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Research for Future Training Modeling and Simulation Strategies

Frederick E. Hartman

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Modeling and Simulation Strategies**

Frederick E. Hartman

Executive Summary

This report documents research in training modeling and simulation to prepare for future training strategies for the Training Community enabled by modeling and simulation (M&S). The Training Community Modeling and Simulation Strategic Plan (TMSSP) will be produced in 2012 to prepare for the next 5-year planning window. The Fiscal Year (FY) 2011 research effort addresses guidance from the next-generation training strategy by focusing on three future technology-related challenges from a training perspective, which this TMSSP addresses:

- Defense Training Environment (DTE)
- Personal Learning Assistant (PLA), and
- More agile business models for training.

This report will also provide a comprehensive and in-depth look at the future of training.

Findings

- The Department of Defense (DoD) training infrastructure can do more to transform itself by training for the full spectrum of mission capabilities required for U.S forces, allies, and coalition partners.
- Challenges in the areas of information operations, cross-domain information sharing, and cyberspace and network assurance will provide increased demand to integrate M&S with live training. While we once considered the distributed live, virtual, and constructive training environments as supplements to the bulk of the Services training, we now find the need for an enhanced DTE as a critical imperative that must be undertaken at the DoD enterprise level.
- Virtual and constructive training venues must be integrated seamlessly with live training to experience the optimal future military training environments necessary to support full-spectrum operations.
- Cell phone and Internet technologies, combined with advances in the understanding of AI software applications, provide capabilities that now make a personal, augmented-reality training device more feasible.
- The DoD acquisition process remains too slow and inefficient to meet today's fast-paced training challenges, while many corporations that have been agile and adaptive in meeting user needs by product and service transformations.

- Apple and IBM provide two well-known business cases to examine as examples for wider public–private collaboration. Each company has used different but effective business models over the years.

Recommendations

- Continue in-depth research to integrate virtual and constructive training venues seamlessly with live training ranges and institutional training and education to enable the next-generation training environments.
- Expand and expedite the Virtual Worlds DoD-wide to provide enhanced training at a time of limited fiscal resources and encroachment and limitations on live training ranges.
- Continue research in human cognition to inform training in non-combat skills and provide a foundation for training to enhance agility and adaptability at all echelons of military forces.
- Leverage breakthrough AI research now incorporated in commercial cell phones and personal assistants to guide development of future PLAs for military training.
- Provide an agile business case model for training acquisitions and conduct a limited prototype with industry.
- Consider DoD-wide efficiencies in training infrastructure to provide balanced training and education venues to impart military learning content.
- Leverage the DoD M&S enterprise efforts to enhance training tools and services with wide reuse and interoperability across training domains and audiences.

As we enter an era of fiscal austerity the three major research areas addressed in this report (i.e., DTE, PLA, and More agile business models) should serve as the start point to optimize the military effectiveness and efficiency of training and education in the DoD.

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Research for Future Training Modeling & Simulation Strategies

A. Introduction

1. Purpose

This report documents research in training modeling and simulation (M&S) to prepare for the Training Community's future training strategies enabled by M&S. The Training Community Modeling and Simulation Strategic Plan (TMSSP) will be produced in 2012 to prepare for the next 5-year planning window. The Fiscal Year (FY) 2011 research effort addresses guidance from the next-generation training strategy by focusing on future technology-related challenges from a training perspective. The 2012 TMSSP will address three major challenges:

- Defense Training Environment (DTE),
- Personal Learning Assistant (PLA), and
- More agile business models for training.

It will also provide a comprehensive and in-depth look at the future of training.

Consistent with the Department of Defense (DoD) M&S Enterprise Strategy, the 2012 TMSSP will complement the DoD-wide enterprise in achieving the strategic vision and goals for DoD M&S¹ through increased collaboration with other communities. The evolving 2012 training M&S Strategic Plan will constitute a significant departure from the previous series of training M&S Business Plans. Previous business plans focused on training gaps and issues and addressed those specific training needs that can be accommodated with technology-based training tools and products. The most current plan, *Training Community Modeling and Simulation Business Plan: 2009 Edition*,² was published in April 2010. That report provided an updated baseline listing of legacy simulators, constructive simulations, live systems, and interfaces. Future TMSSP documents will focus more on innovation and high-payoff initiatives for future training research.

¹ Office of the Director, Defense Research & Engineering, M&S Steering Committee, *Strategic Vision for DoD Modeling and Simulation* (Washington, D.C.: August 24, 2007). http://www.msco.mil/files/Strategic_Vision_Goals.pdf.

² J. T. Brooks, A. W. Hughes, D. P. Sellers, C. A. Singer, P. A. Sargent, and F. E. Hartman (Project Leader), *Training Community Modeling and Simulation Business Plan: 2009 Edition* (IDA Document D-4149) (Alexandria, VA: Institute for Defense Analyses, April 2010). <http://www.dtic.mil/dtic/tr/fulltext/u2/a533812.pdf>.

2. Strategic Context

The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) is the Principal Staff Assistant and advisor to the Secretary of Defense for all matters relating to M&S. This research is funded by the USD(AT&L) through the Modeling and Simulation Steering Committee (M&S SC), consistent with the Department of Defense Directive (DoDD) 5000.59, DoD Modeling and Simulation (M&S) Management, dated August 8, 2007.³ The Office of the Assistant Secretary of Defense for Readiness/Training Readiness and Strategy (OASD(R)/TRS) serves as a member of the M&S SC and, as the leader of the training community, represents training stakeholders in the larger DoD M&S enterprise.

The operational environment in which today's U.S. forces, allies, and coalition partners operate is markedly different from the conventional warfare capabilities environment. Among the changes taking place have been increases in Joint Task Force (JTF) operations that rely on more non-conventional and irregular warfare activities by state and non-state actors, with a corresponding increase in stability, security, transition, and reconstruction activities in many locations around the globe. An added operational challenge in today's environment is applying the social science theories behind human cognition and cultural behavior research and leveraging these theories to develop new training capabilities that support the full spectrum of DoD irregular warfare efforts.

Additional technical challenges for the training community include information operations, cross-domain information sharing, cyberspace domain, and network assurance. These challenges represent just a few of the high-priority operational needs driving the increased demand for training M&S capabilities. To support our vision of a future dominated by a full spectrum of military operations and the need to train to these operations, we must now move to incorporate virtual, immersive, mixed, and augmented reality environments that connect seamlessly to live training ranges. These increased training capabilities must also focus on the training audience at the individual and small-unit levels and on the joint training exercises with large organizations and task forces. Thus, future training, consistent with emerging technologies, must employ personal learning tools that adapt to each individual's learning style and leverage artificial intelligence (AI), human cognition, and human-centered interfaces into an augmented reality learning system.

The DoD Training Community has been hampered by a DoD acquisition process that lacks the agility for developing training tools and M&S software in the rapid-response time frame needed by our operational forces. In recognition of this situation, Mr. Frank DiGiovanni, the Director of Training Readiness and Strategy (TRS) in the Office of the Deputy Assistant Secretary of Defense for Readiness (ODASD(R)), remarked that, "we have an industrial age approach

³ <http://www.dtic.mil/whs/directives/corres/pdf/500059p.pdf>.

to acquisition, and we're in an e-commerce environment.”⁴ Mr. DiGiovanni went on to say that we need to “turn the acquisition approach on its head”⁵ to reduce the long Defense acquisition process delivery times. These training issues are made even more pressing as we enter an era of national fiscal austerity, which will precipitate significant decreases in Defense resources, with the potential use of training and training infrastructures as bill payers for critical operational requirements and systems.

B. Defense Training Environment (DTE)

The concept for a DTE began to take shape during FY 11, with the capabilities, characteristics, and attributes emerging to help with development of the next-generation training environment. The training environment should include virtual, immersive, mixed, and augmented reality training that can connect seamlessly to live training ranges. Although we have made great strides over the last few years with persistent, distributed connectivity of virtual training and constructive content through the Joint National Training Capability (JNTC) network, much still has to be done to achieve our desired training capabilities through a common, integrated distributed training environment. We will meet our training goals for many current and future operations only by providing technically sophisticated and highly effective training environments that are capable of replicating social networks and using technology tools such as games to enhance the learning experience. These new training environments will have virtual simulators and constructive simulations (complete with interactive battlespace content) and will be used to stimulate and enhance live training for the full spectrum of military operations.

A paper by Colonel Benjamin C. Wash, U.S. Air Force, “The Next Training Revolution,” gives a glimpse of what the future of training may become as we embrace the immersive technologies for the future DTE. As a staff member in the Office of the Under Secretary of Defense for Personnel and Readiness/Training Readiness and Strategy (OUSD(P&R)/TRS), he was able to view firsthand his office’s role in shaping and enabling training initiatives across the Department. His paper previews how that environment might affect future training:

The DTE is training writ large. It is inclusive of all live, virtual, and constructive venues. It extends the parameters of how each of those is defined. The DTE integrates simulations, mixed-reality, live training, constructive systems, and all recombinant variants therein. Each activity is viewed as a node or island in the DTE continuum and is temporally malleable to a great extent. More importantly, the concept of the DTE is one that points to the binding of the seams between training and operations.⁶

⁴ Gannett Government Media Corporation, “M&S Acquisition Mired in Industrial Age, Says U.S. Training Readiness Chief,” *Training and Simulation Journal* (June 12, 2011).
<http://www.tsjonline.com/story.php?F=6534014>.

⁵ Ibid.

⁶ Benjamin Wash, “The Next Training Revolution,” *Armed Forces Journal* (May 2011).
<http://www.armedforcesjournal.com/2011/05/6121376>.

Colonel Wash suggests two major areas on which we must focus—both now and in the future—as we train our forces for the wide range of operational challenges: technological improvement and cognitive enhancement. We find that both areas are broad in scope, even when limited to specific training environments. From a technology perspective, Colonel Wash’s office, along with the White House Office of Science and Technology Policy (OSTP), academia, and private industry, is investing in a strategic partnership to produce a personal intelligent tutoring system. He envisions the resulting system as providing an enhanced experience for the individual in classroom and the military unit training. Another technology focus area discussed in the paper is a TRS initiative referred to as “virtual worlds.”

1. Virtual Worlds

During a keynote presentation (*Virtual Worlds in DoD*) at the Federal Consortium on Virtual Worlds (FCVW),⁷ Mr. Frank DiGiovanni, Director of TRS at ODASD(R), defined the term of virtual worlds to be more accurately a “mixed or augmented reality.” Mr. DiGiovanni explains that we must push this virtual world capability to enhance live training because of (1) limited fiscal resources, (2) the encroachment on live training ranges by environmental concerns, urban growth, the airline industry, the renewable energy industry, and frequency spectrum and bandwidth limitations, and (3) the fact that the people we are recruiting into the current force are comfortable with virtual and augmented reality worlds.

Related to this capability is the nature of warfare itself. We are moving toward a more “robotics-based” force, and the most efficient way of training this force is a virtual or augmented reality approach. Mr. DiGiovanni gave an excellent overview and made the case for the emerging DTE technologies. For instance, many of our live training ranges were built in the 1940s for weapons systems that concentrated on “putting rounds on target.” In the future, to provide training for a full spectrum of challenges from squad to large-unit JTF levels, we must augment live training with virtual environments and avatars that will play in a virtual world. The operational environments now require considerations of cyberspace, information operations, and cybersecurity that were unknown when the live ranges were built. Another key point from this presentation is the need for a more agile procurement process for training and training systems. Mr. DiGiovanni said, “We can’t wait two years for software changes,” and “we must concentrate on more user-friendly interfaces.” Future virtual world environments cannot be built within the current DoD business model. The current process is “not agile enough and costs too much,” and these factors provide disincentives for innovation. “We must break away from the early ways of doing business.” Mr. DiGiovanni also feels that trainers can embed training and learning objectives in the game environment and that these environments will become a key part of the future DTE.

⁷ See Panel: FCVW Con 2011, *Keynote*, Mr. Frank DiGiovanni. <http://www.ndu.edu/icollege/fcvw/agendaD2.html>.

An example of a virtual world framework (VWF) has recently been developed and published under contract to the Office of the Under Secretary of Defense for Personnel and Readiness OUSD (P&R):⁸

VWF is a fast, lightweight Web-based architecture for creating and distributing secure, scalable, component-based collaborative virtual spaces. It leverages existing Web-based standards, infrastructure, and emerging technologies with the intent of establishing a powerful yet simple-to-use platform that is built on top of the next generation of Web browsers.⁹

In addition, the document lists the desirable characteristic or elements of a successful virtual world system as

- Providing 24/7 training availability;
- Using the latest graphics to achieve high realism;
- Using common applications;
- Being rapidly scalable and composable by users;
- Being flexible to allow rapid modification to accommodate new operational environments;
- Being linked tightly to live training, including cognitive, social, and a range of cyber and information operations; and
- Allowing interoperable training with interagency and multinational partners.

The document also goes into considerable detail in outlining the technical landscape and architecture for future work on virtual worlds for training.

2. Full-Spectrum and Adaptability Training

Today and for the foreseeable future, our armed forces are/will be called on not only to defeat and destroy hostile armed forces, but also to deal with complex situations involving the social, economic, and political development of a geographically specific population. Current military operations are no longer just about traditional combat. They can now include a range of irregular warfare, non-kinetic warfare, and information warfare tasks involving numerous complex cultural issues. The U.S. Army, beginning with its *2008 Army Posture Statement*, acknowledges that the traditional term “full-spectrum operations” involves more than combat between armed opponents: “Army forces must defeat enemies and simultaneously shape the civil situation

⁸ DoD *Virtual World Framework, Virtual Worlds and Gaming, Current State, Future Vision, and Architecture, Draft 1.05* (Cary, NC: Lockheed Martin Corporation, July 2011).

⁹ Ibid., Executive Summary, p. 1.

through stability or civil support operations.”¹⁰ The term “cognitive readiness” addresses the human behavior and cognitive components necessary for successful individual and small-unit actions in today’s theaters of operation. Consistent with the DTE, future training must adopt a more “holistic” approach that balances topics and tools to introduce training for special and irregular warfare operations early in a military career.

Modern military operations are no different from traditional warfare. Both are cognitively and physically demanding and stressful for the individual combatant. The asymmetric threats of the 21st century, however, now require a wider spectrum of skills for U.S. armed forces—skills that include a central role for human terrain teams and a tight coupling of civilian and military organizations and activities in the given operational areas. Local civilian populations now display an increased emphasis on small-unit operations. Since the days of the Cold War, the dominant role of our military has evolved from a scenario of large-scale combat forces in opposition across the plains of Europe to many scenarios employing small units in operations around the world and relying on competencies specific to the culture, language, economics, and geographic infrastructures. These operations frequently include counterinsurgency actions that employ a wide range of non-combat skills to complement the traditional role of the military in combat. The challenge for military training is to determine what levels and types of non-combat skills our dismounted combatant forces must learn before their deployments.

DoD science and technology (S&T) efforts historically centered on human behaviors (human systems) are now approaching a level of maturity that can support the assessment of individual and group cognitive readiness for irregular warfare. The products can improve understanding of cognitive capabilities for situation awareness, social networking, problem-solving, decision-making, agility, adaptability, flexibility, creativity, and leadership. Research may also identify the cognitive attributes and competencies needed for critical thinking and agility across all levels of leadership and operations.

In parallel with the increased research about human behaviors and the cognitive aspects of military missions, operations in Iraq and Afghanistan are providing a wealth of related operational experience. The combination of lessons learned and the battlefield experience of a “battle-hardened” force will help improve future individual and small-unit training for irregular warfare operations in theater. In a recent Institute for Defense Analyses (IDA) research effort looking at irregular warfare, the study team developed a cognitive readiness framework of domain-specific competencies to translate common irregular warfare small-unit tasks into the basic human cognitive and behavioral components.¹¹ At the outset of the research effort, the study team conducted a literature search to examine the existing publications that related to both human cognitive and

¹⁰ U.S. Army, *2008 Army Posture Statement*, Addendum A, “Information Papers, Transformation, Full-Spectrum Operations” (February 2008).

¹¹ Hartman, F. et al., *Cognitive Readiness for Irregular Warfare* (Alexandria, VA: Institute for Defense Analyses, October 2010).

behavioral task elements of irregular warfare. The team soon found that reference material in both areas varied widely in scope and content. For each area, they compiled a large (over 200 publications), detailed annotated bibliography of authoritative works that provided extensive input for the IDA study report.¹² The bibliography also identifies a number of military publications that capture current operational and behavioral thinking, ranging from the theoretical and experimental to insights gained on today's battlefields. Where source materials did not include formal abstracts, the study team provided extracts to indicate the materials' relevance to the cognitive readiness for irregular warfare research. A list of pertinent DoD and Service materials are included at the end of the bibliography.

2. Military Training in Transition

As our military forces draw down from the last decade of continuous overseas deployments in the two major theaters of operations, we find more and increasingly diverse global requirements characterized by a large spectrum of traditional and irregular operational needs, all of which provide additional imperatives for training. The previous decade of high-tempo operations has subjected our equipment and our military forces to undue stress. Changing conditions will increase competition for training resources as we enter an era in which training has become even more important. The prospect of increased time at a unit's home station and the return to training for full-spectrum military operations may actually make our training issues even more complex than those in the high operational tempo (OPTEMPO) era.

During the coming periods of retrenchment and reconstitution and with the resulting wide variety of garrison postures for large numbers of our operational forces, we have a great opportunity to introduce the next generation of training. Resetting the force must also address critical-skills training. At one time, we considered the distributed live, virtual, and constructive training environments as supplements to the bulk of the Services' training. Now, we also find an enhanced DTE to be a critical DoD imperative as reduced or widely threatened live-range and maneuver areas put more pressure on training venues. The new demands on the force—from the combined threats of more and varied operational requirements, redeployment, reconstitution, fewer live training ranges, and decreasing budgets—make it increasingly important to determine how the DTE can provide the most effective ways to deliver full-spectrum live training in enhanced virtual environments.

In summary, although live, virtual, and constructive training environments were once considered as useful supplements to traditional live training, the evolving DTE is now being viewed as an imperative for our future training strategies. The DTE is currently at somewhat a less-than-optimal level of capability, but it is evolving and must continue to be improved to provide a necessary and integral part of military training. This enhanced training need arises as current

¹² Youngblut, C. et.al., *Cognitive Readiness for Irregular Warfare: Annotated Bibliography* (Alexandria, VA: Institute for Defense Analyses, May 2010).

global political and economic conditions combine to exert significant stress on our U.S. force structure in a manner that is exacerbated by the reduction in operations in the two main theaters. Our forces will face a future that is characterized by extended overseas presence in many geographically and culturally different portions of the world. In the near term, with forces expected to return to a home garrison posture, we find environmental considerations that have significantly reduced the training ranges and maneuver areas for future training. This reduction in physical facilities will limit full-feature, live training with many of today's sophisticated weapons systems. State-of-the-art immersive technologies offer an economically feasible means to maintain particular readiness skills that also take advantage of the training expected by our plugged-in soldiers, sailors, airmen, and marines.

C. Personal Learning Assistant (PLA)

The PLA concept was also discussed briefly in Colonel Wash's paper and highlighted by Mr. DiGiovanni in his Virtual Worlds conference keynote. It is envisioned as a personal augmented reality device that would blend intelligent software, cognitive content, and human-centered interfaces into an individual, host-specific, augmented learning system. The PLA would be capable of adapting to an individual's learning styles and would provide the right level of learning content to the host human at the right time in his/her professional life. In the ultimate form, the PLA would be a personalized learning system that knows everything there is to know about the host human and grows with the individual from early childhood education on.

As discussed in the previous sections, the nature of today's military operations is such that soldiers will need much more than the traditional skill set. To be prepared for the wide range of military missions, military personnel must be versatile and entrepreneurial. They must be agile and adaptable in a full spectrum of operations that encompass not only complex warfare and integrated operations, but also increased human interaction skills and cognitive human behavioral characteristics upon which they can draw in unanticipated social and cultural situations. The advantage of a PLA in tracking an individual's progress over a lifetime would be its use in identifying the necessary critical skills and cognitive behaviors that best fit given military operations. The device could refer to early training and education experiences to remind and refresh the host and could augment those experiences with additional training and education in a timely manner for the next deployment or major military operation.

The latest developments in emerging technology—including the PLA—are frequently grounded in historically tried-and-true concepts and expanded or enhanced to meet today's challenges. Beginning as early as 1945, many of the fundamental concepts that will come to fruition in the PLA were being formulated in technical papers. One such example is the memory extender (memex) concept, which was published in 1945 by President Harry Truman's Director of Scientific Research, Vannevar Bush, as a way to help individuals with their powers of recollection.¹³

¹³ Davies, Stephen, "Still Building the Memex," *Communications of the ACM* 54, no. 2 (February 2011): 80–88.

The original article, in Bush’s words, stated, “Consider a future device for individual use, which is a sort of mechanized private file and library.” He also identified some specific capabilities for the device, including the ability to “add marginal notes and comments.”¹⁴ Dr. Bush’s motivation was the realization that the human mind is imperfect and can reach data overload status. The use of simple logs, diaries, and meeting notes is one form of memory aid used by most individuals in academic (or military) settings. Although hinting at what was to come, Dr. Bush’s concepts were formed in an era of mechanization that was just beginning to build the most primitive of computing machines. Thus, the concepts of data and problems with data fusion for applications such as the PLA were being discussed 60 years ago—before we even began to envision the hierarchical and relational databases in the 1970s, and it would be 30 years later—in the Internet Age—that we are more fully able to consider the necessary formats for building the requisite automated databases and architectures for a PLA.

1. AI in Training

In the 2003 to 2008 time frame, the Defense Advanced Research Projects Agency (DARPA) sponsored a coalition of private and academic researchers who conducted much of the foundational basic AI research needed to go forward with the PLA concept. The DARPA Personalized Assistant that Learns (PAL) program focused on improving the way computers learn and thus can support humans through the use of cognitive systems. This program was targeted specifically at the technical infrastructure needed to develop a learning assistant tailored to individual needs and preferred learning methods. As opposed to the earlier section’s discussion about human cognitive readiness, this research centered more on the underpinning technology for “artificial intelligence” and a system’s ability to reason, learn from experience, and accept guidance from the host human to provide more effective, personalized assistance. This technology is critical as a foundation in building the conceptual PLA. The DARPA program was led by SRI International, with a research team augmented by Carnegie Mellon University, the University of Massachusetts, the University of Rochester, the Institute for Human and Machine Cognition (Florida), Oregon State University, the University of Southern California, and Stanford University. The team developed architectures and components. The PAL Framework Component Architecture was designed to incorporate the emerging deployment systems and to require minimal modification for use with other PAL components. PAL interacts with external training systems through five basic architectural groupings:¹⁵

- **Learning.** This module is the heart of the AI capability and is the PAL components’ group that provides the core technologies. It consists of two capabilities: learning methods to implement general-purpose machine learning algorithms and learning

¹⁴ Ibid., 80.

¹⁵ See <https://pal.sri.com/Plone/framework/framework/architecture>.

applications that embed learning methods to enable improved system performance and to personalize and adapt the system to the host over time.

- **Data management.** This module stores and processes data to support learning and reasoning.
- **Data acquisition.** This module collects data either directly (harvesting) or indirectly (using application program interface (API) linkages).
- **Controllers.** These modules provide executive features to manage interactions within and external interfaces for the PAL system.
- **User interface.** This module provides interface capabilities to interact with learning components.

Some 20 or more PAL components were developed during the project and are captured in the format of the architecture framework. The largest number of components is found in the “learning applications” category, with 12 software systems. The learning applications components range from a meeting assistant and time manager for mundane personalized calendar management to a very sophisticated application called Cognitive Assistant that Learns and Organizes (CALO) Express. CALO Express is described as a desktop assistant that uses learning technology to identify relevant information on the system and quickly assemble the data into new presentations. The five components under “learning methods” range in function from classifying individual items into groups that are preselected by the host to a clustering suite that clusters objects into groups based on three widely known clustering algorithms. The learning support category includes capabilities to record and execute events from Thunderbird (a freeware e-mail application provided by Mozilla) and Firefox (a freeware Web browser provided by Mozilla), including sending and composing e-mails with attachments and browsing. A learning support capability that has been considered to be out of date since project ended in 2008 (SideBar UI) provided a generic interface capability for learning components. A complete description of these PAL components is available online, with some available for download.¹⁶

The DARPA PAL program has been described as one of the largest AI projects in U.S. history. One of the long sought-after capabilities in AI research is putting together a personal assistant that is friendly, useful, and reliable. The DARPA research reportedly made great strides in that area with the CALO Express component, whose team set out to design a cognitive software system that could reason, learn from experience, be told what to do, explain what is being done, reflect on experience, and respond decisively to surprise. The CALO software, which learns by direct interaction and by cues from the host, can reportedly handle a range of decision-making tasks that have traditionally been resistant to automation.¹⁷ The CALO-based Siri, a

¹⁶ See <https://pal.sri.com/Plone/framework/framework/Components>.

¹⁷ See <http://ignoranceisfutile.wordpress.com/2008/10/15/darpa-backed-siri-nearing-launch-of-personal-artificial-intelligence/>.

virtual assistant technology, hit the cell phone applications market when the venture company by the same name (Siri) was purchased by Apple in the spring of 2010. Siri is now a highly sophisticated smartphone application that can take care of menial tasks for everyday users (e.g., finding restaurants, hearing reviews, and booking tables with only voice commands). In the underlying software, the application uses a Global Positioning System (GPS), speech recognition technology and AI to find the nearest restaurant or gas station, sort by type, and provide “smart” answers to any other host questions. For now, those questions may only involve finding an Italian restaurant nearby or ordering a taxi; however, when applied to military education and training, the possibilities may be endless. Siri is also advertised as being capable of asking simple questions to refine the search data and reacting to the host’s responses to provide more-specific searches.

This technology would appear to be a tremendous step forward in DoD’s quest for intelligent tutoring devices and PLAs. Future research in the quest for developing PLAs should harvest the technologies and build on the DARPA investment with the PAL Framework program team.

D. Agile Business Models for Training

For many years, the DoD procurement process has been recognized as slow, inefficient, wasteful, and not capable of producing the required products in a timely manner because of the lengthy Defense acquisition process. The USD(AT&L), Dr. Ashton B. Carter, recently addressed these issues as some of his top priorities in testimony before Congress. In defending the 2012 Budget, Dr Carter’s stated

My number one mandate from Secretary Gates when I assumed this office was to put my organization—Acquisition, Technology, and Logistics (AT&L)—on a war footing. A close second, however, was gaining control of a defense acquisition system that was too slow, too costly, and at times too careless with taxpayer’s dollars.¹⁸

Over time, the training community has recognized that rapidly changing operational requirements present training challenges that are not being met within the current acquisition process that must be followed to purchases training tools and services. This recognition gets us to the third technology-related challenge addressed in the introduction to this document. On multiple occasions, Mr. Frank DiGiovanni, Director of TRS at ODASD(R), has articulated his frustrations with the Defense acquisition process—and has used many of Dr. Carter’s own words. Most recently, and in response to an interview question published in August 2011, Mr. DiGiovanni responded to a question about the “larger challenges” he had faced since assuming his current position. The first bullet in his response—reflected the high priority of a new training business model: “Advocating for DoD to adopt an agile acquisition business model

¹⁸ Ashton Carter, *Testimony to House Appropriations Subcommittee on Defense on Department of Defense Acquisition in the Fiscal Year 2012 Budget* (Washington, D. C., April 13, 2011).

for training capabilities, particularly for software-based capabilities.”¹⁹ As we turn to industry for examples of agility, we find companies that have been forced by the marketplace to transform. Frequently, those pressures come from internal management problems, but they also come with the selection of current technologies to enable larger shares of the market. The differences between the public and private sector marketplaces are significant. Mr. DiGiovanni advocates using a prototype or trial program for the training community to find ways to adapt agile private sector initiatives to the DoD acquisition process.

The term agility, from a business perspective, was recently defined in an *MIT Sloan Management Review* article by Michael Hopkins. This article reflected an interview and review of a book by Professor of Management, Michael Cusumano:

Businesses must cultivate agility – the ability to adapt quickly to or even anticipate and lead change.²⁰

In the interview, Dr. Cusumano continued by expanding on the simple business definition of agility to indicate that agility, in its broadest forms, affects strategic thinking, operations, and technological innovation, including the ability to innovate in products, processes, and business models. He goes on to list some firms that have been agile in adapting their business models (e.g., IBM and Apple) but also mentions others that have not been so agile. While IBM has been adapting its fundamental business models successfully for more than 100 years, firms such as Control Data and Wang went from market or sector dominance to oblivion because of their unwillingness to be agile and adapt their primary business models as technology moved forward.

As stated previously, the Defense acquisition process is considered too cumbersome and too expensive, particularly for the acquisition and support of most modern training capabilities. The DoD has traditionally bought training tools and support with a business model that has evolved over the years but is still characterized as slow, fiscally wasteful, and a hindrance to innovation because it perpetuates inefficient, long-term dependencies on what are essentially contractor-proprietary simulation systems. The fundamental issue is how DoD can acquire training tools and support and do so in an agile manner that meets the varied and constantly evolving needs of the users. To meet our rapidly emerging and widely diversified training needs, DoD must break away from dated and inefficient business models that are based largely on industrial age concepts and large-scale hardware procurements.

This section provides ideas to encourage the DoD to adopt an agile business model for training and M&S software development projects that will accept more risk (from government and industry), shorten and streamline the transition to new applications (over legacy system/

¹⁹ Frank DiGiovanni, “Training Overseer, Q&A, Overseeing Military Training and Readiness,” *Military Training Technology* 16, no. 5 (August 2011): 16–18.

²⁰ Michael Cusumano, interview with Michael Hopkins, “How to Innovate When Platforms Won’t Stop Moving,” *MIT Sloan Management Review* 54, no. 4 (Summer 2011): 55–60. <http://sloanreview.mit.edu/files/saleable-pdfs/52410.pdf>.

applications), and mirror best practices in today's gaming and information business industries. Today's underlying technologies change faster than ever before, so how do companies compete to stay abreast of the market and maintain the agility and adaptability needed today? These questions are relevant to the DoD. The manner in which companies react to changes may contain insights into improving the acquisition process.

1. The Apple Business Models

Over the last several decades, a large number of articles and business case studies have been written about the U.S.-based Apple Computers (Apple, Inc). The things that make Apple so interesting to analyze are its resounding success at self-transformation as a business entity and its brilliant market transformation from a technical perspective, both of which led it back from near extinction to dominate multiple sectors of the technology market.

Apple can be used as an example of agility and adaptability in the technology marketplace from several separate innovative business models. From a business perspective, it is instructive to look at Apple the business entity from September of 1985 when it ousted its founder, Stephen Jobs, and the incidents that followed before his return in 1997. This period was not a good time for Apple as it moved from a great product company that tried to control everything and nearly went bankrupt after losing the desktop battle to Microsoft and Intel-based personal computers (PCs). Apple transformed itself, however, to become a much broader based company. Looking back, we can see the changes that Steve Jobs made on his return—changes that literally resurrected Apple through the transformation of the Apple business model. He reinstituted stronger cost controls, rationalized the multiple existing product lines, revamped the distribution system, and introduced critical new products. Although other portable audio devices existed when Apple introduced the iPod, its design and features were revolutionary and played a major role in turning around Apple's fortunes and placing it on a growth track to become the industry leader. The iPod had an additional benefit for the company in that it was no longer only a computer or software manufacturer but emerged into a diversified media company with a significantly wider market. One case study that provides these insights and examines the Apple transformative years is offered by the IBS Center for Management Research (ICMR).²¹

Apple's product philosophy is a "closed system" model, which means strict control of the user experience and also managing all support issues within the company. Controlling all the functions attaches a perceived value to the Apple brand.²² Moving from the iPod to iPhone and now to the iPad, Apple did not escape early criticism from Web bloggers. Technically savvy users identified the early iPad's lack of a camera and lack of openness as two complaints from a long list. The lesson here is that the developer (or the government sponsor for our training

²¹ ICMR, *The Transformation of Apple's Business Model* (Case Code BSTR212) (2006).

²² Pearson, Mike. *The Apple Business Model*, Presentation to the New Zealand Computer Society (NZCS) (Wellington, NZ, April 2010).

systems) sometimes loses touch with what the users want from technology. Similar to the iPad technical users, the military training community wants a training device that works reliably without artificial restrictions, offers new technology (features) as they become available, and protects them from security/cyber threats.²³ Even in private industry, users sometimes acquire new technology with applications that are bloated, slow performers with many bugs. The security issues then result in escalating security measures that inconvenience and limit the user's capability.

Getting back to the iPod however, Apple cleverly added another part of its business model following the introduction of the device. Within the Apple "closed system," it developed an "ecosystem" for the content industry—first for iTunes and now in the iPad for publishers and gamers. The iTunes Store that Apple launched in 2003 provides an excellent analogy to training users. Initially, users could purchase 200,000 iTunes items. Today, the store has over 11,000,000 songs.²⁴ From this business model, consider that Apple with its iPod and iTunes Store has fundamentally changed the music industry and the way the end users expect to buy things. iPod owners used to buy albums. They now buy individual songs, and purchasing these songs is just one easy click away with a verified credit card and billing address. Today, Apple has extended the iTunes Store to not only provide music, but also videos, ringtones, podcasts, and audio books. More importantly, it has now added generic applications (Apps) that are typically priced lower than those in regular stores. Apple, by introducing the Apps service to its user base, uses a pricing formula that allots 70% of the purchase price for the developers and 30% for Apple. The importance of this business model to Apple is that they added a business line that resulted in a major increased revenue stream with no major development or marketing costs. Think now of how the training community might work with the private sector in developing applications (training tools or services) for military training and education while conforming to published standards and meeting training objectives.

The Apple iPhone illustrates yet another unique business model. When the iPhone sales began to tail off in 2010, the company rapidly reassessed the market base and introduced a new strategy for 2011. First, they cut the price of the iPhone in half (to \$99.00) to boost sales.²⁵ The overall business strategy sees Apple focusing on strong defense of their market share with elegant product designs that simply integrate their hardware, software, and access to services. The result of this "closed system" significantly increases Apple's total market as happy users become part of the Apple family and continue to purchase more products and services.

²³ Ibid.

²⁴ Ibid.

²⁵ Small Business Plan, Opportunities, Ideas, *What is Apple Business Strategy* (blog: posted November 29, 2010). <http://smallbusiness-plan.net/apple-business-strategy/>.

In 2011, Apple's strategy is not time-to-market or significant new technology, but rather leapfrogging over competitors by using new platforms to deliver the next level user experience.²⁶ Apple launched the iPad 2 in March 2011 with a decided major advantage—it was the first company to provide the user an updated version on a tablet at a relatively low price. According to Steve Jobs, this concept is just a continuation of the Apple business model introduced in the mid-1970s. To quote Jobs, “Apple is the only company in the IT [Information Technology] industry that sells the whole widget.”²⁷

Apple's agility and adaptability continue as patterns of business that include finding multiple, compelling business models for its family of products and then adding services. Apple products and services are built on user demand but also include intensely competitive business strategies to take them forward. The challenge for future training research is how to incorporate Steve Jobs' visionary leadership of transformation into a training acquisition process through an agile, adaptive, but not too costly real business prototype.

2. The IBM Business Model

The IBM business model is considerably different from that of Apple, but IBM has survived the last 100 years by understanding how enterprises use and process data.²⁸ From the early years of building mechanical tabulators and, later, the vacuum tube computing machines, IBM continued to transform itself within the user market. It reinvented the product line from electro-mechanical tabulating machines and typewriters to mainframe computers, where it dominated for years. It then transitioned to modern workstations and later to delivering cloud computing services with open-source software products. Its venture into PCs was fraught with some of the same challenges that Apple had experienced, in that IBM lost desktop market share to Microsoft and Intel.

Although IBM's entry had legitimized PCs in the business world, it realized early on that it had lost control of the PC market, just as it had in earlier decades when it lost control of the mainframe platform business. IBM realized, however, that its business customers were using PCs in much the same way as they had used mainframes in the past (i.e., data storage and manipulation). So, IBM demonstrated its agile nature again and changed its business model to develop new capabilities in services (e.g., software, hardware, global networking, Internet services, and open-systems environments). IBM's latest reinvention is providing products and services to IT enterprises to help these companies manage their IT areas productively.²⁹

²⁶ Ibid.

²⁷ Flat World Business, *The Apple Business Model Success?!*.
<http://flatworldbusiness.wordpress.com/2011/03/07/the-apple-business-model-success/>

²⁸ Cusumano, “How to Innovate When Platforms Won't Stop Moving,” 56.

²⁹ Cusumano, 59.

In a recent (August 28, 2011) *Forbes* magazine article, the header reads, “IBM Thumps Oracle and Ties HP in Servers.”³⁰ This article refutes the “word on the street” that IBM’s hardware business is going away, as Big Blue pulled into a first place tie with Hewlett-Packard for world leadership in servers sales (for the second quarter of 2011). These sales reflect a 24.5% growth in a down economy and are viewed as a truly transformational event—another success in the long history of IBM market successes. The article goes on to quote an IBM Senior VP, Rod Adkins, regarding its surging successes in 2011:

IBM has rolled out new and upgraded systems throughout its portfolio, from Power Systems to System x servers, and most recently, in its mainframes, with the July rollout of the zEnterprise 114, a mid-level offering in its breakthrough zEnterprise System mainframe portfolio, which first launched a year ago.³¹

The article suggests that IBM is pulling ahead of its hardware competitors with a clear business strategy and clear focus on its customers. Bob Evans concludes the article with the following:

So while it is indisputably true that IBM’s software and services business have overtaken hardware as the company’s chief source of growth and competitive advantage, IBM’s systems business under Adkins has demonstrated that IBM will continue to be a match for enterprise-hardware vendors in the world.³²

Even though IBM is over 100 years old, adaptability and market agility are still the keys to its success.

3. Public–Private Business Collaboration

What one finds in the private sector business model that is missing in the public sector (that controls the Defense acquisition process) are profit incentive, competition, and the ability to fail or simply go out of business. Just as the examination of Apple and IBM found that they made the necessary transformations and adopted new business models, the marketplace graveyard is full of companies that failed to make the necessary transitions. According to the Michael Hopkins journal article, about 75% of the software products companies that existed in 1998 have disappeared.³³

Early DoD efforts aimed at improving acquisition have not been successful in transforming what is still an overly bureaucratic process. However, the intent has been consistent with that of the current USD(AT&L) goals as expressed to Congress earlier this year. One enduring AT&L goal in recent years has been to make the acquisition process more efficient and more effective at

³⁰ Bob Evans, “IBM Thumps Oracle and Ties HP in Servers,” *Forbes* (August 28, 2011).
<http://www.forbes.com/sites/sap/2011/08/28/ibm-thumps-oracle-and-ties-hp-in-servers/>.

³¹ Ibid.

³² Ibid.

³³ Cusumano, 57.

providing the warfighting capabilities in a timely manner. The AT&L vision some 10 or more years ago foresaw an acquisition process in which DoD and industry partners are enabled by the robust, collaborative use of simulation technology integrated across all acquisition phases and programs, with the express purpose of

- Reducing time, resources, and risks associated with the entire acquisition process;
- Increasing the quality, military worth, and supportability of fielded systems;
- Reducing total ownership costs throughout the system life cycle; and
- Enabling integrated product and process development across the entire acquisition life cycle.

The problem in the public sector seems to be its inability to follow through on key transformational goals to achieve lasting change.

Prescriptions for a more agile and competitive business model include the privatization of training support/development of training tools—with competitive market forces driving the development of technologies to reduce the cost of training. One can compare this approach to the Apple services business model described earlier. In this concept, a private sector training service provider (TSP) would set up training events (or even blocks of classroom instruction) and conduct training on a fixed-price, fee-for-service basis. The TSP would be required on a regular basis to provide metrics on the performance of training tools and the training audiences to initiate performance action (either bonuses or penalties) on the contract. For this model to work, the government training users would establish the need for training based on operational requirements, would gather outcome metrics on the performance of training tools and training services for meeting the training objectives, and would pay the TSP for training hours delivered, plus any license or user fees for the tools. Government training users would also be required to ensure that the training tools available for a given event comply with requirements for common architectures and standards as a means of enforcing reuse and interoperability across training and Service boundaries. If the TSP provides ineffective or negative training, the government would terminate the TSP contract.

The underlying rationale for separating training tools and services providers is

- To eliminate the counterproductive business relationships that exist in most current business models
- To create an incentive for collaboration between TSPs and tool builders (to include models and games) to provide the best and most effective training at the most efficient cost (i.e., best value for the government).

Multiple TSPs are likely to compete for training courses or events. This competition should provide costing choices for government user and strong incentives for the TSP's proposal to meet or exceed expectations.

Another public–private business model from which we can learn was developed in Australia and the United Kingdom and has been in use in those countries to encourage “public–private partnerships (PPPs).” The resulting contractual arrangement forms the PPP to provide equipment or services or both. The use of the Private Finance Initiative (PFI) as a form of PPP was first introduced in 1992 in the United Kingdom. The aim was to achieve closer partnerships between the public and private sectors and increase accountability and efficiency, as compared to the more traditional public sector models.³⁴

The PPP, by loose definition, is considered to be any joint venture between a public body and a private company, generally with the intent of improving the efficiency of public services. The PFI, which involves private sector funding, is employed to deliver projects that have been traditionally provided by the public or private sectors separately. The PFI, as used in the United Kingdom, normally involves the private sector firm owning and operating, while the responsible public (government) entity has a larger role in regulation. In the most common forms, the PFI private sector business entity designs, builds, finances, operates, and maintains products or facilities based on specifications and funding by the public sector sponsor in a risk- and cost-sharing arrangement. Variants of this model have now been adopted by other governments and international business bodies such as the World Trade Organization (WTO), the International Monetary Fund (IMF), and the World Bank.

This form of public–private sector collaboration is sometimes likened to the decision an individual must make when he/she decides to buy or lease an automobile. Although the underlying framework of how PFIs are employed today remains focused on the best value for the end user (with appropriate allocation of risk), they rarely end up that way. What we learn from this example is that any prototype formed as a more agile model for training must find ways to break out of the bureaucratic model followed by the public sector and implemented in the Defense acquisition process.

4. Training in an Era of Fiscal Austerity

At a time when our U.S. national economy is experiencing fiscal challenges that will ultimately result in reducing DoD budgets, our military forces are facing threats that require increased adaptability, resiliency, and critical thinking. Past history shows that one source of funds to pay for DoD shortfalls has been to reduce the quality and quantity of training and training infrastructure. A 1996 Government Accountability Office (GAO) report, *DoD Training, Opportunities Exist To Reduce the Training Infrastructure*, observed that one source of funds to pay for DoD’s acceleration of modernization efforts was to reduce training infrastructure. The report goes on to address DoD’s efforts to reduce formal training infrastructure as part of the

³⁴ E. Roy, *The Private Finance Initiative & Public Private Partnerships*, National Assembly of Wales, Member’s Research Service (Paper number 08/005) (Cardiff, Wales, January 2008). <http://www.assemblywales.org/08-005.pdf>.

total infrastructure consolidation effort.³⁵ The GAO's report underscores the fact that the DoD has leveraged training and training infrastructure as bill payers to meet increased costs in systems acquisition, modernization, and operating and maintenance costs. The coming period of budget reductions is especially threatening to joint training since these cuts come during a transitional/transformational period in which our military forces face new and rapidly changing global threats and home-station basing changes. Training needs and assessments are typically driven by the latest National and Defense guidance, such as the National Security Strategy, Quadrennial Defense Review (QDR), and various military doctrinal publications. Unfortunately, for the foreseeable future, training may be driven by budgetary as opposed to operational requirements. For the fiscal trade space, the DoD defines training infrastructure to include billeting, mess facilities, classrooms, equipment, software packages, and instructors used to provide, facilitate, or support training of the military forces. As discussed previously, the training community must respond to current and future fiscal realities. We can expect many if not all of the following to occur in the next few years:

- Military Services forced to retrench and reset following drawdowns of forces in the Iraqi and Afghanistan operations,
- Training costs that compete with recapitalization of equipment after the increased OPTEMPO of the past decade,
- Increased global requirements for diverse military operations, and
- Competition from infrastructure and social programs.

The DoD can be expected to receive less funding at a time when equipment readiness, personnel, and training costs require increased investments. To maintain the operational edge and the readiness levels that our national security demands, we should undertake actions now to reform and reengineer military training and education, to include the training infrastructure. This call goes back once again to the argument that military training must learn to do more with less and that the increased capabilities that could be harvested from the technologies incorporated in the DTE provide a means to that end.

One can look back to the 1990s as addressed in the 1996 GAO report to find how the Services responded at that time. With the drawdown in resources following Desert Shield/Desert Storm, the cost metric used for training was tied to overall end strength. If the Army and Marine Corps face end-strength reductions during the next decade, the military training funds can be expected to fall proportionally (based only on the traditional factors used in the operations and maintenance accounts). In the decade of the 1990s, the Services responded to reduced funding by cutting down on the number of training locations and frequency of specific training courses, increasing inter-Service training for similar course content, and closing or realigning training bases, ranges, and facilities.

³⁵ <http://www.gao.gov/archive/1996/ns96093.pdf>.

Resetting our forces must address the critical training and equipment readiness issues. As has been true over history, real opportunity is often born of hardship and necessity. Training should lead the way to “... make our Army [future forces] smarter, better, and more capable with the resources we are given so that we provide the Nation with the greatest number of options for an uncertain future.”³⁶ These words came from the Army Chief of Staff, General Martin Dempsey, as he took command in April 2011. They constitute a challenge to training in that the potential energy found in force structure and advanced fighting strategies and equipment is only brought to full capability through a series of robust training programs. As addressed earlier, military training and education has a definable infrastructure and is managed by the Services training commands. We believe this area offers the most likely bounty for increasing future DoD effectiveness as we find fiscal efficiencies.

E. Training M&S in the Wider DoD M&S Enterprise

The Director of TRS serves as the senior DoD training member on the M&S SC. This affords the training community access to enterprise-wide M&S initiatives that should result in cost efficiencies when the capabilities are integrated and reused in training our forces. In the draft DoD M&S Enterprise Strategy, “the DoD M&S enterprise is the portion of the [greater] DoD enterprise enabled by M&S.” The DoD M&S Enterprise extends to include non-DoD organizations (i.e., other federal agencies, industry, academia, and international partners). This strategy provides for the development of policies and standards, technical frameworks, and common services and tools that encourage and enable M&S enterprise functionality, interoperability, and reuse. It supports the operational needs and guides investments of the DoD components and communities enabled by M&S, without intruding on their individual missions and Title 10 responsibilities. The M&S enterprise approach identifies component and community capabilities that have value across the M&S enterprise. This identification of capabilities should facilitate a better use of resources, increasing both the capabilities and efficiencies in M&S use. The training community leads other M&S communities in the degree of use and reuse of distributed simulations, tools, and data—capabilities that can be shared on a DoD-enterprise basis. During the last 5 years, the M&S SC has funded a series of products to increase understanding of simulation architectures and data visibility, to name but two important areas. The M&S SC strategy focuses on tools, data, and enterprise services to achieve the strategic vision and goals for DoD M&S.³⁷

³⁶ General Martin Dempsey, Chief of Staff, U.S. Army, *Memorandum for the United States Army: Thoughts on Crossing the Line of Departure*, Department of the Army (4 April 2011).

³⁷ M&S Steering Committee, *Strategic Vision for DoD Modeling and Simulation* (Washington, DC: August 24, 2007). http://www.msco.mil/files/Strategic_Vision_Goals.pdf.

F. Findings and Recommendations

The evolving 2012 TMSSP should provide a wider look at the future of training. However, this interim research effort bridges the span between the last in the series of detailed Training M&S Business Plans and provides a more in-depth look at several of the larger issues facing the future of training modeling and simulation. The 2012 Plan should also illuminate DoD corporate and crosscutting issues that are being addressed by the training community's M&S efforts.

Future investments in training tools and support will provide capabilities to support full-spectrum combat operations and global capabilities—with training and education provided anytime, anywhere—for a wide range of military operators. These investments should, where possible, leverage existing Services and agencies' capabilities, with a goal of optimizing reuse and reducing unnecessary redundancy through live, virtual, and constructive simulation interoperability.

1. Findings

- The DoD training infrastructure can do more to transform itself by training for the full spectrum of mission capabilities required for U.S. forces, allies, and coalition partners.
- Challenges in the areas of information operations, cross-domain information sharing, and cyberspace and network assurance will provide increased demand to integrate M&S with live training. While we once considered the distributed live, virtual, and constructive training environments as supplements to the bulk of the Services training, we now find the need for an enhanced DTE as a critical imperative that must be undertaken at the DoD enterprise level.
- Virtual and constructive training venues must be integrated seamlessly with live training to experience the optimal future military training environments necessary to support full-spectrum operations.
- Cell phone and Internet technologies, combined with advances in the understanding of AI software applications, provide capabilities that now make a personal, augmented reality training device more feasible.
- The DoD acquisition process remains too slow and inefficient to meet today's fast-paced training challenges, while many corporations that have been agile and adaptive in meeting user needs by product and service transformations.
- Apple and IBM provide two well-known business cases to examine as examples for wider public-private collaboration. Each company has used different but effective business models over the years.

2. Recommendations

- Continue in-depth research to integrate virtual and constructive training venues seamlessly with live training ranges and institutional training and education to enable the next-generation training environments.
- Expand and expedite the Virtual Worlds DoD-wide to provide enhanced training at a time of limited fiscal resources and encroachment and limitations on live training ranges.
- Continue research in human cognition to inform training in non-combat skills and provide a foundation for training to enhance agility and adaptability at all echelons of military forces.
- Leverage breakthrough AI research now incorporated in commercial cell phones and personal assistants to guide development of future PLAs for military training.
- Provide an agile business case model for training acquisitions and conduct a limited prototype with industry.
- Consider DoD-wide efficiencies in training infrastructure to provide balanced training and education venues to impart military learning content.
- Leverage the DoD M&S enterprise efforts to enhance training tools and services with wide reuse and interoperability across training domains and audiences.

As we enter an era of fiscal austerity the three major research areas addressed in this report (i.e., DTE, PLA, and More agile business models) should serve as the start point to optimize the military effectiveness and efficiency of training and education in the DoD.

Abbreviations

ACM	Association for Computing Machinery
AI	artificial intelligence
API	application program interface
CALO	Cognitive Assistant that Learns and Organizes
DARPA	Defense Advanced Research Projects Agency
DoD	Department of Defense
DoDD	Department of Defense Directive
DTE	Defense Training Environment
FCVW	Federal Consortium for Virtual Worlds
FY	Fiscal Year
GAO	Government Accountability Office
GPS	Global Positioning System
ICMR	IBS Center for Management Research
IDA	Institute for Defense Analyses
IMF	International Monetary Fund
IT	Information Technology
JNTC	Joint National Training Capability
JTF	Joint Task Force
M&S SC	M&S Steering Committee
M&S	modeling and simulation
MIT	Massachusetts Institute of Technology
NZCS	New Zealand Computer Society
OASD(R)/TRS	Office of the Assistant Secretary of Defense for Readiness/Training Readiness and Strategy
ODASD(R)	Office of the Deputy Assistant Secretary of Defense for Readiness
OPTEMPO	operational tempo
OSTP	Office of Science and Technology Policy
OUSD(P&R)	Office of the Under Secretary of Defense for Personnel and Readiness
OUSD(P&R)/TRS	Office of the Under Secretary of Defense for Personnel and Readiness/Training Readiness and Strategy
PAL	Personalized Assistant that Learns
PC	personal computer
PFI	Private Finance Initiative (
PLA	Personal Learning Assistant
PPP	public–private partnership
QDR	Quadrennial Defense Review
S&T	science and technology

TMSSP	Training Community Modeling and Simulation Strategic Plan
TRS	Training Readiness and Strategy
TSP	training service provider
U.S.	United States
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics
VWF	virtual world framework
WTO	World Trade Organization

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