# At the Tipping Point: Learning Science and Technology as Key Strategic Enablers for the Future of Defense and Security

| **Elaine M. Raybourn, Ph.D.** | **Sae Schatz, Ph.D.** | **Jennifer Vogel-Walcutt, Ph.D.** | **Kendy Vierling, Ph.D.** |
|---|---|---|---|
| ADL Initiative | ADL Initiative | ADL Initiative | Training and Education Command |
| Sandia National Laboratories* | Office of the Secretary of Defense | Office of Personnel Management | U.S. Marine Corps |
| Orlando, FL | Alexandria, VA | Orlando, FL | Quantico, VA |
| elaine.raybourn@adlnet.gov | sae.schatz@adlnet.gov | jj.vogelwalcutt@adlnet.gov | kendy.vierling@usmc.mil |

## ABSTRACT

According to former U.S. Secretary of Defense, Ash Carter, today's national security environment is "dramatically different—and more different and complex in the scope of its challenges—than the one we've been engaged with for the last 25 years, and it *requires new ways of thinking and new ways of acting*" (2016, emphasis is ours). These new ways cannot be achieved without significant changes to lifelong (or at least career-long) personnel development. This paper focuses on one aspect of that (r)evolution, i.e., specifically examining the challenges, goals, projects, and recommended actions related to the transformation of training and education in the defense and security sectors.

For more than a decade, training and education professionals have beaten this drum. Researchers and dedicated practitioners have pursued tactical-level programs in cognitive readiness, improved decision-making, adaptability, accelerated learning, instructional excellence, and so on. Small "inkblots" of excellence formed, and many papers were written. These inkblots are now converging, and grassroots efforts are being strengthened by serious top-level patronage and policy direction. Now, strategic-level organizational change seems possible.

All of the U.S. military services, as well as many other security agencies and coalition partners, have released detailed guidance on how to evolve their learning and development processes. This paper summarizes these complementary efforts and then recommends collective actions that may yield meaningful returns in the short- to mid-term. Specifically, these recommendations focus on instructional quality, competencies, credentials, data analytics, data interoperability, personalization, learning on demand, integrated human–machine systems, a technology-enabled continuum of learning providing multiple paths for achievement, and an enterprise approach to talent management.

## ABOUT THE AUTHORS

**Elaine M. Raybourn, Ph.D.** is a Principal Member of the Technical Staff in Cognitive Science & Systems at Sandia National Laboratories, and an ERCIM (European Research Consortium for Informatics and Mathematics) Fellow who has worked as a guest scientist in premier research laboratories in Germany, England, and France.

**Sae Schatz, Ph.D.** serves as the Director of the Advanced Distributed Learning (ADL) Initiative, a research and development program under the Deputy Assistant Secretary of Defense for Force Education and Training.

**Jennifer Vogel-Walcutt, Ph.D.** is the Director of Innovation at the ADL Initiative. She has over 15 years of experience in research and development for training and education with specific interests in applying instructional techniques to improve the effectiveness and efficiency of cognition and educational development.

**Kendy Vierling, Ph.D.** serves as the Director of the Future Learning Group (FLG) and lead for science and technology at the United States Marine Corps (USMC) Training and Education Command (TECOM). Her work focuses on the development of innovative methodologies, science, and technologies to enhance military learning, resilience, and human performance.

# At the Tipping Point: Learning Science and Technology as Key Strategic Enablers for the Future of Defense and Security

| Elaine M. Raybourn, Ph.D. | Sae Schatz, Ph.D. | Jennifer Vogel-Walcutt, Ph.D. | Kendy Vierling, Ph.D. |
|---|---|---|---|
| ADL Initiative | ADL Initiative | ADL Initiative | Training and Education Command |
| Sandia National Laboratories* | Office of the Secretary of Defense | Office of Personnel Management | U.S. Marine Corps |
| Orlando, FL | Alexandria, VA | Orlando, FL | Quantico, VA |
| elaine.raybourn@adlnet.gov | sae.schatz@adlnet.gov | jj.vogelwalcutt@adlnet.gov | kendy.vierling@usmc.mil |

> *"In order to succeed in the asymmetric battlefields of the twenty-first century—the dominant combat environment in the decades to come, in my view—our Army will require leaders of uncommon agility, resourcefulness, and imagination; leaders willing and able to think and act creatively and decisively in a different kind of world, in a different kind of conflict than we have prepared for the last six decades."*
>
> Robert Gates, 22nd U.S. Secretary of Defense
> *"Reflections on Leadership"*

## INTRODUCTION

In recent years, it has become almost cliché in articles about military training and education (such as this one) to begin with an outline of the uniquely demanding future operating environments. However, the fact that the training and education community has become increasingly aware of these evolving operational demands does not diminish their importance or relevance. Therefore, our paper begins by discussing the demands of the strategic environment and then reviews ongoing training, education, and personnel development efforts intended to address these challenges. Later in this article, we also recommend some potential actions as targets for greater interagency and interorganizational coordination that may yield meaningful returns on investment for collaborating agencies.

## STRATEGIC ENVIRONMENT

Volatile, uncertain, complex, and ambiguous conditions continue to define the norm for defense operations. The national security environment ebbs between the extremes of "great power competition" with the rise of nations such as Russia, China, North Korea, and Iran to asymmetric conflicts focused on countering insurgencies comprised of "smaller and smaller groups" (Carter, 2016). The disruptive use of pervasive low-cost technologies, social media, information operations, and irregular tactics adds to the volatility, creating an ever-changing operational landscape (Barno & Bensahel, 2017). Yet, military personnel must be prepared to anticipate second- and third-order effects on these connected battlefields, within wider ranges of missions that vary in scale and tempo and that span all domains—land, sea, air, cyber, space, and electronic warfare—often simultaneously and across all phases of warfare (e.g., see National Military Strategy, 2015).

Ensuring our people, processes, technology, and organizations are *ready* for these challenges will require significant effort and organizational reforms. Indeed, as U.S. Secretary of Defense Jim Mattis recently stated, the DoD must "be prepared to deal with technological, operational, and tactical surprise, which requires changes to the way we train and educate our leaders and our forces, and how we organize for improved Departmental agility" (Mattis, 2017; p. 7). This follows former Secretary of Defense Ash Carter's remarks from the year prior, where he observed that the contemporary defense environment is "dramatically different—and more different and complex in the scope of its challenges—than the one we've been engaged with for the last 25 years, and it *requires new ways of thinking and new ways of acting*" (2016, emphasis is ours).

These new ways of thinking and acting will require military and security sector personnel (and many others within our societies) to possess a broader set of competencies and capabilities, higher levels of proficiency in them, and a greater ability to rapidly adapt and grow their capabilities to meet changing conditions (e.g., see Dempsey, 2010; Schatz et al., 2015). Naturally, training, education, and professional development programs are key components in

growing those expanded personnel capacities. However, the old ways of training and educating are no longer sufficient. We must become more effective, efficient, agile, and proactive in the development and real-time support of our personnel for the future challenges they will face.

**RESPONSE TO THE STRATEGIC ENVIRONMENT**

In his June 12, 2017 testimony to the House Committee on Armed Services, Defense Secretary Mattis underscored the urgency for a response to the strategic environment: "In this competitive environment, the Department must pay much more attention to future readiness…" (Mattis, 2017, p. 7). Notably, each of the U.S. Services, U.S. Joint Staff, other federal programs, and many coalition partners have released publications all highlighting similar goals related to evolving their learning and personnel development systems to address such challenges. In this section of the paper, we summarize several of those initiatives, in order to highlight their convergence and encourage increased unity of effort. While this section does not include all of the listed organizations' efforts (nor does it include all possible organizations), it highlights many notable policies and programs relevant to this discussion.

**U.S. Army**

For many years, the U.S. Army has been prolific in its discussions about the shifting operational environment and corresponding actions required in response. For instance, as early as 2010, General Martin Dempsey (then-commander of the Army's Training and Doctrine Command [TRADOC]) published a series of essays calling for "a Campaign of Learning," urging the Army to invest in a host of organizational initiatives including methods for developing decision-making expertise and adaptability (Dempsey, 2010). These articles complement the (now) well-established *Army Learning Concept* and related Human Dimension efforts.

TRADOC originally published the *Army Learning Concept for 2015* (Pamphlet 525-8-2) in January 2011. It was among the first doctrinal (versus scholarly) publications to call for a holistically new model of military learning, declaring "our Army is at risk if we do not recommit ourselves to the value of learning in the development of our Soldiers and leaders" (p. i). The pamphlet specifically requested a reduction in slideshow-based classroom experiences, increase in problem-focused learning, better use of technology-delivered instruction, integration of learner-centric personalization, and application of training and education methods that engage learners to think and understand the relevance and context of what they learn. Note that in 2012, when the *Army Learning Concept* began moving from the conceptual to the execution phase, stakeholders started referring to it as the "Army Learning Model" (e.g., see TRADOC press release, Christian, 2012).

In April 2017, TRADOC published the updated *Army Learning Concept for Training and Education for 2020–2040* (TP 525-8-2). In addition to reworking the *Army Learning Concept for 2015*, this revision also synthesizes and replaces the *Army Training Concept 2012–2020* (TP 525-8-3). Similar to its predecessors, this latest publication defines "a continuous, adaptive learning enterprise that facilitates a career-long continuum of learning" (iii). The revised *Army Learning Concept* also emphasizes the following tenets:

- Learner-centric approach – with learning adapted to individual/team needs and interests
- Continuous learning engine – adaptive and continuous career-long learning (vice episodic exposures)
- Training – via a holistic, efficient technology-based infrastructure that supports realistic experiences
- Education – by world-class instructors, using learner-centric techniques and outcomes-based curricula
- Blended learning environment – blurring the distinctions between institutional learning and operations

The *Army Learning Concept* represents top-level Army guidance, but not the sole guidance. Many closely related Army publications reiterate similar messages. Perhaps most significant among these include the *Leader Development Strategy*, *Leader Development* (FM 6-22), *Leadership* (ADRP 6-22), *Training Units and Developing Leaders* (ADRP 7-0), *Human Dimension Strategy 2015*, *Human Dimension in the Future 2015–2024* (TP 525-2-7-01), *Capstone Concept* (TP 525-3-0), and the *Army Operating Concept: Win in a Complex World* (TP 525-3-1). Notably, that latter publication spans a range of topics, but most relevantly for this discussion, it describes future force development under *Force 2025 and Beyond* and introduces the *Army Warfighting Challenges*.

The *Force 2025 and Beyond* initiative, a strategy overarching many of the aforementioned concept papers, guides Army future force employment; science, technology and human performance optimization; and force design plans. Meanwhile the *Army Warfighting Challenges* outline 20 specific objectives designed to focus other Army concepts towards shared strategic ends. Many of these challenges have substantial implications for learning and development; in particular, #9 calls to "Improve Soldier, Leader, and Team Performance" and #10 calls to "Develop Agile and Adaptive Leaders." Summaries and full publications of both *Force 2025 and Beyond* and the *Army Warfighting Challenges* are available on the Army Capabilities Integration Center (ARCIC) website: http://www.arcic.army.mil.

**U.S. Navy**

In a 2015 memo, then-Secretary of the Navy, Ray Mabus, observed, "Today we find ourselves at the intersection of revolutionary technology changes and emergent operational concepts, both of which compel us to create a truly adaptive workforce. We must ensure that the talents and skills of our Sailors and Marines align to the challenges they will encounter in the complex operational environment of the future" (Secretary of the Navy, 2015, p. 1). The memo goes on to outline four specific goals:

- Reevaluate officer billet requirements for specialized disciplines (e.g., energy, robotics)
- Modernize officer training, especially for emerging capabilities and complex problem-solving
- Determine how to best apply data analytics to personnel selection, development, and management
- Provide alternative, more easily accessible training and certification for rapidly changing environments

The *Sailor 2025* program, the capstone Navy strategy for learning, development, and human capital management, is intended to address these objectives. It encompasses 43 initiatives, grouped into three major thrusts: Personnel System Modernization; Ready, Relevant Learning; and Enriched Culture. The second grouping best applies to this discussion. Ready, Relevant Learning focuses on providing the "right training at the right time in the right way" (Navy Personnel Command, 2017, p. 2). Its features include:

- Career-long continuum of learning – delivered via modern methods throughout a career
- Instructional quality – replacing the "industrial, conveyer-belt-training-model" with proven techniques
- Blended learning in classrooms – using a mix of classroom, training, and technology unique to each career
- Ease of access – increasing access to learning, e.g., via mobile training, embedded job aids, and reach-back
- Technology – leverage cloud-hosted training content

Notable progress in Ready, Relevant Learning has occurred since 2015. Two key areas have been among the most observable changes. First, Naval personnel have begun comprehensive curricula reviews of select ratings (i.e., enlisted Sailor paygrades) to identify opportunities for improvement or areas to eliminate redundancy. Second, the Navy has started a rigorous analysis to inform reorganization of front-loaded accession training, breaking massed-training into smaller modules that can be delivered closer to their time of actual use. The Naval Education and Training Command (NETC) calls this approach "block learning" and describes initial reform recommendations for it in the *Block Learning Recommendations Report* (2017; see also Center for Service Support Public Affairs office, 2016). Of the eight "guiding recommendations" for block learning, three stand out of particular note:

- Align learning to the point of need
- Make it flexible, via learning continuums supported by modular training and new means of delivery
- Build-in continual process improvement, with ongoing measurement of the system's efficiency and validity

**U.S. Air Force**

The *Air Force Future Operating Concept* (2015) is the USAF's overarching force development vision document. It provides the context for, and aligns with, the Air Force's *Strategic Master Plan* (2015) as well as related documents, such as *Global Vigilance, Global Reach, Global Power for America* (2013) and *America's Air Force: A Call to the Future* (July 2014). The *Operating Concept* covers a range of desired outcomes, including achieving a pool of Airmen "some with deep expertise and some with different experience, supported by a greater and purposeful

differentiation of selection, development, and placement…" and "Airmen who are ready and responsive, and demonstrate general qualities such as critical thinking, adaptive behaviors, innovation, creativity, collaboration, social networking skills, emotional and cognitive intelligence, initiative, and resilience" (p. 43).

The *Human Capital Annex* within the *Strategic Master Plan* outlines specific actions the Air Force will take to meet these goals. It explains, "We are compelled to modernize both our education and training processes and content to ensure we provide lifelong education that is individually tailored and appropriately delivered. This requires a system that differentiates and adjusts content delivery methods, quantity, and frequency to optimize our Airmen's learning opportunities" (p. 9).

Known for its cutting-edge capabilities, it should be no surprise that the USAF plans to use emerging training and education technologies to meet these goals. As the most recent Air Force *Global Science and Technology Vision* report observed, "As improvements continue in adaptive and intelligent web-based systems, mobile networks, desktop trainers, wearable devices, visualization, virtual spaces and avatars, the AF can leverage integrated, personalized learning that allow seamless, relevant, mission-focused simulations and courses to be available when needed…" (USAF, 2013, p. 33). Similarly, the *Future Operating Concept* recommends "…training across multiple mission sets, including integrated LVC [Live, Virtual, Constructive] venues and operator-in-the-loop Modeling & Simulation (M&S), to cultivate Airmen trained in agile and robust decision-making who can devise multi-domain solutions to complex problems in uncertain, contested environments" (2016, p. 42).

These learning and development strategic concepts were recently explored in the Corona exercise, an annual meeting of the topmost Air Force leaders, including most of its three- and four-star generals. The prevailing response from Air Force leaders was that "to develop agile Airmen required for future operations, the AF must redesign the CoL [Continuum of Learning] from a production-centered approach into an agile, learner-centered model…" (Roberson, 2017, p. 2). The generals went on to describe a vision for the future, including the following:

- Enterprise-focused (versus functionally focused) force development
- On-demand learning via chunked content (versus more time-constrained, linear, and batched learning)
- Blended learning combining various delivery technologies and methods
- Rapidly updated and relevant content
- Recognition of credentials and competencies earned from experience or learning outside of the military
- An integrated learning ecosystem (versus stovepiped learning systems and technologies)
- An integrated "master learner record" that aggregates learner data from across different data sources

**U.S. Marine Corps**

The USMC has long emphasized their personnel's expeditionary mindset and ability to operate in contested, complex environments. The evolving operational environment only strengthens this focus. For instance, General Robert B. Neller, 37th Commandant of the Marine Corps, recently wrote:

> …we recognize the current and future fight may not be what we experienced in the past. It will encompass not just the domains of land, air, and sea, but also space and the cyber domain. It will include information operations and operations across the electromagnetic spectrum. It will involve rapidly changing and evolving technologies and concepts, which will force us to be more agile, flexible and adaptable. Most importantly, it will require Marines who are smart, fit, disciplined, resilient, and able to adapt to uncertainty and to the unknown (*Marine Corps Operating Concept*, 2016, p. 28).

The *Marine Corps Operating Concept* builds upon the USMC *Expeditionary Force 21*, *Service Strategy 2016,* and *Force Development Strategic Plan*. Together, these documents provide the foundation for a campaign of learning. They urge the Marine Corps to better leverage technologies, partnerships, and innovation to train and equip Marines to thrive in complex, urban littorals, recognizing that an "essential ingredient to mission success is the competence of the individual Marine to think and act effectively under chaotic, uncertain, and adverse conditions" (*Operating Concept*, p. 24). This latest set of strategic documents follows a trend set by the *Marine Corps Vision and Strategy*

*2025* (published in 2008). It spurred Training and Education Command (TECOM) to embark upon significant learning and development reforms, such as the *Small Unit Decision Making* and *Instructor Professionalization* initiatives (e.g., see Schatz et al., 2012), and to further develop leadership and sociocultural curricula.

Today, TECOM continues to pursue innovation in learning with support from science and technology partners. This includes projects focused on enhancing instructional methods, training technologies, assessment tools, distributed learning, experiential learning, learner-focused education, and leadership and professional development across all echelons (e.g., Ross et al. 2015; Oles, 2016). The Marine Corps has also implemented new instructional technologies and simulation enhancements to support both tactical and higher-order cognitive skills development. These, along with Live, Virtual, and Constructive Training Environment efforts, build towards developing a comprehensive Marine Corps Synthetic Training Environment (Vierling, Whittington, & Cross, 2012). Ultimately, with these many initiatives, TECOM aims to develop an interoperable, easily accessible, scalable, and resilient learning ecosystem that provides Marines with multiple ways to learn, at the point of need.

To aid these modernization endeavors, the Marine Corps recently established the Future Learning Group, a special staff unit reporting directly to the Commanding General of TECOM. Its mission is to "seek and assess innovative methods and technologies in order to enhance Marine Corps learning" and to lead "the exploration, identification, testing, and assessment of new science, technology, and innovation methods to improve Marine Corps training and education" (*TECOM Policy Letter 1-17*, 2017, p. 1–2). The Future Learning Group leads TECOM's science and technology initiatives, and its work will help the Marine Corps better capitalize on emerging innovative methods, technologies, and opportunities to substantially enhance the USMC learning enterprise.

**U.S. Office of the Secretary of Defense**

In the last two years, the U.S. Office of the Secretary of Defense (OSD) has championed two large campaigns relevant to the current discussion: *Force of the Future* and the *Third Offset Strategy*.

Force of the Future

Former Secretary of Defense Ash Carter announced the *Force of the Future* initiative in 2015. Its aim was to comprehensively reform the Defense talent management system affecting recruitment, selection, accession, compensation, development, transition, and retirement. As he explained in a memo, dated 18 November 2015:

> …in this ever changing environment, one of my top priorities is to ensure the Force of the Future remains as great as the Force of Today, especially in terms of our most important competitive edge—*our people*. One important way to do this is to update and adapt the Department's active and reserve military and civilian personnel systems to account for new conditions affecting workforce markets, generational change, and innovative new practices in people and talent management, while retaining the professionalism, rigor, and tradition required for an institution charged with defending our Nation's interests (p. 1).

Following the then-Secretary's official announcement, he directed the Pentagon to comprehensively review the Department's civilian and military personnel systems. Ultimately, this analysis "produced a document in excess of 150 pages and included 29 reform proposals that captured almost 80 individual reform initiatives" (Force of the Future fact sheet, 2015, p. 1). The Pentagon approved and released dozens of these reforms, significant portions of which affect DoD learning and development systems. Among these, some of the most relevant include:

- Expand the Secretary of Defense corporate fellows program to infuse private-sector ideas into DoD
- Implement a web-based talent management system to help match the right skills to available assignments
- Establish the Office of People Analytics to better harness big data capabilities in managing talent
- Offer a doctoral-level program in strategy to enhance existing Professional Military Education
- Establish the Center for Talent Development to provide DoD-wide guidance on talent policy and strategy
- Establish a public–private talent exchange (for civilians) for sharing new ideas among industry and DoD
- Leverage career broadening rotational programs (for civilians) to expand the breadth of experience
- Better leverage civilian employee training funds

Third Offset

In November 2014, then-Secretary of Defense Chuck Hagel appointed Deputy Secretary of Defense Robert Work to architect the Department's "game changing" *Third Offset Strategy*. This strategy was to identify ways to sustain U.S. military dominance in the contemporary environment. That is, it was designed to "identify, develop, and field breakthroughs in the most cutting-edge technologies and systems—especially from the fields of robotics, autonomous systems, miniaturization, big data, and advanced manufacturing, including 3D printing" (Hagel, 2014).

In contrast to the *Force of the Future* initiative, the *Third Offset Strategy* focuses largely on technological advancement rather than human capital; nonetheless, it includes significant implications for learning and development. Additionally, of the $18 billion slated for the development of technologies for the Third Offset, $3 billion was allocated to human–machine collaboration (Erwin, 2016). "The Third Offset is really kind of simple at its core," explained Deputy Secretary Work. "It basically hypothesizes that the advances in artificial intelligence and autonomy—autonomous systems—is going to lead to a new era of human–machine collaboration and combat teaming" (Work, 2016). This means that humans will be paired with artificial intelligence, which will support those personnel's mental agility and problem-solving abilities—especially for quick, complex calculations of large, interrelated data sets (Lange, 2016).

This has direct implications for the learning and development enterprise. Not only will training and education systems require significant changes to support new curricula involving integrated human–machine systems, but the entire paradigm will be affected. As artificial intelligence, robotics, and other autonomous systems start to manage the "easier" (i.e., more procedural and well-defined) tasks, humans will be expected to concentrate on ever-more creative, sophisticated, and challenging operational components, such as tasks requiring social acumen, creative problem-solving, and strategic thinking. In other words, the Third Offset reinforces the need to cultivate *higher-order* cognitive, affective, and social competencies for all personnel. "We're trying to conceive of how this will unfold," Deputy Work explained. "That's very important. We don't have an endpoint in this. This is very much a walk, crawl, run—see what we can do, how we train our people, how our people react" (Pomerleau, 2016).

**U.S. Joint Staff J7 (Joint Force Development)**

In 2017, VADM Kevin Scott, Director for Joint Force Development, announced the *Joint Force Development – Next* initiative, a holistic reform to joint training, leader development, and capability and concept development (Fautua et al., 2017). The initiative includes four lines of effort, with its "Professional Development" line most applicable to this discussion. It seeks to "…develop critical thinkers who are agile, adaptive, and innovative leaders with the competencies to think strategically, build and lead different coalitions, and operate within a complex, dynamic social context anywhere around the world" (Joint Staff J7, 2017). It includes four integrated subordinate efforts:

- Desired leader attributes – revise and expand these, and consider defining desired competencies, as well
- Connect and lead the Joint learning community – via a holistic strategy to integrate training and education
- Reinforce and inform talent management – by intentionally supporting informal learning and experiences
- Create a learner-centric learning environment (enabled via technology) – with modern learning methods

*Joint Force Development – Next* represents an overarching strategy, intended to affect a variety of related joint publications and efforts, including the *Officer Professional Military Education Policy* (CJCSI 1800.01E), *Enlisted Professional Military Education Policy* (CJCSI 1805.01B), *Joint Training Policy* (CJCSI 3500.01H), and *Growing Civilian Leaders* (DoDI 1430.16), as well as the broader civilian and senior executive service learning and development policies (DoDI 1400.25, v. 410, and DoDD 1403.03, respectively).

**U.S. Special Operations**

The Special Operations Forces (SOF) community has long recognized that "humans are more important hardware," and USSOCOM plans to enable its people, in part, via the *Future Special Operator Concept*. This holistic talent management initiative will "ensure the Enterprise can place the right operators in the right place, at the right time,

and with the right training and education..." (*SOF Operating Concept*, 2016, p. 5). Specific actions under this initiative include identifying emerging personnel requirements, defining a competency model for future special operators, and investing in relevant personnel lifecycle management and information technologies (Deck, 2016). These efforts also align with Joint Special Operations University's 2017 research topics, including (2016, p. 2/11):

- A2. How does USSOCOM ensure it has the right people, skills, and capabilities now and in the future?
- B1. Training SOF for the future: Identifying skill gaps associated with the next fight

The SOF service components have issued similar guidance. For example, the *Army SOF Concept 2022* calls for "innovative solutions to train, educate, and retain the world's premier SOF and meet the demands of the future security environment." It also highlights the need for "Networked, web-based training solutions [to] enable ARSOF operators to rapidly leverage capabilities of centers of excellence, combat subordinate commands, and command subordinate units" and new capabilities "in all of the training environments: live, virtual, constructive, and gaming" (2014, p. 25). The same concept document also discusses talent management for special operators and Army civilians, saying "Our leader development approach must be all-encompassing and continuous. In the future, ARSOF must emphasize a form of talent management ensuring highly skilled personnel are trained at the right time and serving in the right positions" (p. 28).

**Other Agencies and Related Initiatives**

Rather than attempt to list all similar efforts across the security community, below we summarize a final three examples, in order to underscore the pervasiveness of this movement.

The Defense Intelligence Training and Education Board (DITEB), reporting to the Under Secretary of Defense for Intelligence (part of OSD), is also pursuing revisions to its learning and development enterprise. This community faces unique training and education challenges, due to the sensitive nature of its learning content and environments. DITEB's project, named the Talent Development Toolkit, seeks to develop a modern learning ecosystem of interconnected, data-driven learning, including personalized discovery of learning opportunities, improved assessment delivery and evaluation, enhanced data collection and visualization, program evaluation, competency-based learning, and expanded management of credentials (Madsen, 2017).

The National Geospatial-Intelligence College is pursuing *On Domain, On Demand (OD²)*, a project designed to "Transform the culture of GEOINT learning by increasing accessibility to a range of learner-centric solutions at the point of need" (p. 4). The effort is designed to move Geospatial-Intelligence learning from instructor-centric to learner-centric, make content more accessible and discoverable, and refocus learning more towards the point of need (i.e., performance support; see Riordan, 2017).

As a final example, in 2015, the U.K. Ministry of Defence launched the *Strategic Edge Through People 2040*, a program with similarities to the *Force of the Future* initiative. This four-year, multi-million pound research initiative focuses on uncovering the capabilities U.K. personnel will need by 2040 and refining personnel systems to meet those needs. Specific actions include examination of competency-based approaches, integration of credentialing, and development of an enterprise approach to talent management (Defence Science and Technology Laboratory, 2015).

More initiatives could be listed…but we've made the point.

**RECOMMENDATIONS: AREAS OF CONVERGENCE**

Given the chorus of voices calling for change in Defense learning and development systems, the question becomes: "Where should we invest our limited resources?" The initiatives previously described above recommend expansive reforms. Diffused efforts or unfocused approaches could have significant costs without producing meaningful outcomes. Instead, implementing a more considered approach, with focused effort in priority areas, may not only save resources but also yield more sustainable outcomes. Towards that end, we have curated a "Top 10" of possible investment areas (*not* in priority order) derived from a convergence of the formal publications listed above.

**(1) Enhance instructional quality.** Learning science offers evidence-based strategies and tactics that reliably and substantially improve learning outcomes. By investing in enhanced professional development for military faculty and staff, the community could reap immediate benefits without significant costs. Developing interagency faculty and staff resources is a particularly good opportunity because these learning science principles are fully portable across agencies, making them a ripe target for collaboration and resource-sharing (Schatz et al., 2012).

**(2) Adopt a competency-based approach to learning and development.** In this context, "competencies" refer to formally defined, organized, and structured descriptions of knowledge, skills, attributes, and other characteristics. A competency-based approach, therefore, uses these standardized competency frameworks to manage human capital functions, such as selection, job assignment, professional development planning, curricula design, and workforce management (Belanich, Moses, & Lall, 2016). This approach supports outcomes-focused training and education, which could help improve assessment quality and accountability. Competencies can also serve as a "common currency" for describing and sharing data about human performance across systems, which supports several desired outcomes including increased technical interoperability of learning and development systems, better personalization of professional development trajectories, and greater permeability of personnel across organizational boundaries.

**(3) Record and credit credentials.** In this case, "credentials" refer to formally asserted qualifications, such as college degrees or professional certifications. Current systems adequately manage credentials earned within formal intra-agency training and education opportunities (although these systems could be more interoperable, user-friendly, and reliable). However, DoD does not effectively manage credentials earned outside of its own formal structures. The defense enterprise could better capitalize on the wealth of available external learning opportunities if it would invest in the organizational and technological systems needed to reliably and seamlessly accept, verify, and accredit credentials, particularly those earned outside of a given agency. Similar to the competency approach, above, this promises to aid permeability, encourage self-development, help DoD better identify and place capable personnel (who have developed skills elsewhere), and improve personalization of learning.

**(4) Integrate and visualize data across multiple systems.** Today, personnel data are scattered across numerous systems and lack the integration needed to effectively make higher-level, data-driven decisions. In the future, data collected from various learning and development stovepipes must be interoperable—able to be aggregated and analyzed across organizational and technological boundaries (Lang et al., 2017). Further, the integrated data must also be visualized in usable ways, so that leaders, instructors, and learners can readily understand them. For instance, master learner records, as proposed by the USAF (Roberson, 2017), could capture relevant personnel data in one place, and embedded individual and collective data visualizations could help their viewers uncover trends, spot anomalies, and use the amassed data to inform decisions.

**(5) Use improved data analytics.** Improved data analytics are the key to greater insights, and thus finer management. In this case, data analytics applied to personnel data could inform organizational assessments of learning effectiveness, improve personnel selection and placement (resulting in greater person–job fit), and offer more clarity on individual and unit personnel readiness. Such analytics could also support "data-driven learning," facilitating broad adaptation of learning delivery, content, and development plans, whether in instructional or operational contexts (e.g., Raybourn, 2014; Schatz et al., 2015). However, before this vision can be realized, we will need to implement improved human performance measurement methods, leverage more authentic data collection devices (e.g., stealth assessments and wearable technologies), and develop systems for ethically, safely, and effectively managing masses of learning and development data. We also need to determine how to best apply (big) data analytics to personnel processes, whether performance assessment, system-level awareness for continuous improvement, or selection and assignment actions.

**(6) Provide personalization and multiple pathways for achievement.** As mentioned in the preceding recommendations, aggregated system-wide data combined with enhanced analytics could facilitate much greater personalization of learning. However, automated technologies and data-driven adaptations, while desirable, are not the only ways to achieve greater personalization of learning. The learning and development enterprise can also provide learners, both individuals and teams, with multiple ways to achieve a given competency standard, when applicable. This may mean different personalized learning trajectories, different formal or informal options, and/or

opportunities to use various media and technologies that are *connected* and woven into the learning experience (Raybourn, 2014). This creates flexibility within the system, which supports practical implementation of the learning continuum. It addition, it may also increase learners' motivation, understanding, and willingness to pursue self-development.

**(7) Deliver more learning at the point of need.** Where appropriate, consider breaking time-based, linear learning opportunities into more modular content that can be delivered on-demand. In other words, consider just-in-time training and informal learning opportunities as explicit and critical parts of the learning and development system. Make it easier for personnel to access such learning, whether via mobile training teams, embedded job aids, mobile devices, mentorship, embedded training, or a social learning system.

**(8) Anticipate integrated human-machine systems.** Just as future military plans consider how artificial intelligence and automation will impact the operational environment, we must equally anticipate how integrated human–machine systems and other "technological surprise" could disrupt the ways we conduct and conceive of training and education. These emerging technologies will cast human operators into categorically new roles, creating new and shifting learning and development requirements, and innovations such as human–machine collaboration and teaming will force us to reconsider comfortable notions of mentorship, apprenticeship, and peer learning.

**(9) Develop a technology-enabled continuum of learning.** Today's learning and development system consists largely of distinct and separate learning blocks, ordered in a fairly linear arrangement. Rather than this "industrial" model, the future system should employ a "continuum of learning" that unites the range of formal and informal learning experiences into a cohesive career-long tapestry. In other words, instead of stovepiped and episodic learning instances, the various learning opportunities will reference one another, share data, and interconnect in intelligible and explicit ways (Raybourn, 2014). This necessarily means the boundaries between training and education—and even operations—will blur, as learning and human-support technologies share data, support high-level decisions, and interconnect across these boundaries. Although this may seem like a distant vision, new technologies, such as those facilitated by the Total Learning Architecture, have already begun testing "meta-adaptation" of learning trajectories across loosely federated technologies (Folsom-Kovarik & Raybourn, 2016).

**(10) Develop an enterprise approach to talent management.** This recommendation enables many of the previous suggestions listed above. It observes that true progress in learning and development reform requires the elimination of unnecessary organizational divisions separating training, education, and other human resources functions. This could better enable the data collected through training and education to inform personnel selection and assignment, and it could allow for a more purposeful recruitment, selection, assignment, and management personnel, their professional development, management of the workforce, and force structure design.

## CONCLUSION

Learning science and technology are key strategic enablers for the future of defense and security. However, the modernization of human capital management practices and technologies will require revolutionary change of existing systems in order to effectively and efficiently transform the people, processes, technologies, and organizations to meet contemporary and emerging demands (e.g. Raybourn, 2013). It is now time to unite efforts to build the widespread, institutional change needed to meet the demands of the future force.

## ACKNOWLEDGEMENTS

## REFERENCES

Barno, D. & Bensahel, N. (2017, May 23). Three things the Army chief of staff wants you to know. Retrieved from https://warontherocks.com/2017/05/three-things-the-army-chief-of-staff-wants-you-to-know/.

Belanich, J., Moses, F. L., & Lall, P. (2016). *Review and Assessment of Personnel Competencies and Job Description Models and Methods* (No. D-5803, H-16-000534). Alexandria, VA: Institute for Defense Analyses.

Carter, A. (2016, February 2). Remarks by Secretary Carter on the budget at the Economic Club of Washington, DC. Retrieved from www.defense.gov.

Carter, A. (2015, November 18). *Force of the future: Maintaining our competitive edge in human capital* [Memorandum]. Washington, DC: Department of Defense.

Center for Service Support Public Affairs Office. (2016, February 10). Training center moves out on Ready Relevant Learning. Retrieved from www.navy.mil.

Christian, T. (2012, June 8). Army Learning Model to begin fiscal year 2015. Retrieved from www.army.mil.

Deck, B. (2016, April). *SOF Operating Concept*. Presented at the SOF Education Conference 2016, Tampa, FL.

Defence Science and Technology Laboratory (2015, May 15). Achieving the strategic edge through people: 2040. Retrieved from www.gov.uk.

Dempsey, M.E. (2010, November). A dialogue about our army: A campaign of learning to achieve institutional adaptation. *Army Magazine*, 34–35.

Erwin, S.L. (2016, August 20). A defense technology revolution could happen sooner than you think. Retrieved from www.nationaldefensemagazine.org.

Fautua, D., Schatz, S., Boring, C., Reitz, E., & Reist, J. (2017). Joint Force Development – Next: Why training, education and talent management must adapt. *Proceedings of the I/ITSEC*. Arlington, VA: NTSA.

Folsom-Kovarik, J.T. & Raybourn, E.M. (2016). Total Learning Architecture (TLA) Enables Next-generation Learning via Meta-adaptation. *Proceedings of the I/ITSEC*. Arlington, VA: NTSA.

Gates, R. (2010). Reflections on leadership. *Parameters, 40*(4), 184–191.

Hagel, C. (2014, November 15). Reagan National Defense Forum keynote. Presented at the Ronald Reagan Presidential Library, Simi Valley, CA. Retrieved from www.defense.gov.

Joint Staff J7 (2017, March). *What, why and how we produce master learners.* Presented at the Joint Force Development – Next offsite, Suffolk, VA.

Lang, C., Siemens, G., Wise, A., Gašević, D. (2017). *Handbook of learning analytics.* Society for Research on Learning Analytics (SoLAR). Retrieved from https://solaresearch.org/hla-17/.

Lange, K. (2016, March 30). 3rd Offset Strategy 101: What it is, what the tech focuses are. *DoD Live.* Retrieved from www.dodlive.mil.

Mattis, J. (2017, June 12). Secretary of Defense Jim Mattis House Armed Services Committee written statement for the record. Retrieved from http://www.politico.com/f/?id=0000015c-9f04-d070-a57d-fffe4c600001.

Madsen, A.R. (2017, March 9). *DITEB LEA WG.* Presented at the DITEB Talent Development Toolkit working group, Washington, DC.

Navy Personnel Command. (2017, January 11). *Sailor 2025 pamphlet.* Retrieved from www.public.navy.mil.

NETC N7. (2017, January 13). *Block Learning Recommendations Report.* Pensacola, FL: NETC.

OSD. (2015, November 18). *Fact sheet: Building the first link to the force of the future* [Memorandum]. Retrieved from www.defense.gov.

Oles, W.S. (2016). First to teach: Every Marine officer a teacher. *The Breckinridge Papers: Selected studies from the Marine Corps University, 1*(1). Quantico, VA: Marine Corps University Press.

Pomerleau, M. (2016, May 4). DoD's third offset strategy: What man and machine can do together. Retrieved from https://defensesystems.com/articles/2016/05/04/dod-work-on-third-offset-strategy.aspx.

Raybourn, E.M. (2013). Addressing changing mindsets: Transforming next generation leader development with transmedia learning. In T.C. Hailes and L. Wells (Eds.), *Changing mindsets to transform security: Leader development for an unpredictable and complex world.* Washington, DC: National Defense University.

Raybourn, E.M. (2014). A new paradigm for serious games: Transmedia learning for more effective training & education. *Journal of Computational Science*, (5) 3, Elsevier, 471–481.

Riordan, S. (2017, March 14). National Geospatial-Intelligence College (NGC): On Domain, On Demand (OD$^2$). Presented at the DITEB LEA working group, Washington, DC.

Roberson, D.L. (2017, February 26). *Training agile Airmen through the continuum of learning.* Presented at Corona South, MacDill Air Force Base, Tampa, FL.

Ross, K.G., Phillips, J.K., & Lineberger, R.E. (2015). *Marine Corps Instructor Mastery Model*. Report to the Office of Naval Research and USMC Training and Education Command for Contract N000014-14-C-0106.

Schatz, S., Bartlett, K., Burley, N., Dixon, D., Knarr, K., & Gannon, K. (2012). Making Good Instructors Great: USMC cognitive readiness and instructor professionalization initiatives. *Proceedings of the I/ITSEC*. Arlington, VA: NTSA.

Schatz, S., Fautua, D., Stodd, J., & Reitz, E. (2015). The changing face of military learning. *Proceedings of the I/ITSEC*. Arlington, VA: NTSA.

Secretary of the Navy (2015, July 28). *Anticipate Future Military Personnel Demands* [Memorandum]. Washington, DC: Department of Defense.

Vierling, K., Whittington, E, & Cross, A.L. (2012). Challenges in Developing HSCB Standards and Interoperability for Marine Corps Training Simulations (paper 12s-siw-039). Simulation Interoperability Standards Organization (SISO), *Proceedings of the Spring 2012 Interoperability Workshop*, Orlando, FL.

Work, R. (2016, May 2). 2016 speech at the Atlantic Council Global Strategy Forum. Art, narrative, and the third offset. Retrieved from http://www.atlanticcouncil.org/events/webcasts/2016-global-strategy-forum.

**Formal Policy Documents Referenced**

- CJCSI 1800.01E, "Officer Professional Military Education Policy" (2015, May)
- CJCSI 1805.01B, "Enlisted Professional Military Education Policy" (2015, May)
- CJCSI 3500.01H, "Joint Training Policy" (2014, April)
- DoDD 1403.03, "The Career Lifecycle Management of the SES Leaders Within the DoD" (2007, October)
- DoDI 1400.25, v. 410, "DoD Civilian Personnel Management System" (2015, September)
- DoDI 1430.16, "Growing Civilian Leaders" (2009, November)
- *The National Military Strategy of the United States 2015* (2015, June)
- SOF: *ARSOF Operating Concept 2022* (2014, September)
- SOF: *SOF Operating Concept* (2016, February)
- USA: ADRP 6-22, *Army Leadership* (2012, August)
- USA: ADRP 7-0, *Army Training Units and Developing Leaders* (2012, August),
- USA: *Army Human Dimension Strategy 2015* (2015, May)
- USA: *Army Leader Development Strategy* (2013, June)
- USA: FM 6-22, *Army Leader Development* (2015, June)
- USA: TP 525-2-7-01, *Army Human Dimension in the Future 2015–2024* (2008, June)
- USA: TP 525-3-0, *Army Capstone Concept* (2012, December)
- USA: TP 525-3-1, *Army Operating Concept: Win in a Complex World* (2014, October)
- USA: TP 525-8-2, *Army Learning Concept for 2015* (deprecated)
- USA: TP 525-8-2, *Army Learning Concept for Training and Education for 2020–2040* (2017, April)
- USA: TP 525-8-3, *Army Training Concept 2012–2020* (deprecated)
- USAF: *America's Air Force: A Call to the Future* (2014, July)
- USAF: *Air Force Global Science and Technology Vision* (2013, June)
- USAF: *Air Force Strategic Master Plan* (2015, May)
- USAF: *Future Operating Concept: A View of the Air Force in 2035* (2015, September)
- USAF: *Global Vigilance, Global Reach, Global Power for America* (2013, August)
- USMC: *Expeditionary Force 21* (2014, March)
- USMC: *Force Development Strategic Plan* (2015, October)
- USMC: *Marine Corps Operating Concept* (2016, December)
- USMC: *Marine Corps Vision and Strategy 2025* (2008, June)
- USMC: *Marine Corps Service Strategy 2016* (2016, February)
- USMC: *TECOM Policy Letter 1-17: Establishment of the Future Learning Group* (May 10, 2017)