Admiral Dewolfe Miller, III, Commander Naval Air Forces Pacific, noted, "Your performance in combat never rises to the level of your expectations. It always falls to the level of your training."[111] Many simulators are designed to build individual skills, even in realistic and challenging environments. More than a decade ago, with help from the entertainment industry, the Navy built the USS *Trayer,* a $56 million, 210-foot long replica of an Arleigh Burke-class destroyer. It is permanently moored on-shore inside a training facility at the Recruit Training Command to run Battle Stations-21. This award-winning, large-scale, and immersive simulator is used as the capstone test of individual recruit proficiency and teamwork skills for 30,000 to 40,000 recruits annually. The intense environment of Battle Stations-21 provides stress inoculation through constructive problem-solving scenarios designed after the terrorist bombing of the USS *Cole* in 2000.[112]

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[110] Admiral Boxall cited in David B. Larter, "The US Navy is planning for its new frigate to be a workhorse," *Defense News,* January 20, 2019, https://www.defensenews.com/naval/2019/01/30/the-us-navy-is-planning-for-its-new-frigate-to-be-a-workhorse/

[111] Quoted in George Seffers, "Training for the Gore of War," *Signals,* February 13, 2019, https://www.afcea.org/content/training-gore-war

[112] Cf. Jeff Wise, "Surviving on the USS *Trayer*, the Navy's Disaster Simulator," *Popular Mechanics,* October 1, 2009, https://www.popularmechanics.com/military/a12481/4288185/; Design Island, http://www.design-island.com/projects/detail/battle-stations-21/.

Figure 11. Watch standing evolution on the USS *Trayer* during Battle Stations-21. US Navy photo, Mass Communication Specialist 1st Class Amanda S. Kitchner.

Since the USS *Trayer* project was conceived in 2002, there have been significant innovations in simulator technology. Improvements in networked simulators show the potential for collective constructionist learning. The US Army is developing the next generation of simulator training featuring an immersive synthetic training environment that can include augmented-reality live training, virtual tutors, 3-D virtual reality, AI, gaming, or networked live and constructive training using. The Air Force is currently using live, virtual, and constructive (LVC) training through its Link-16 system and incorporating it into exercises like Red Flag. The concept links live training brings pilots flying in the Nevada sky, pilots in simulators on the ground, and computer constructive (synthetic) programs in realistic battles where advanced fifth-generation systems can operate virtually.[113] Likewise, its *Pilot Training Next* leverages learner-centric training with LVC technology to provide a cost-effective way of building individual skills that may transform training.[114] The true promise of LVC technology is in collaborative training. The solution to building a lethal 21st Century Navy, including futureproofing it for rapid innovation and disruptive technology, will leverage the service's considerable expertise in using simulators, advances in intelligent-agent software, America's competitive spirit, and an appropriate learning theory.

4. Preventing Catastrophic Failure

The factor consistent across the historic examples presented in this paper is that failure begins with seemingly minor, uncorrected errors. Just like Pearl Harbor and Savo Sea, each of the four ship-handling mishaps in 2017 began with small errors going undetected and building a causal chain to catastrophic failure. The Navy criticized its own Naval Safety Center for shallow (single loop) analysis that "seldom yielded unique insights or recommendations applicable to particular mishaps or to broader performance issues."[115]

> *With planning: our Commander's options to accomplish a greater number of missions have incrementally placed a greater emphasis on rationalizing deviations where planning did not reinforce challenging the assumptions. On practice: well before the Bridge watchstanders assumed the watch, they had not rehearsed emergency or extremis situations; in execution: ships and headquarters failed to question if what they were doing was adequate to what they needed to do and make corrections.*[116]

113 Cf. The Role of Live, Virtual, and Constructive in Training, *The Potomac Institute for Policy Studies,* 2016, https://potomacinstitute.org/images/studies/CAE/caewebinteractive.pdf.
114 Cf. US Air Force, *Pilot Training Next*, https://www.aetc.af.mil/About-Us/Pilot-Training-Next/.
115 USFF, 99.
116 Ibid, 95-6.

The report breaks the mishaps into three principal modes of failure: failure to plan, failure to practice, and failure in execution. All three show the absence of double-loop learning, and all three can be nested into the military misfortune categories of failing to adapt, anticipate, and learn.

Preventing catastrophic failure from an organizational inability to adapt, anticipate, or learn requires a process to manage knowledge. This begins with a method to capture and organize information, perform analysis of the information based on environmental scanning, and push relevant and contextual knowledge out to decision makers faster than an adversary. The process of managing knowledge is enhanced if it also helps overcome organizational resistance to change, affects learning at both the individual and collective organizational levels, and, because the business of the military is organized and deliberate violence on behalf of the state, inoculates organizations through bloodless battles. It also demands an organization willing and capable of next generation learning where baseline assumptions are questioned frequently through double loop analysis.

The challenge facing senior Navy leaders is to respond faster than the nation's adversaries. This includes an ability to master the ever-changing technology faster and an ability to adapt to disruptive change faster. If either rapid fielding of technology and disruptive innovation or disruption from environmental change occurs faster than the organization can learn and adapt, it will create the conditions for failure. Successful adaption requires deliberate leadership to learn, anticipate, and adapt internal processes and structures to the new external conditions. Leadership failure, or worse mental complacency and inflexibility, will lead again to catastrophic failure and the unnecessary sacrifice of blood and treasure. The race to acquire and weaponize artificial intelligence to improve perception, sense-making, and decision-making means that technology will be rapidly fielded and continuously improved. If experts are correct, the coming "algorithmic battlefield" and its resulting hyper-war will reduce the decision-making time to seconds. While this challenge may be compounded exponentially with AI or intelligent agent systems that will soon underlie nearly every warfighter task, the very nature of sudden disruptive change is the lack of action when forewarned because leaders do not recognize or understand the change.

Training the organization to adapt and win in this hyper-fast environment will require a multifaceted approach that includes the individual and collective learning with robust feedback loops found in next-generation learning organizations. All potential solutions should be evaluated against a balance of transformational and incremental change to build a multi-loop and continuously adaptive environment in the five areas described earlier. First, one of the most relevant results of organizational learning is an organization's improvement of task performance over time.[117] This requires a consistent method to measure performance. Second, solutions must be able to preempt the indicators of organizational failure: inability to learn, anticipate, or adapt. Third, it must support Finkel's four flexibility success factors: enhance doctrinal flexibility, improve organizational and technological diversity, develop leaders (and followers) with mental agility, and incorporate a process to push institutional knowledge with historical context from past events and lessons learned into the decision cycle. Fourth, it must support the principal activities of a next-generation learning organization. These include the creative ability to question underlying assumptions, learning from individual experience and organizational lessons

[117] Argyris and Schön, 1977, 4.

of the past, experimentation with new approaches, active environmental scanning, and rapid and continuous feedback loops. Finally, all solutions should incorporate the foundational aspects of the anticipatory learning model. Information silos are eliminated, and networks are created to speed information flow across the organization through revamped policies, structures, and processes. This includes questioning and eliminating outdated or inefficient learning processes embedded in the organization's culture, socialization, and traditions.

There is a fair degree of internal and external consistency across the five evaluative criteria as they chart a course towards the goal of creating an effective next-generation learning organization. This application of multi-looping organizational learning theory demonstrates parallels with the elegant simplicity of John Boyd's OODA loop model that emphasizes agility and innovation through faster situational awareness and feedback. The rest of this section outlines two conceptual and interlocking next-step solutions, one for individual learning and one for collective learning, that meet this criterion and that the Navy should consider implementing.

Figure 12. Recruits trains on the VESSEL system. Virtual Environments for Ship and Shore Experiential Learning system at Recruit Training Command in preparation for Battle Stations-21, September 16, 2010, US Navy photo, Scott Thornbloom.

Self-Directed Learning

The Navy is encouraging self-development through incentives and promotion paths with the new Community College of the Navy. This is a step forward from its 2002 Revolution in Training that included "creating an environment of learning that promotes growth by giving Sailors the tools and opportunities to learn, grow and lead," using incentives for Sailors "to develop themselves."[118] A decade later, its development strategy noted that the Navy had to respond to "rapidly changing and challenging times" with "proactive, strategic, and

[118] US Navy, "Navy Keys on Personal Development," January 23, 2002, https://www.navy.mil/cck/NNS020123-05.pdf.

comprehensive" leader development.[119] But the strategy included few self-development opportunities and then only as an apparent afterthought. Because an organization's ability to anticipate and adapt is mainly dependent on its ability to learn, self-directed learning should be part of every learning organization's deliberate planning.

Self-directed learning (SDL) is an interdisciplinary approach to learning. It benefits when educators build learning paths to facilitate individual learner decisions in conjunction with robust social support. Studies have shown that high performing employees, especially those in jobs that require significant problem-solving skills, are not just prolific self-directed learners but comprise the heart of learning organizations.[120] Keeping in mind the goal of improving critical thinking and decision making skills are foundational to the organization's ability to adapt to rapidly fielded and disruptive technology; SDL capacity should target highly motivated technology innovators and early adopters while leveraging developments in game theory and the potential motivation factors found in "esports" could provide a cost-effective adaptation edge.

From Friday night football games and rooting for the old college team to the variety of professional sports, the fact that people love competitive sports cannot be understated. The newest entry into this socio-cultural phenomenon is competitive video gaming or esports. From the release of first-person-shooter games in the mid-1990s, this sport has grown into a billion-dollar business, and academic institutions, from high schools to universities, are getting

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[119] US Navy, "The Navy Leader Development Strategy," January 31, 2013, https://www.hsdl.org/?abstractanddid=748304.

[120] Lucy M. Guglielmino and Paul J. Guglielmino, "Productivity in the workplace: the role of self-directed learning and the implications for human resource management, " *International Journal of Human Resources Development and Management* 8, No. 4, pp. 293-305.

involved.[121] Globally, more than 650 million people are expected to watch esports teams annually by 2022.[122] The military has shown an interest as well, as a recruiting venue. The Navy shifted advertising funding from traditional sports commercials to esports. Rear Admiral Brendan McLain announced a partnership with several esports companies to cosponsor events saying, "Like the Navy, esports requires a variety of skills and roles and a strong commitment to continual improvement."[123]

More than three decades of research confirm the use of gaming in conjunction with simulators increases learner motivation and commitment to SDL.[124] This is especially true for educational applications using experiential learning theory. Some have differentiated these as "serious games" when developed for educational or professional use instead of pure entertainment in academic literature. However, most gaming allows for both organizational and affective strategies needed to build confident learners. Gaming builds intrinsically motivated learners, especially when there is a competitive element, uses compensatory strategies that improve attention, memory, and cogitative skills related to decision-making.

Neural psychology research has shown a significant difference between people with a fixed mindset and a growth mindset where it comes to experiential learning. A fixed mindset is when people believe their abilities are innately fixed or are fully developed. These people tend to be fixated on performance feedback and social approval. They are risk-averse and will avoid

[121] See Michael G. Wagner, "On the Scientific Relevance of eSports," *International Conference on Internet Computing,* 2006, http://www.academia.edu/download/54196160/On_the_Scientific_Relevance_of_eSports.pdf.
[122] Christina Gough, "eSports audience size worldwide from 2012 to 2022, by type of viewers," *statista,* August 9, 2019, https://www.statista.com/statistics/490480/global-esports-audience-size-viewer-type.
[123] Quoted in Andy Chalk, "US Navy enters the esports scene with ESL North America and Dreamhack deal," *PCGamer,* February 10, 2020, https://www.pcgamer.com/us-navy-enters-the-esports-scene-with-esl-north-america-and-dreamhack-deal/.
[124] Cf. Sweller 1988, Ericsson et.al., 1993.

unfamiliar challenges where failure is possible. Faced with the possibility of looking incompetent, they may turn to unethical behavior and toxic leadership to shift blame to others. These tendencies make them less likely to seek out SDL opportunities. Those with a growth mindset, believing that their abilities are developed and improved through practice and effort, tend to seek hard challenges and treat setbacks and failure as an opportunity to learn and improve.[125]

The Navy should contract with a digital gaming company (as opposed to a traditional defense contractor) to develop an esports capable, multiplatform (i.e., PC, Xbox, Playstation) and multiplayer role-playing game where skills are learned and practiced through experience and interaction with the game. The skills, which could include ship handling and navigation based on the International Regulations for Preventing Collisions at Sea (the "Rules of the Road"), leadership and people skills, ethics and the law of armed conflict, strategy, ship and multi-ship combat tactics, and decision making under stress, anchor the gameplay to provide positive transfer—*situated learning* in educational research terms—and development of a growth mindset.[126] This allows for task improvement over time through 'transfer of training' from the digital environment to the real world, learning, following, and evolving doctrine; and improving mental agility.

While some accommodation must be made for classified technologies, the game should replicate ship controls, missions and tactics, weapons, and behavior as much as possible. This could be accomplished by setting the game into the near future using theoretical capabilities that

[125] Jennifer Mangels, Brady Butterfield, Justin Lamb, et al. "Why do beliefs about intelligence influence learning success? A social cognitive neuroscience model," *Social Cognitive and Affective Neuroscience*. 2006, Vol. 1, 75–86.
[126] Cf. Jean Lave and Etienne Wenger, *Situated learning: Legitimate peripheral participation*. (Cambridge, UK: University of Cambridge Press, 1991).

include AI-enabled decision-making systems, autonomous weapon systems, or a range of challenging enemies from low-intensity small boat swarms to high-intensity hypersonic, or space-based weapons and variable environmental conditions difficulty. While playing the game is self-directed learning supported by intrinsic motivation, the game's structure should include instructional feedback, both constructive from the game structure, design, and rules (e.g., being killed in Call of Duty provides near instant feedback and the opportunity to try something new) to reviews and comments on gameplay shared online through platforms like twitch.tv. Designers should also build in capability for future expansion packs.

The Navy has experience in building and using role-playing games. In 2009, it worked with Raytheon BBN Technologies to develop the Virtual Environments for Ship and Shore Experiential Learning (VESSEL) software used to train recruits on shipboard damage control procedures before the immersive Battle Stations-21 simulation. The single-person, low-fidelity simulation game software seems to be an effort to augment or partially replace instructor-led technical training rather than using it to its full potential by evaluating game 'transfer of training' efficacy through feedback from recruit performance in Battle Stations-21. The intent for this solution is to build a product with a much broader scope (player versus player, free play or "Paidia" areas, first-person shooter, real-time strategy, multiplayer online battle arenas, or massively multiplayer online role-playing) and deeper learning while encouraging local and online multiplayer competition through scaffolded campaigns with adjustable difficulty levels.

Collective Learning: The Navy BattleLab

The first rule of BattleLab is that you must talk about BattleLab!

On a recent visit to the Surface Warfare Schools Command simulator facility at Naval Station Newport, Rear Admiral Dave Welch, the commander of Carrier Strike Group 15, noted that the fleet was beginning to see better qualified junior officers arriving in the fleet after hands-on simulator training.

> *The power of technology does a couple of things for us. It allows us to do repetitive exercises where we can vary the complexity. We can control all the variables such as current, wind and visibility, but we also have the ability to go back and debrief and reinforce positive learning behaviors or learn lessons from mistakes. Being able to do all of this in a safe training environment is very beneficial.*[127]

As he notes, the benefit of rigorous training is well known. It begins with individual training to standard and continues to realistic collective training that is harder in peacetime than war. Simulators provide the ideal environment and ability to manipulate reality to achieve this level of intensity. It is time to extend this level of rigorous training to build mentally agile leadership teams that can learn, anticipate, and adapt to preempt disruption.

The idea of tactical leadership training is not a new one. Command team training (CTT) simulators are available on the commercial market. Norway's Kongsberg Defence & Aerospace has a networkable surface warfare trainer intended to familiarize command teams with their ship's weapons, sensors, and communications while working as command information center

[127] Derien Luce, "Commander CSG-15 Observes Surface Warfare Training," *Press Release,* Naval Education and Training Command Public Affairs, February 26, 2020, https://www.dvidshub.net/news/364182/commander-csg-15-observes-surface-warfare-training.

team.[128] The Royal Navy's Maritime Warfare School's simulator training facility operated a CTT program putting 16-person command teams into an operations room simulator where they trained together on joint maritime operations in a multi-threat environment.

The idea of a battle lab is also not a new one. In May 1994, General Frederick Franks, Jr. looked at the coming revolution of digitally enabled warfare and decided the Army needed an intellectual change in the way it thought about land warfare. He introduced the concept of a battle laboratory where the Army would experiment with ideas on warfare using emerging technologies.[129] Today, the Maneuver Battle Lab at Fort Benning, Georgia, conducts "experimentation and evaluation of combat unit structure and equipment" as well as constructive modeling and simulation designed to assist Army leaders stay ahead of adversary capabilities.[130]

The Navy BattleLab concept expands significantly on these ideas to serve as a leadership crucible and a catalyst propelling the Navy into a next-generation learning organization. BattleLab will provide collective training and evaluation of ship command teams, permit wide-area networked wargaming for new doctrinal concepts, and serve as a testbed for emerging AI-enabled technology. Importantly, it forces a departure from the existing ACTION - REACTION "do more of the same expecting better results" paradigm that has led to a lack of organizational agility. Importantly, the concept is not intended as a command preparation school but to provide robust team building activities for command teams. The simulator can use untethered LVC to

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[128] Kongsberg Defence and Aeropace. *Proteus Surface Warship Command Team Trainer (CTT).* https://www.kongsberg.com/globalassets/kda/products/defence-and-security/naval-systems/naval-training/proteus-surface-warship-command-team-trainer-ctt/proteus-surface-ctt_productsheet.pdf
[129] Frederick M. Franks, Jr., "Winning the Information War," *Vital Speeches of the Day* 60 (15): 453. http://search.ebscohost.com.usnwc.idm.oclc.org/login.aspx?direct=trueanddb=mthandAN=9406232592andsite=ehost-live.
[130] SAIC, "The Army's Future Takes Shape at Battle Lab," nd., http://www.saic.com/features/The-Army-Future-Takes-Shape-at-Battle-Lab.

allow for both scripted scenarios and unrestricted competitive combat environment "gameplay" with a collaborative, whole command team training focus. It will use technology available now while serving as a platform for the rapid integration of new capabilities. Policy and management of the BattleLab facilities should use a balance of transformational and incremental change to build a continuous adaptive environment and preempt the indicators of organizational failure: inability to learn, anticipate, or adapt. At the same time, it will support the principal activities of a learning organization.

Technology advancements in live, virtual, and constructive (LVC) training, immersive simulator design, and the potential of human/machine teaming through intelligent-agent computer programs will soon approach simulators portrayed in fiction from Orson Scott Card's *Ender's Game* to Star Trek's *Kobayashi Maru*. Building on lessons learned in a decade of operating the immersive Battle Stations-21 simulator and others, the Navy will design and construct BattleLab simulator complexes for high-intensity collective training of one to three ship command teams at a time per facility with simulator facilities at key naval bases around the country. These simulators will operate a hybrid of live, virtual, and constructive technologies in a dynamically distributed environment to provide an environment where specific individual and collective skills and tactical and operational leadership are evaluated and improved until they are overlearned (reflexive) for transfer to real-world performance.[131]

Additional capabilities will be included as new technology is developed, including machine learning, autonomous systems, incremental and disruptive technology innovation. Using the simulator, these technologies can be exercised in realistic scenarios to find flaws. Defense

[131] Cf. DoD 5000.59-M, "DoD Modeling and Simulation (MandS) Glossary," January 1998.

contractors providing new technology, like the *McCain's* IBNS, should be required to prove system efficacy and usability in simulated combat and stress conditions before final acquisition and fielding. This gives sailors the opportunity to "break" the system and provide feedback to improve the technology. This could lead to fleet standardization for new technology, systems, consoles, and software to build trust and validate contractor provided training material. Additionally, big data collection will provide a rich database for analysis to inform future force structure, manning, and command selection and promotion policies. The data could also be used for supervised training of intelligent agent systems. These systems could be used to act as friendly or enemy forces during scenarios or to control future autonomous surface vessels. The simulator is, however, primarily a tool the Navy will leverage to evolve itself as an anticipatory learning organization in multi-domain and joint warfare.

Built using the same immersive style as the USS *Trayer* (BST-21), BattleLab deployments will be realistic, immersive, and function as both a stress inoculation and team building exercise. In this concept, ship command teams,[132] including its assigned captain, leadership team, and bridge/Combat Information Center (CIC) watch teams, will "deploy" for about eight days to a BattleLab facility between the basic training and crew training phases. This assumes a 36-month cycle that once the ship shipyard maintenance phase is complete, crews begin a basic training phase that includes individual Sailor training and qualification on shipboard functions and systems. The next phase includes crew training on ship operations and

[132] Considering the 1994 *Black Hawk* friendly fire incident (see p. 41-2), it is critical that all members of the command team attend the training. This includes the executive officer, which challenges the culture of ship ownership. Command responsibility cannot be delegated requiring the organization (the sea component commander for example) to develop a plan that emphasizes trust in people, systems, and processes.

tactics followed by a deployment phase where crews operate their ships in support of combatant commander missions.

Figure 13. USS *Trayer* (BST-21) Naval Station Great Lakes. US Navy photo.

Once isolated aboard the self-contained LVC simulator "ship," the captain will set watch teams, bring their ship online, cast off, and proceed out of port to sea through normal sea lanes and set a normal watch schedule. Onboard facilities will include a bridge, combat information center, sleeping bays, a captain's cabin, galley, and associated rooms needed for evolution exercises. By the completion of the final combat evolution on day six, the ship's captain and crew will have demonstrated individual and collective proficiency to established Navy standards, cohesive teamwork, exemplary leadership, and sound judgment under stress and sleep deprivation in combat, emergency, and *in extremis* situations including ship damage, fire, and flooding.

Instructional feedback after each evolution may degrade realism but is necessary to improve the effectiveness of the training simulation. At the end of each training evolution, after-action reviews will identify and reward systematic problem solving and experimentation with new approaches. Instructional personnel will come aboard and lead after-action reviews and provide feedback after evolutions on the mess deck. If required, senior mentor feedback and mentorship may take place in the captain's quarters.

Human Performance Factors and Competition

Human factors research is concerned with the role of humans as distinct from other aspects of systems. It uses multidisciplinary psychological and physiological tools that do not function well in command and control environments. Many of these challenges are overcome by conducting research in simulator facilities. This was demonstrated during a study conducted at the Royal Navy's Maritime Warfare School's simulator training facility. The Command Team Training (CTT) program put 16-person command teams into a Type-23 Frigate Operations Room Simulator, where they trained together on joint maritime operations in a multi-threat environment. Researchers looked at communication, decision making, and coordination. Scenarios (defend against air attack, defend against surface attack, etc.) were broken into phases and evaluated to give the command team quantitative scores in each area. They concluded that because scenarios were "very intense and quickly changing with an enormous amount of communications occurring over a relatively short period of time," the volume of observed data quickly overwhelmed their ability to record it. This problem can be overcome with big data systems enabled with AI-agents.

The belief that working at a high pace of operations builds proficiency is mistaken when teams cannot recognize their own limitations, and the scenario evolutions will be designed to challenge and exceed those limits. During the BattleLab deployment, participant failure is, by design, an expected and necessary step in the command team's experiential learning process. Any feasible solution to preventing future catastrophic failures must include insights into human performance factors. Multiple training evolutions during the deployment will present opportunities for the command team to practice systematic problem-solving. Challenges will be designed into the scenario using a scaffolding methodology to exponentially increase the difficulty as the 136-hour deployment progresses. This also presents an opportunity for human performance research in a controlled environment. Placing psychologists on staff will enable data collection on cognitive load, behavior under stress, rest management models and crew endurance, ethical decision making, crew performance, and human-machine interaction. At the same time, leadership will be evaluated by a senior officer who will serve as an observer and mentor meeting with the captain privately several times during the deployment.[133]

A standardized quantitative scoring should be developed and used for competition. This could extend, using esports techniques, to annual fleet competition for a "Top Gun" style trophy for the best of the best. Remembering that the first rule of BattleLab is to talk about BattleLab, videos demonstrating success should be shared across the fleet. Likewise, reports analyzing human performance and leadership should be published frequently with the idea that they will

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[133] Naval Technology. "War Games: A New Generation of Simulators" (February 2, 2011). https://www.naval-technology.com/features/feature108861/.

become feedback “gouge” for future success. Each successive iteration should gradually raise the bar for success. Over time, junior officers who grew up competing in the BattleLab crucible will become mentally agile, creative, ethical under stress, and growth-mindset leaders who drive organizational learning.

5. Conclusion

Disruption from artificial intelligence is on the horizon. Today, machine learning technology is used for non-lethal applications, including improving maintenance schedules, scanning through hundreds of hours of surveillance video, or testing autonomous robots and self-driving vehicles. Surges in computing power are rapidly leading the world towards algorithmic warfare, where autonomy and human-machine teaming are used at scale to transform military operations. In just a few years, weapon systems will have artificial intelligence (AI) programmed to act autonomously on the battlefield. Command and control systems will have intelligent agents that work with humans to improve decision making speed and accuracy. Across government and industry, leaders are encouraging people to think out-of-the-box, find innovative solutions, and get new, effective technologies quickly into the hands of warfighters. Fielding these highly autonomous systems will require high levels of trust based on a process to validate and verify machine decisions. More importantly, it will require assertive consideration for the human side of advanced technology.

Technological optimism, though widespread, is insufficient to push an organization into the adaptation of new “game-changing” technology. Both incremental innovation and exponential innovation from disruptive technology can exceed an organization's ability to manage change. Closing the gap between the capability of new technology and human ability depends on the warfighter's intellectual ability and mental flexibility. The military has a long track record of training operators of new technology, but if that training does not embrace the entire organization, notably including older senior leaders who may lag in technology adoption, results may be disastrous.

Historically, the problem of neglecting the human side of disruptive technology has resulted in a catastrophic loss of national blood and treasure. The example of rapid fielding of surface RADAR during the Second World War clearly demonstrates that failure to adapt faster than our adversary to disruptive technology results in failure. Battlefields across time are littered with the remains of armies that could not perceive, learn, and adapt to change. The challenge of creating an agile organization that learns, anticipates, and adapts quickly can be solved using a transformational learning approach that layers the best practices of learning organization and change management theories.

To evolve into a next-generation learning organization, the Navy must move away from industrial age learning methods and a reliance on incremental change. This begins with finding "rogue" thinkers, like Admiral Rickover, and giving them the authority to champion transformational change, question underlying assumptions, values, and beliefs deeply, and create a robust process to acquire, retain, and disseminate institutional knowledge at the right point in the decision cycle. Having a champion is the first step but the organization needs a learner-centric method to circulate change through the Fleets. The Navy is a large, multifaceted organization. First, it needs to build a self-directed 'esports style' learning platform to take advantage of individual motivations to learn and experiment with creative solutions. Second, it needs a robust collective experiential training platform that provides a safe environment to take risks and make mistakes while inoculating ship and fleet leadership teams to the stress of battle. Navy BattleLab simulation facilities will provide realistic, immersive, and highly stressed command team training (CTT). This fills a gap in surface warfare leadership training while leveraging advancements in networked live, virtual, and constructive (LVC) training, immersive simulator design, and human/machine teaming. By the completion of the CTT exercise, a ship's leadership team (captain, bridge and CIC staff) will have demonstrated individual and collective proficiency to established Navy standards, cohesive teamwork, creativity, exemplary leadership, and sound judgment under stress and sleep deprivation. This program will provide a stable and reproducible research platform for human performance studies and clean big data analysis, as well as a testbed for intelligent agent ship control or ship command and control systems and supervised machine learning for future autonomous surface warships.

The Department of Defense has been a leading user of simulators for decades. Hundreds of thousands of Soldiers, Sailors, and Airmen have trained in them. The Navy has extensive experience with simulators for training individual and small-team skills, basic navigation and ship handling, and bridge resource management. However, the expertise and management of Navy simulators is decentralized, which has resulted in one-off systems that cannot communicate with other systems. For example, the Navy Warfare Development Command's Advanced Modeling and Simulation Center provides a baseline level of networkable LVC simulations for fleet exercise, wargaming, and doctrine validation. However, many warfare simulators are managed by different commands, and simulators from one contract may not be able to communicate with simulators on another contract—even if they are manufactured by the same company. The BattleLab concept will significantly expand the effective ecosystem from a unique, one-off solution into a system for routine and repetitive leadership training up to fleet battle problems. It should also be a catalyst to streamline, if not centralize, policy, planning, management, oversight, funding, development, and use of modeling and simulation service-wide.

The focus of this study has remained on informing purposeful learning on the cultural and training side of human/machine teaming to prevent adaption failure and catastrophic results. The organizational skills associated with anticipatory learning are applicable to all situations, environments, and events. However, since it is difficult to scale anticipatory learning up from teams to the enterprise-level, the Navy must begin with a manageable catalyst led by a visionary champion who encourages testing assumptions, freedom of choice, and information sharing. Over time, the changes will permeate the Navy's culture producing leaders who are adaptive thinkers. This is not intended to marginalize the impact educational programs have in influencing leader mental agility, but to recommend a pragmatic methodology to fill a gap between formal training and formal education with self-directed learning and a collective training crucible to improve organizational warfighter mental agility. A next-generation learning organization will have robust processes to manage institutional knowledge and the ability to switch between incremental (single-loop) and transformational (double-loop) methodologies. Further research is needed to understand how learning and knowledge is transmitted from teams and groups to the larger organization.

An organization's ability to learn and adapt rapidly to change depends on a workforce with critical thinking skills, the ability to synthesize information into actionable knowledge, and the will to act decisively when faced with the unexpected. Amateurs, it is often said, practice until they can get it right; professionals practice until they cannot get it wrong. The two conceptual solutions presented in this study will provide a robust practice field for tomorrow's professional warriors so they cannot get it wrong. The result will be a Navy adapting on the leading edge of disruptive change as a next-generation learning organization.

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