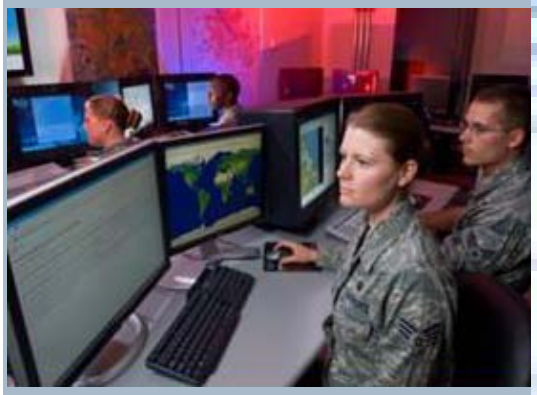
Foreign Policy
at BROOKINGS



Be Quick, Be Useable, Be On Time

Lessons in Agile Delivery of Defense Analytic Tools

Colonel Lourdes M. Duvall,
United States Air Force
FEDERAL EXECUTIVE FELLOW

21st CENTURY
DEFENSE INITIATIVE
POLICY PAPER
6 June 2012

Foreign Policy
at BROOKINGS

CONTENTS

Page

ILLUSTRATIONS

Page

EXECUTIVE SUMMARY

When faced with urgent national security needs, the Department of Defense (DoD) has historically bypassed conventional processes and allowed a greater degree of agility to flourish for critical programs. Over the past decade of combat operations, this again has held true. For all the criticism of defense acquisition, there have been examples of extremely successful efforts that quickly delivered new capabilities responsive to urgent warfighter needs.

These efforts were characterized by an intense focus on the user, a commitment to rapid delivery, and an acceptance of an incremental approach to improving capabilities. Instead of seeking the ideal solution, programs adopted a continuous cycle of deliver, learn, adapt, and improve.

As our active war fighting commitments draw down, and budgets tighten, we risk losing important lessons. The urgency behind these agile efforts will decline at the very time when we may need them most. The importance of agile practices for the Department is growing. These practices need to expand beyond urgent combat needs to be the norm for more mission capabilities, including analytic tools.

Four key factors are driving this need for increased agility. They include: the rate and unpredictability of advances in technology; the difficulty specifying requirements early in a program; the wide range of future potential conflicts and adversaries; and the rapid expansion of data sources and data volumes. Taken in concert, these factors call for alternative approaches for how systems, specifically those heavily dependent on information technology, are developed and acquired.

There are significant differences between agile and conventional processes that pose challenges to more widespread adoption of agile methods. Historical cases, contemporary experience, and commercial lessons can inform DoD efforts to scale up existing agile pockets to institutional processes. To be successful, efforts need to be coordinated across functional and process boundaries and cannot be left to the acquisition community alone, or instituted in isolation.

This analysis identified three critical pre-conditions that need greater attention in the ongoing discussions on transitioning to more agile methods in DoD. First, recognize the central role of user collaboration throughout development. Second, create mechanisms to easily bring together multifunctional teams to fuel the cycle of deliver, learn, adapt, and improve. Finally, foster a culture characterized by agility as a routine, vice requiring senior leader intervention to break down barriers, through

consistency in what is stated as important and valued, such as agility and adaptability, with what is measured and incentivized.

Fortunately, there is contemporary experience within defense organizations with agile methods. There are successful practitioners with years of experience that can seed expansion of these practices. Areas such as intelligence analysis and cyber require this agility now. Continuing to view these practices as exceptions limited to urgent national security needs is ill advised.

CHAPTER ONE
Introduction

"… Why was it necessary to bypass existing institutions and procedures to get the capabilities needed to protect U.S. troops and fight ongoing wars?"[1] -- Robert Gates, Secretary of Defense, February 2009

A culture of agility flourished in pockets across the Department of Defense (DoD) over the past decade. The warfighter engaged in combat demanded it. Leadership responded to the imperatives of contingency operations with a focus on rapid delivery of capabilities to answer new and difficult problems. Cross-functional teams were formed. Many provided game-changing capabilities, including advanced intelligence analytical tools. Their efforts fueled a pace and precision of operations unseen in prior conflicts.

Success in some cases came from significant technology innovations. But more than that, these pockets of agility functioned under organizational constructs and cultures that affected *how* systems were developed and fielded. It influenced how users, software engineers and system developers interacted. It also shaped how testing, accreditation, and training were integrated.

Agile efforts are characterized by an intense focus on the user, a commitment to rapid delivery, and an acceptance of an incremental approach to improving capabilities. Instead of seeking the ideal solution, programs adopt a continuous cycle of deliver, learn, adapt, and improve.

The urgency behind these agile efforts may soon decrease. The primary driver behind the current focus has been troops in harm's way. As the number of troops in combat decline, leadership attention and emphasis on speed and usability may also decline. There is irony in this timing. While DoD is attempting to develop more agile processes, its efforts are still a work in progress.[2] Facing significant spending cuts over the next decade, the appetite for making necessary changes to longstanding organizations is also uncertain.

We risk losing valuable lessons at a time when the importance of being agile is growing. Agile approaches are better suited to keep pace with unpredictable advances in technology, dynamic adversaries and mission requirements, and expanded data sources. This alternative to the standard DoD system development model is needed for the delivery of next-generation analytic tools and other critical defense capabilities.

The purpose of this paper is to examine common characteristics evident in efforts noted for their agile approach and propose organizing concepts and principles required to scale best practices to more DoD programs. This paper focuses on a subset of capabilities - intelligence analytic tools used by the military services - as an instructive example of capabilities requiring adaptive, iterative, and constant development. It predominantly emphasizes areas that must be addressed by leaders outside of traditional acquisition functions. These include broader issues of organizational commitment, construct and culture.

Contemporary, agile experiences within the DoD, paired with historical examples and commercial experience, can serve as a foundation for thinking about how to expand agile practices. This analysis points to three institutional adaptations required to scale these efforts. They are necessary conditions for success.

- Insist upon user collaboration throughout development;
- Create and invest in cross-functional organizations;
- Measure and incentivize what is most valued.

While these recommendations may seem intuitive, there are significant organizational and cultural challenges within DoD for each. Most contemporary literature focuses on required acquisition process changes to foster more agile approaches. This study expands beyond acquisition organizations to broader institutional changes that are required for widespread adoption of agile practices.

The first section introduces and provides a comparison of "conventional" development and acquisition processes with "agile" principles, particularly as they relate to information technology systems. This is followed by a discussion of the converging forces that are driving the need to expand agile principles to more mission areas. Three contemporary DoD cases of agile efforts are then analyzed to present lessons. From this evaluation, the key institutional adaptations required to up-scale agile practices are identified.

Notes

[1] Robert M. Gates, "A Balanced Strategy: Reprogramming the Pentagon for a New Age," *Foreign Affairs*, 88(1), January/February 2009, 28-40. ProQuest Research Library. Accessed January 12, 2012: 35.

[2] Ronald W. Pontius, Director Command and Control, OUSD (Acquisition, Technology, and Logistics), "Acquisition of Information Technology: Improving Efficiency and Effectiveness in Information Technology Acquisitions in the Department of Defense," Given at the Association for Enterprise Information, Agile in Defense Conference, March 21, 2012. http://www.afei.org/events/2A01/ Documents/ Pontius_Ron_IT% 20Acquisition %20Brief%20(17).pdf. Accessed April 10, 2012: 6, 7, 9.

CHAPTER TWO
Not One Size Fits All

"… (IT) programs designed to deliver initial functionality after several years of planning are inevitably doomed."[1] -- Vivek Kundra, United States Chief Information Officer, December 2010

The "conventional" Defense Department decision support systems (to include requirements, acquisition, and resource allocation processes) predominantly used to acquire defense capabilities were created and optimized for large-scale weapon system development (e.g. airplanes, ships, and tanks). It is a very deliberate process grounded in analysis of national security needs. It seeks to ensure that delivered capabilities satisfy specific and well defined military requirements, are of high quality, meet stringent test and evaluation criteria, and are acquired and sustained at a reasonable cost.

The relationship between the requirements generation (i.e. user needs) and the acquisition system is principally serial. There are hand-offs from the warfighter requirements to the acquisition system at various stages in the process. Validated capability needs, in the form of requirements and performance criteria, inform each major acquisition decision point.[2]

The stages of the acquisition system itself are also predominantly serial.[3] The Department and the Services have developed functional organizations over time that serve as "process owners" for the various stages, such as requirement generation, research and development, acquisition, and testing. Each function has its own well defined processes and inject points, largely based on their role in large weapon system development.

Overlaying this "conventional" process to software development drives an institutional preference for well defined and documented requirements up front, followed by a long development phase that culminates in testing of the entire system. This is often referred to as "waterfall" development.

Most large information technology (IT) system development within DoD has followed this sequential process. As described by the 2009 Defense Science Board Task Force on DoD Policies and Procedures for the Acquisition of Information Technology: "Today's "big bang" approach used in the acquisition of IT begins with an analysis

phase followed by an equally long development phase that culminates in a single test and evaluation event."[4]

To illustrate how long this process can take, the same report cites a study conducted by the Office of the Assistant Secretary of Defense for Networks and Information Integration (OASD (NII)) that analyzed 32 major automated information system acquisitions. The average time to deliver initial program capability was over seven years.[5] These figures do not include the programs that, after years of analysis and development activity, were cancelled entirely.

Unfortunately, many military personnel have experienced the operational impact of a failed or significantly delayed critical IT program using the waterfall process. Creative workarounds or homegrown IT alternatives are often developed without sufficient resources, sustainment tails, or linkages to an overarching system architecture concept. The mission need persists when the program does not deliver as planned.

Alternatives to the "waterfall" approach for software development are referred to in a variety of terms, such as iterative and incremental development (IID) and agile.[6] Key characteristics of these approaches include: well defined objectives without overly specified requirements; early and continual involvement of the user; multiple, quickly executed releases of useable capability; and work organized around collaborative multifunctional teams.[7] An oft cited summary of the principles of agile development are found in a statement known as the Agile Manifesto. It was issued in 2001 by practitioners of alternatives to documentation- and process-driven software development.

Manifesto for Agile Software Development

We are uncovering better ways of developing
software by doing it and helping others do it.
Through this work we have come to value:

Individuals and interactions *over processes and tools*
Working software *over comprehensive documentation*
Customer collaboration *over contract negotiation*
Responding to change *over following a plan*

That is, while there is value in the items on
the right, we value the items on the left more.

Figure 1. The Agile Manifesto[8]

While there are a variety of Agile practices (such as Scrum, Extreme Programming, and Unified Process), these practices share key values from the Agile Manifesto. These values include collaboration, user interaction, frequent (time-boxed) iterations, working software and flexible requirements.[9]

In a military environment, the concept of risk also is arguably different with agile approaches. Instead of framing risk predominantly within functional boundaries (e.g. security, mission assurance), a broader prism of risk explicitly attempts to capture war fighting risk. When asked to give advice to acquisition professionals, then US CENTCOM commander General Petraeus stated: "…never, ever underestimate how important speed is...."[10] His statement implied a greater linkage between the risks born by the end user left without a capability to the risks accepted by stakeholders that pace capability delivery by their actions or inactions.

Beyond software development, the agile values of collaboration, user interaction, and working prototypes are very similar to those used to characterize defense rapid acquisition efforts. These typically respond to warfighters' operational needs that could not be accommodated through traditional DoD processes.[11] Of late, they have ranged from the rapid fielding of counter improvised explosive device technologies, mine resistant ambush protected vehicles (MRAPs), and intelligence, surveillance and reconnaissance platforms. These success stories have all involved agile processes. They have required exceptions to normal bureaucratic processes and broadened risk calculations.[12] A summary of the primary distinctions between conventional DoD acquisition processes and agile processes is provided in Figure 2 below.

DoD processes and functional organizations are more closely aligned to support high-end, serial, waterfall development processes. Waterfall methods are often cited as preferable for systems requiring high reliability, assurance, and strict requirements control. Defense programs, in varying degrees, face constraints that most commercial enterprises do not in areas such as system security, acquisition security, mission assurance, and legislative oversight. Conventional defense processes have been optimized to deal with the extremes of these constraints.

All functional organizations with equity in the program get a chance at their stage in the process to review the program. With significant documentation and a plan that defines deliverables, cost and schedule, this method appears more appealing to the funding organization and other stakeholders that want to see up front what will be delivered for the investment. In reality, significant planning up front is not ideal for all types of systems. Problems with initial estimates of cost and schedule occur when unexpected, but not necessarily unpredictable, variables come into play.[13]

To better accommodate variability and the unexpected, agile methods may be preferred. While functional areas within DoD are working to better support agile

development efforts, there is not a well established end-to-end process to guide these programs. As a result, agile efforts have been known to bypass existing organizations and processes. Fundamental differences exist on a variety of levels such as workflow, the relationships between users, developers and acquirers, the level and frequency of collaboration needed across functional boundaries, value judgments regarding documentation and pacing of delivery, and risk acceptance.

Acquisition Practice	Conventional DoD Process Characteristic	Agile Process Characteristic
Requirement Definition	Extensive requirements definition, documentation, and approval process	Defined and approved at top-level mission capability/ objective level
User input	User documents requirements; Acquisition organization serves as proxy during development; User provides operational evaluation of completed system	Early, direct and continuous; Specific requirements developed through iterative interactions with user
Scope	Large, bundled capability delivery	Small, frequent, incremental deliveries aggregated into comprehensive capability
Release Schedule	Typically years	Increments delivered in weeks/months
Testing	Serial approach; culminating events	Integrated testing function; test early and often; test-driven development
Documentation	Heavy reliance	As simple as possible
Oversight	Well defined	Less defined, requires flexibility
Risk	Emphasis on process risk; executing process correctly	Increased weight on risk to end user left without capability of value

Sources: National Research Council, Carnegie Mellon Software Engineering Institute[14]

Figure 2. Comparison of Conventional and Agile Processes

While not the predominant acquisition practice, there is a long history of agile approaches within DoD.[15] Not unexpectedly, many past efforts noted for their use of agile principles were undertaken in response to urgent national security needs. For example, the P-80, America's first jet fighter, and SR-71, the first reconnaissance aircraft to travel at three times the speed of sound, were built using many principles that can be characterized as agile. These revolutionary aircraft developed by Lockheed Martin

"Skunk Works" were built in response to Cold War threats.[16] Skunk Works was led for decades by Clarence "Kelly" Johnson, whose motto was "Be quick, be quiet, be on time."[17] He formalized rules of operations that valued great flexibility for making changes, early testing of prototypes to learn from experience, and close cooperation on a day-to-day basis between the user and contractors.[18] His rules emphasized usability and on-time delivery.[19] He was also known for challenging bureaucratic obstacles and going straight to decision makers with the ability to say "yes" when process owners laid out barriers.[20]

There are many other examples from the 1970s through the present that point to a foundation of agile and adaptable values within the defense establishment. Oft cited examples include: the command and control system for the first U.S. Trident submarine developed by IBM's Federal Systems Division (FSD), which used time-boxed iterations and feedback driven development; the Navy Acoustics Rapid COTS Insertion program, whose open architecture delivered capability iterations through numerous extensively tested technology insertions; and the Advanced Medium- Range Air-to-Air Missile (AMRAAM) program, cited for extensive user involvement in development and upgrades.[21]

Another instructive case is Global Combat Support System-Joint (GCSS-J), the Defense example highlighted in the 2011 Government Accountability Office report examining critical factors for successful IT acquisitions.[22] GCSS-J, a system that supports military logistics operations, adopted agile methodologies after experiencing unsatisfactory delivery cycles of 18 months.[23] This rate of development was not meeting warfighting combatant command needs. The GCSS-J team used Central Command's (CENTCOM's) top logistics requirement as a pilot focus for its initial agile effort.[24] They reduced delivery cycles to six months by time-boxing releases, locking-in requirements incrementally, and ensuring all stakeholders were more involved.[25]

Alternatives to "conventional" development and acquisition processes have a long history of existing alongside conventional processes within DoD. They share common themes of urgency to deliver, feedback driven and iterative development, high-user involvement, and early testing. They have existed at the margins, often using ad hoc processes.[26] As a whole, however, agile processes do not have a Defense-wide institutional foundation across all decision support systems.

Clearly, the conventional Defense Department decision support systems may remain the best fit for some system development. It has provided the nation with the most technologically advanced, full-spectrum, armed forces in the world. Agile approaches are not advisable for all programs. There are significant, and legitimate, tensions between speed of delivery and no-fault testing and security accreditation processes. There are also tensions between detailed specifications and tailored usability. However, as the next chapter argues, the balance between systems requiring

the conventional approach, and those that would be better suited with an agile approach is shifting toward a need for more agile approaches. Creating the supporting institutional foundation through new processes, organizational constructs and culture, will be required to complete this shift.

Notes

[1] Vivek Kundra, "25 Point Implementation Plan to Reform Federal Information Technology Management," The White House, Washington DC: December 9, 2010. http://www.cio.gov/documents/25-Point-Implementation-Plan-to-Reform-Federal%20IT.pdf. Accessed October 7, 2011: 11.

[2] Defense Acquisition University, "Defense Acquisition Guidebook," January 10, 2012. https://acc.dau.mil/adl/en US/350719/file/49150/DAG_01-10-2012.pdf. Accessed January 18,2012: 13.

[3] Defense Acquisition University, "Defense Acquisition Guidebook," https://dap.dau.mil/aphome/das/ Pages/Default.aspx. Accessed January 18, 2012. Additional information on the interaction of these processes can be found in CJCSI 3170.01H Joint Capabilities Integration and Development System, January 10, 2012, https://acc.dau.mil/adl/en-US/267681/file/62221/CJCSI%203170%2001H%20-%2010%20January%202012.pdf; and Department of Defense Instruction 5000.02 Operation of the Defense Acquisition System, December 8, 2008, http://www.dtic.mil/whs/directives/corres/pdf/500002p.pdf.

[4] Defense Science Board, "Report of the Defense Science Board Task Force on Department of Defense Policies and Procedures for the Acquisition of Information," Washington DC: March 2009. http://www.acq.osd.mil/dsb/reports/ADA498375.pdf. Accessed March 5, 2012: 36.

[5] Ibid.

[6] Craig Larman and Victor R. Basil, "Iterative and Incremental Development: A brief history," IEEE Computer, June 2003: 46-56, and Mary Ann Lapham, et al, "Agile Methods: Selected DoD Management and Acquisition Concerns," Carnegie Mellon, Software Engineering Institute, October 2011, Technical Note CMU/SEI-2011-TN-002. http://www.sei.cmu.edu/library/reportspapers.cfm. Accessed February 27, 2012: 1.

[7] National Research Council, "Achieving Effective Acquisition of Information Technology in the Department of Defense," The National Academies Press, Washington DC: 2010. http://www.nap.edu/catalog.php? record_id =12823. Accessed December 1, 2011: 50-51 and Craig Larman, "Agile and Iterative Development: A Manger's Guide," Addison-Wesley, Boston: 2004: 9-39.

[8] Kent Beck, et al, "Manifesto for Agile Software Development," http://www.agilemanifesto.org/. Accessed October 3, 2011.

[9] Craig Larman and Victor R. Basil, "Iterative and Incremental Development: A brief history." IEEE Computer, June 2003: 46-56.

[10] David H. Petraeus, "Adaptive, Responsive, and Speedy Acquisitions," *Defense AT&L*: January-February 2010: 5.

[11] Defense Science Board, "2010 Summer Study: Enhancing Adaptability of US Military Forces," Washington, DC: January 2011. http://www.acq.osd.mil/dsb/reports/ADA536755.pdf. Accessed November 29, 2011: vii.

[12] Gates, 35.

[13] Tobin Lehman and Akhilesh Sharma, "Software Development as a Service: Agile Experiences," 2001Annual SRII Global Conference, IEEE computer society: 751.

[14] National Research Council: ix, 6, 9, 10 and Lapham 2011: 67, 68.

[15] Rex B. Reagan and David F. Rico, "Lean and Agile Acquisition and Systems Engineering, A Paradigm Whose Time Has Come," *Defense AT&L*, Defense Acquisition University, Nov-Dec 2010: 51.

[16] Ben R. Rich and Leo Janos, *Skunkworks: A Personal Memoir of My Years at Lockheed*, Little, Brown and Company, Boston: 1994: 8 and Lockheed Martin, "Kelly's 14 Rules & Practices" http://www .lock heed martin .com/us/aeronautics/skunkworks/14rules.html. Accessed January 11, 2012 and Lockheed Martin, "Skunk Works," http://www.lockheedmartin.com/us/aeronautics/skunkworks.html. Accessed January 11, 2012.

[17] Rich, 9.

[18] Lockheed Martin, "Kelly's 14 Rules & Practices" http://www.lockheedmartin.com/us/ aeronautics/skunkworks/ 14rules.html. Accessed January 11, 2012.

[19] Rich, 116.

[20] Rich, 7.

[21] Craig Larman and Victor R. Basil, "Iterative and Incremental Development: A brief history." IEEE Computer, June 2003: 49 and Defense Science Board, "2010 Summer Study: Enhancing Adaptability of US Military Forces," Washington, DC: January 2011, http://www.acq.osd.mil/dsb/ reports/EnhancingAdaptabilityOfUS Military ForcesB.pdf. Accessed November 29, 2011: Part B 21, 22.

[22] Government Accountability Office, "Information Technology: Critical Factors Underlying Successful Major Acquisitions," Washington, DC: October 2011. http://www.gao.gov/new.items/d127.pdf. Accessed November 22, 2011: 10, 11.

[23] Peter Buxbaum, "Getting Agile on Software," *Military Information Technology 2012*, Vol 16: Issue: 1: February 2012. http://www.military-information-technology.com/mit-home/379-mit-2012-volume-16-issue-1-february/5168-getting-agile-on-software.html. Accessed March 20, 2012: 1.

[24] Rita, Boland, "Military Enhances Supply Tracking," *SIGNAL online*, AFCEA: April 2010. http://www.afcea.org/ signal/articles/templates/ Signal_Article_Template.asp? articleid=2252& zoneid=292. Accessed March 20,2012: 1.

[25] Buxbaum, 3.

[26] Defense Science Board, "Report of the Defense Science Board Task Force on the Fulfillment of Urgent Operational Needs," Washington, DC: July 2009. http://www.acq.osd.mil/ dsb/ reports/ ADA503382.pdf. Accessed April 11, 2012: p vii-viii.

CHAPTER THREE
Driving Forces for Agile Approaches

A first order question is whether there is a need for DoD decision support systems to support agile methods. The cascade of reinforcing drivers points to the affirmative. Agile processes are gaining in importance to meet future defense needs.

Four of the most critical driving forces are: the pace and unpredictability of technological advances; the high level of uncertainty in specifying IT requirements; the range in the characteristics and capabilities of our adversaries; and the rapid growth in data sources, types and volume. These are most relevant for IT-intensive programs supporting warfighting (as opposed to business processes). They are particularly salient for intelligence analysis, but apply to other information heavy mission areas as well. Combined, they counter the ability to fix system requirements early and the expectation for requirements or technology stability through the lifecycle of the program.

Drivers for more agile approaches to system development in DoD
Pace and unpredictability of information technology advances
High level of uncertainty with specifying requirements
Range in the character of conflict and the capabilities of adversaries
Increases in data sources, types, and volume

Figure 3. Drivers for more agile approaches

Pace and Uncertainty of Technology Advances

The inherent nature of an information technology program, or a program heavily reliant on IT, is central to this discussion. Increasingly, DoD weapon systems are reliant on software to deliver functionality.[1] The pace and unpredictability of information technology advances call into question the desirability of using the same model optimized for acquiring large weapon systems for acquiring information technology heavy systems, such as intelligence analysis tools.

Major trends in computing have been measured in exponential growth instead of linear growth. This exponential growth has been seen in computer chip capacity,

computing power, processing speed, storage capacity, and communication network bandwidth.[2] Lock-in of design on current technology without allowing for and encouraging flexibility for significant advances in technologies does not make sense. Technological advances do not follow predictable trajectories that can be dropped into a multi-year program schedule. Creating flexibility to take advantage of opportunities from technological advances needs to be part of a program plan.

High Level Uncertainty with Specifying Software Requirements

In a 2001 study of 1,027 IT projects, detailed requirements analysis and requirements freeze were cited as the number one contributing factor for failure by 82% of the failed projects.[3] These findings have been supported by a series of similar studies.[4] Why is it so hard to nail down detailed requirements for IT systems?

Users find it difficult to describe desired software capability, beyond large objectives, until they can interact with a working prototype. This is particularly true for user-interfaces.[5] Additionally, users often are unaware of potential solutions outside the systems they are currently operating. Technologists often have insights into advances in technology that users are not aware of during requirement generation. Users also have difficulty envisioning radical changes to their day-to-day workflow and processes created by new technologies, which may limit their statement of requirements to incremental improvements in existing processes. As Henry Ford is credited to have stated: "If I'd asked my customers what they wanted, they'd have said 'faster horses'."[6]

Using a commercial example going back to 2007, it would have been difficult for an average cell phone or computer user to document a specific requirement for an iPhone aside from the utility of combining a phone, the Internet, and entertainment access in one device.[7] Once experiencing the "system", users quickly provided feedback, identified new applications, and fueled more capability advances. As a result, the fifth generation iPhone was delivered in October 2011 with over 500,000 apps available.[8]

Shortly after the war in Afghanistan began, the need for greater situational awareness for AC-130 aircraft crews led to the development of a full-motion video link to the aircraft from the Predator unmanned aerial system (UAS). Awareness of this new capability by ground special operations personnel led to a request for a similar real-time video link from airborne platforms to ground units. Without initiating the standard procedure to detail requirements, the Air Force quickly developed an initial Remote Operated Video Enhanced Receiver (ROVER). When the first systems were taken to the field, users started making lists of improvements.[9] The system has continuously incorporated user feedback and the fifth generation ROVER V was released in 2009.[10] From its start as a broadly stated objective, ROVER has developed through the interaction of users identifying what is needed and industry and

technologists raising what is possible. The capability has significantly enhanced air to ground coordination for time-critical operations.[11]

Beyond the difficulty of specifying detailed user requirements, IT systems have unique technical complexities. For example, internal and external interrelationships with code and interfaces often cannot be fully known until development begins.[12] It is unrealistic to expect detailed and fully accurate documentation of these dynamic interrelationships in advance.

Agile proponents acknowledge that there is an inherent level of uncertainty in requirements and thus they propose thinking about requirements differently. As described in the Agile Manifesto, iterative and agile principles directly address the inevitability of change in requirements. Practices are designed to manage complexity of inter-related systems and focus on user learning to refine requirements by providing early versions of a system.

Character of Conflict and Capabilities of our Adversaries

Overlaying the pace of technology change and uncertainty defining system requirements is the operational reality of an increasingly complex and unpredictable security landscape. If we fast forward seven years to 2019, what types of military operations will our nation's military be involved in and be planning for? What will be the most critical tactical and operational questions commanders will ask their staffs to drive decisions?

The specific answers to these questions are not knowable. It was not predictable in the spring of 2004, that in the spring of 2011 our nation's military would be simultaneously conducting combat and support operations in Iraq and Afghanistan, supporting NATO operations in Libya, and providing assistance to Japan in the aftermath of an earthquake, tsunami and nuclear emergency.

Nevertheless, the rough outlines of this future can be sketched while acknowledging the future is likely to hold significant surprises. The U.S. will continue to face and counter threats by extremist non-state groups and individuals on a global scale. It will maintain a force capable of countering aggression by state and potentially non-state actors possessing weapons of mass destruction, long-range and precise weapons, and increasingly lethal or disruptive asymmetric capabilities. The U.S. will engage globally to deter aggression and assure allies. Defense of cyberspace and space capabilities will take on increased importance. Humanitarian operations, disaster relief and operations to defend our homeland will be required on short notice. Despite our current national desire to avoid long-duration commitments, counterinsurgency or stability operations are likely as well.[13]

The complexity and uncertainty of the security environment is significant. Secretary of Defense Leon Panetta, in his first public address, stated: "…we live in a world that is rapidly changing, a world that is growing in complexity and uncertainty…more unpredictable, more volatile, and, yes, more dangerous."[14] The Joint Operating Environment envisions a wide range of threats: "From non-state actors using highly advanced military technology and sophisticated information operations, to states employing unconventional technologies, to the improvised explosive devices that pose grave threats to our troops, smart adversaries will tailor their strategies and employ their capabilities in sophisticated ways."[15]

Based on past experience, our ability to predict with certainty the specifics of the future security environment should not be oversold. Former Secretary of the Navy Richard Danzig argues, "The acceleration, proliferation, and diversification of technical and political change make the 21st-century security risks even more unpredictable than those in the past."[16] A reading of the future trends and disruptions, ranging from urbanization issues, to technology proliferation and resource scarcity, provides a similar sense of the difficulty in detailing the timing, scale, and character of future military engagements.[17] All that we can know is that we are going to have to be adaptable.

The wide range of future military missions, and the appreciation of creative and innovative adversaries across the spectrum of conflict, requires systems and processes that can quickly adapt and evolve to new requirements. Can systems optimized for aggregating and displaying data related to a conventional state adversary and their capabilities be adapted to assist analysts in answering questions for a counterinsurgency operation, such as economic trends, status of development projects, and social relationships? Or is a new system needed? Is a particular system able to share or accept information with an ally, a new coalition partner, a non-governmental organization, or a relief team? How adaptable are our current systems, and our systems development processes, to emerging requirements?

Operationally, the need for adaptable systems has been expressed from the unit level through the highest echelons of the Defense Department. Take the observations of a commander of an intelligence squadron charged with executing world-wide intelligence, surveillance and reconnaissance operations. He strongly voiced the need for on-site developers to innovate based on emerging requirements of both his operators and those in the field they support: "Analysts…must continuously adapt to the needs of warfighters…, and by extension that means we routinely need new technical capabilities, such as access to databases or tools developed in theater." [18]

At a higher level, observations by Major General Michael Flynn, then Deputy Chief of Staff, Intelligence, for the International Security Assistance Force in Afghanistan, clearly highlight the difficulty of using existing systems to meet demands of intelligence support to counterinsurgency operations. While not focusing on

technology issues in his assessment of intelligence operations in Afghanistan, he specifically detailed the persistent technical challenges with collecting, aggregating, and analyzing critical ground-level information from a variety of uncommon sources and providing intelligence up chain, laterally and back to tactical levels to inform decisions.[19]

Whatever the future operating environment, existing systems will require modification to maximize their value to the fight we are in. Operations that often occur simultaneously across a range of military actions, against adaptive adversaries who innovate to counter our advantage, will demand it. If no fundamental adjustments are made to the way DoD develops and delivers programs, such as analytic tools, we will be lacking in the ability to address the range and complexity of intelligence questions that inform military decisions.

As simply put in a 2011 Software Engineering Institute document on Agile Methods in DoD: "…we must successfully address the difference in tempo of need (the tempo of the warfighter) and the tempo of the provision (the tempo of the developer and the acquirer)....By acknowledging that requirements are dynamic, not static, and by going directly to the end users who will be employing the provided capabilities, Agile helps collapse the time lag between identification of a new threat or demand and its satisfaction."[20]

The Rapid Growth in Data Sources, Types and Volumes

A fourth and final overlay in the factors driving to adaptive systems is the rapid growth in data sources, types and volumes. This is paired with new approaches being developed to deal with vast amounts of data. Trends evident in the commercial sphere impact and have parallels in the realm of defense.

According to a 2011 McKinsey report, projected growth in global data generated is 40 percent per year.[21] These growth estimates vary, but numerous studies have agreed that the volume of data is growing exponentially and is expected to continue on this trajectory.[22] More people, devices, and sensors are being connected by digital networks. The same McKinsey report estimates that the number of sensors providing data to networks in the transportation, automotive, industrial, utilities, and retail sectors will increase at a rate of more than 30 percent a year.[23] Additionally, some new data types create significant new challenges. For example, a second of high-definition video generates more than 2,000 times the number of bytes required to store a page of text.[24]

As the commercial sector seeks to gain value from data growth and figure out how best to manage it, the industry surrounding analytics and data management is growing at almost 10 percent a year.[25] New approaches to deal with data are being

developed to address the demand. These range from new data mining, data fusion, pattern recognition, and data visualization techniques.[26] Take, for example, the Hadoop software, which allows linked PCs to analyze huge quantities of data. In one example, a Visa company trial crunched 73 billion transactions in 13 minutes, a process that previously took one month.[27] Innovation that provides a commercial competitive advantage through better data analysis is positioned to continue.

How much data, and what types of data, will our defense organizations need to manage over the next decade? In the case of intelligence data, few predicted that unmanned aerial systems (UAS), a relatively small class of DoD platforms in 2002 used predominantly for surveillance and reconnaissance, would grow more than 40-fold by 2010.[28] With larger numbers of UAS, some with up to 24-hour endurance, data volumes have drastically increased.[29] Longer endurance vehicles, operating for weeks to months, are also envisioned and are set to provide more persistence and more data.[30]

Developments in sensors are also contributing to increases in data volume and data management challenges. Wide area surveillance technology is an instructive case. Wide area surveillance sensors were designed to increase the size of the geographic area that can be imaged to the equivalent of a small city or larger. In the past two years, wide area airborne surveillance missions have increased collection by 2,250 percent.[31] This type of sensor can provide persistent surveillance and tracking of vehicles and targets on the move - a valuable capability that comes with a lot of data. However, the true value is not in the data itself but in efficiently identifying what part of that data, often in combination with other sources, can increase knowledge and better inform decisions.

There are many additional examples of new platforms, data sources, and advances in traditional sensors that are exponentially increasing data volumes and variety. Growth in open source information, biometrics data, advanced imaging techniques, and signals collection will all require novel automated approaches to allow analysts to key in and connect the critical pieces of decision-influencing information.

Three years ago, the Defense Science Board highlighted the growing challenges to intelligence analysis based on these trends:

> The rapid proliferation of sensors both enables and overwhelms the current ISR infrastructure….decision makers and intelligence analysts have difficulty knowing what information is available…analysts spend much of their time inefficiently sorting through this volume of information to find the small subset they believe is relevant to the commander's needs….[32]

While some advances have been made, there is much work still to be done to convert the increasing volumes of data to useful, decision-enabling, knowledge.

Many of the advances in data analytics are likely to come from commercial sectors facing their own data challenges. Some will continue to come from visionary defense and intelligence research and development organizations, such as the Defense Advanced Research Projects Agency (DARPA). Programs such as DARPA's XDATA aim to provide new techniques and tools for processing and analyzing vast amounts of defense-related information.[33] Some techniques will likely be undeveloped or unknown at the beginning of requirements analysis for a new defense program, but may still be worth integrating during the program if it addresses the program's overall objective.

Defense processes need to be adaptable enough to take advantage of advances in data analytics techniques to tackle the data environments of the future. A rational process on-ramp that routinely seeks out and is able to apply promising technologies is required. Rapid execution of the "solution identification to improvement" cycle is imperative.

Summary

These four reinforcing forces - the pace and uncertainty of technological developments; the high level of uncertainty in specifying IT requirements; the range in characteristics and capabilities of our adversaries; and the rapid growth in data sources, types and volume – confirm the defense need for more agile development processes. Certain defense mission areas, such as intelligence and cyber, will be more affected by these factors than others. However, nearly all mission areas will be impacted. Deliberate reform toward true co-existence within the Department for organizational norms that support agile principles is critical to our national security, beyond the conflicts we are currently engaged in.

Notes

[1] Defense Science Board, "Report of the Defense Science Board Task Force on Department of Defense Policies and Procedures for the Acquisition of Information," Washington, DC: March 2009. http://www.acq.osd.mil/dsb/reports/ADA498375.pdf. Accessed March 5, 2012: 6.

[2] R. S. Houghton, "Major trends of the fourth age of computing: New pressures for growing educational capacity," http://www.wcu.edu/ceap/houghton/readings/technology_trends.html. Accessed February 24, 2012: 5, 9.

[3] Craig Larman, *Agile and Iterative Development: A Manger's Guide*, Addison-Wesley, Boston: 2004: 55 citing Thomas, M, "IT Projects Sink or Swim" British Computer Society Review, 2001.

[4] Ibid.

[5] Ibid, 53.

[6] Tim Brown, Tim and Jocelyn Wyatt, "Design Thinking for Social Innovation," *Stanford Social Innovation Review*, Winter 2010. http://innernorthfoundation.org.au/downloads/design_thinking.pdf. Accessed April 30, 2012: 33.

[7] Steven Jobs, "Keynote speech introducing the new iPhone," Uploaded by mclane76 on Jan 10, 2007. http://www.youtube.com/watch?v=ASkis57blsc Accessed February 27, 2012.

[8] Apple, "iPhone," http://www.apple.com/iphone/from-the-app-store/. Accessed April 25, 2012 and Wikipedia, "iPhone," http://en.wikipedia.org/wiki/IPhone. Accessed April 25, 2012.

[9] Julie Weckerleing, "ROVER gives joint force new vision," Air Force Print News, December 16, 2005. http://www.af.mil/news/story.asp?id=123013585. Accessed April 12, 2012.

[10] Katherine McIntire Peters, "Air Force leaders describe plan to improve ISR capabilities," GOVEXEC.com. July 6, 2009. http://www.govexec.com/defense/2009/07/air-force-leaders-describe-plan-to-improve-isr capabilities/ 29502/. Accessed April 12, 2012.

[11] Interview with Colonel Charles Menza, Headquarters Air Force/A2Q (April 23, 2012).

[12] Carlton Northern, et al, "Handbook for Implementing Agile in Department of Defense Information Technology Acquisition," The MITRE Corporation. 15 December 2010: 2, 3.

[13] U.S. Department of Defense, "Sustaining U.S. Global Leadership: Priorities for 21st Century Defense," Office of the Secretary of Defense, Washington DC: Jan 2012. http://www.defense.gov/news/Defense_ Strategic_ Guidance .pdf. Accessed January 8, 2012: 4-6 and United States Joint Forces Command, "The Joint Operating Environment (JOE) 2010," February 8, 2010. http://www.dtic.mil/dtic/tr/fulltext/u2/a518100.pdf. Accessed November 29, 2011: 60-62.

[14] Leon Panetta, "Defense Priorities: Today and Tomorrow." Given at the Woodrow Wilson International Center for Scholars. October 11, 2011. http://www.wilsoncenter.org/event/defense-priorities-today-and-tomorrow-secretary-leon-panetta#field_files. Accessed October 18, 2011: 5.

[15] United States Joint Forces Command, 66.

[16] Richard Danzig, "Driving in the Dark: Ten Propositions about Prediction and National Security," Center for a New American Security, Washington, DC: Oct 2011: 5.

[17] United States Joint Forces Command, 12-37.

[18] Jason M. Brown, "Rethinking the network," *C4ISR Journal*, March 2010: 33.

[19] Maj Gen Michael T. Flynn, Capt Matt Pottinger, USMC, and Paul D. Batchelor, "Fixing Intelligence: A Blueprint for Making Intelligence Relevant in Afghanistan," Center for a New American Security, Washington DC: January 2010: 17, 19.

[20] Lapham 2011, 2, 3.

[21] McKinsey Global Institute, "Big data: The Next Frontier for innovation, competition and productivity," McKinsey & Company, June 201: introduction.

[22] Ibid, 16.

[23] Ibid, 2.

[24] Ibid, 1.

[25] "Data, Data Everywhere," *The Economist*. February, 27 2010: 3,S.5. ProQuest Research Library. Accessed March 7, 2012.

[26] McKinsey Global Institute, 27-31.

[27] "A different game," *The Economist*. February 27, 2010, 6, S.8. ProQuest Research Library. Accessed March 7, 2012.

[28] Jeremiah Gertler, "U.S. Unmanned Aerial Systems," Congressional Research Service, Washington DC: January 3, 2012: summary.

[29] Ibid, 22.

[30] Jim Martin, Director ISR Programs, Undersecretary of Defense for Intelligence, "Disruptive Technologies, Innovation or Disruption? The Impact of Changing Technology upon ISR Capabilities," 11 Oct 10. http://www.dtic.mil/ndia/2010disrupt/Jim_Martin.pdf. Accessed January 18, 2012: 49.

[31] Josh Hartman, "NGA's Shifting Analysis: Challenges and Opportunities of the New Direction," *Imaging Notes*, Winter 2011, Vol 26, N 1. http://www.imagingnotes.com/go/articleJ.php?mp_id=249. Accessed March 1, 2012: 3.

[32] Defense Science Board, "Report of the Joint Defense Science Board Intelligence Science Board Task Force on Integrating Sensor-Collected Intelligence," Washington DC: November 2008: 3.

[33] "DARPA Calls for Advances in "Big Data" to Help the Warfighter," DARPA website. March 29, 2012. http://www.darpa.mil/NewsEvents/Releases/2012/03/29.aspx. Accessed April 11, 2012.

CHAPTER FOUR

Growing Consensus on Need for Agile Approaches

"The Department must not only prepare for those threats we can anticipate, but also build the agile, adaptive, and innovative structures capable of quickly identifying emerging gaps and adjusting program and budgetary priorities to rapidly field capabilities that will mitigate those gaps." [1] -- Quadrennial Defense Review (QDR), February 2010

The need to be more agile is widely recognized. Increasing the agility and adaptability of defense processes was a goal in the 2010 QDR and the subject of the OSD-requested Defense Science Board 2010 Summer Study.[2] Top Defense Department leaders have stated the need for the deliberate processes designed for conventional weapons to coexist with more agile processes for unanticipated or emergent requirements.[3]

A number of respected boards and organizations, to include the Defense Science Board, National Research Council, Government Accountability Office, and the Office of the U.S. Chief Information Officer, have also affirmed the need to make Information Technology acquisitions more agile.[4] As early as 1987, the Defense Science Board Task Force on Military Software recommended adopting agile principles:

> In the decade since the waterfall model was developed, our discipline has come to recognize that setting the requirements is the most difficult and crucial part of the software building process, and one that requires iteration between the designers and users. In best modern practice, the early specification is embodied in a prototype, which the intended users can themselves drive in order to see the consequences of their imaginings.[5]

Subsequent studies, including the 2009 Report of the Defense Science Board (DSB) Task Force on Department of Defense Policies and Procedures for the Acquisition of Information Technology and the 2010 National Research Council (NRC) report, "Achieving Effective Acquisition of Information Technologies in the Department of Defense" recommend adopting a new acquisition process tailored for IT programs. [6] Their findings are consistent with broader federal IT findings and recommendations found in the 2010 U.S. Chief Information Officer (CIO) report, "25 Point Implementation Plan to Reform Federal Information Technology Management."[7] A summary of these reports' recommendations can be found in the Appendix.

The DSB and NRC reports are predominantly targeted at acquisition audiences and cover a range of considerations and suggestions for programs considering the use of agile methods. They acknowledge that the current DoD process environment and culture is not designed to support these methods. Challenge areas include, but are not limited to, cost estimating, contracting, program roles, project management tools, and documentation.

Informed by these studies, Congress' National Defense Authorization Act for Fiscal Year 2010 directed the Secretary of Defense to develop and implement a new acquisition process for IT systems that encompasses the main characteristics of incremental and iterative development.[8] Section 804 specifically recommends; early and continual involvement of the user; multiple, rapidly executed releases of capability; early, successive prototyping; and a modular, open-systems approach.[9]

Strong positional advocates also exist in the DoD and intelligence community. For intelligence systems, an outspoken proponent for more agile approaches has been Dawn Meyerriecks, Deputy Director of National Intelligence Acquisition and Technology. She has advocated for greater collaboration between users, scientists, technologists and acquisition/procurement experts to look more holistically at capabilities.[10] She also is a strong proponent of user engagement, learned from her private sector IT experience.[11]

Within the DoD, the Chief Information Officer, Teri Takai, recently cited "deploying new technologies quickly" as one of the biggest challenges facing the DoD in the field of IT.[12] To address this challenge, the DoD CIO's 10-point modernization plan includes enabling more agile IT.[13] The plan includes core agile concepts such as active user involvement, delivery of useable capabilities at time-boxed increments, and integrated test and evaluation during development.[14] Ronald Pontius, Director, Command and Control for OUSD AT&L also highlighted in a March 2012 presentation a range of initiatives and reforms in progress by the Joint Staff and OSD organizations that are aimed at IT reforms.[15] He also noted that different functional areas were moving out on reforms separately vice having a coordinated effort.[16]

A 2010 MITRE report observed "the use of Agile development methodologies in DoD are on the rise." The report references ten current programs using some form of agile development.[17] Similarly, a 2011 Carnegie Mellon report found, "interest in these methods within the DoD acquisition community has recently been increasing."[18]

While this movement within the Department to support agile principles is gaining momentum, it is not without significant challenges. The Carnegie Mellon study reported the two primary DoD institutional motivations to move towards agile were:

- A program facing cancellation if they do not try something different or;
- An operational need that is urgent/mission-critical enough to warrant a different approach.[19]

Neither indicates an inherent appreciation at the program level of the driving factors described earlier and the value of applying an agile approach for the purpose of gaining mission value for non-urgent capabilities. If accurate, these motivational observations indicate that there is still work to be done to make agile more than a "go to" approach in a crisis.

Longstanding institutions, processes, and organizational values have been built up and matured to support the characteristics of the deliberate acquisition of weapon systems. As depicted in Figure 2, there are significant differences in the character of a traditional versus an agile program. As it moves forward, the Department should critically assess its organizations and processes for the necessary attributes for agile success. This assessment can be informed by historical practice, contemporary experiences, and lessons from commercial efforts. Changes will be necessary to not just allow but encourage and support more wide-spread adoption of agile principles.

Notes

[1] U.S. Department of Defense, "Quadrennial Defense Review Report," February 2010. http://www.defense.gov/ qdr/images/QDR_as_of_12Feb10_1000.pdf. Accessed November 29, 2011: 80.

[2] Ibid, and Defense Science Board, "2010 Summer Study: Enhancing Adaptability of US Military Forces," Washington, DC: January 2011. http://www.acq.osd.mil/dsb/reports/ADA536755.pdf and http://www.acq.osd.mil/ dsb/ reports/EnhancingAdaptabilityOfUSMilitaryForcesB.pdf. Accessed November 29, 2011.

[3] Gates, 4 and Defense Science Board, "2010 Summer Study: Enhancing Adaptability of US Military Forces," Washington, DC: January 2011. http://www.acq.osd.mil/dsb/reports/ADA536755.pdf Accessed November 29, 2011: Terms of Reference.

[4] Defense Science Board, "Report of the Defense Science Board Task Force on Military Software," September 1987. http://handle.dtic.mil/100.2/ADA188561 . Accessed February 21, 2012 and National Research Council, "Achieving Effective Acquisition of Information Technology in the Department of Defense," The National Academies Press, Washington, DC: 2010. http://www.nap.edu/catalog.php?record_id=12823. Accessed December 1, 2011 and Government Accountability Office, "Information Technology, Critical Factors Underlying Successful Major Acquisitions. Washington, DC: October 2011. http://www.gao.gov/new.items/d127.pdf. Accessed November 22, 2011 and Vivek Kundra, "25 Point Implementation Plan to Reform Federal Information Technology Management," The White House, Washington, DC: December 9, 2010. http://www.cio.gov/documents/25-Point-Implementation-Plan-to-Reform-Federal%20IT.pdf. Accessed October 7, 2011.

[5] Defense Science Board, "Report of the Defense Science Board Task Force on Military Software," September 1987. http://handle.dtic.mil/100.2/ADA188561 . Accessed February 21, 2012: 3.

[6] Defense Science Board, "Report of the Defense Science Board Task Force on Department of Defense

Policies and Procedures for the Acquisition of Information," Washington, DC: March 2009. http://www.acq.osd.mil/dsb/reports/ADA498375.pdf. Accessed March 5, 2012: x and National Research Council: 5.

[7] Vivek Kundra, "25 Point Implementation Plan to Reform Federal Information Technology Management," The White House, Washington, DC: December 9, 2010. http://www.cio.gov/documents/25-Point-Implementation-Plan-to-Reform-Federal%20IT.pdf. Accessed October 7, 2011.

[8] U.S. Congress, "Public law 111–84 National Defense Authorization Act for Fiscal year 2010 Sec. 804. Implementation of new acquisition process for information technology systems," October 28, 2009. http://www.gpo.gov/fdsys/pkg/PLAW-111publ84/pdf/PLAW-111publ84.pdf. Accessed January 23, 2012.

[9] Ibid.

[10] Harrison Donnelly, "Intel Technologist: Developing Great Technology to Address Key Intelligence Challenges, Dawn Meyerriecks, Deputy Director of National Intelligence Acquisition and Technology," GIF 2011 Vol: 9 Issue: 6. http://www.geospatial-intelligence-forum.com/mgt-home/345-gif-2011-volume-9-issue-6-september/4647-qaa-dawn-meyerriecks.pdf. Accessed January, 8 2012: 18.

[11] Ibid, 20.

[12] Harrison Donnelly, "Interview with Terri Takai, Enterprise Architect: Strengthening the Ability to Share Information Quickly and Securely," Military Information Technology 2011 Vol: 15 Issue: 10. http://www.military-information-technology.com/mit-home/367-mit-2011-volume-15-issue-10-november/4993-qaa-teri-takai.pdf. Accessed April 13, 2012.

[13] Teri Takai, "DoD CIO's 10-Point Plan for IT Modernization," DoD CIO. http://dodcio.defense.gov/ Portals/0/Documents/ITMod/CIO%2010%20Point% 20Plan% 20for% 20IT%20Modernization.pdf. Accessed April 26, 2012: 2, 9.

[14] Ibid, 9.

[15] Pontius, 9.

[16] Ibid.

[17] Northern, 8-38.

[18] Lapham 2011: ix, 8.

[19] Ibid, 65.

CHAPTER FIVE
Agile Principles in Action

To gain additional insights into adopting agile methods for analytic tools, I interviewed members of three intelligence-related program teams using agile methods and senior members of a number of intelligence organizations sponsoring or managing agile efforts. Their experiences are instructive in both the potential for agile methods and the challenges that remain. While the selected program efforts varied in size, scope and complexity, they delivered significant value to users supporting wartime operations. Themes from their experiences provide foundational lessons on organizational values, culture, and construct.

Program A

The first program will be referred to as Program A given that its name has not been publicly released. Program A was initiated within a U.S. intelligence agency in 2005 in response to an operational need for tactical-level analysts in Iraq to have faster access to traditionally national-level data and tools.[1] For over seven years, the program has followed a 90-day build/test/deliver release cycle. The officer-in-charge in the forward operating area and the system trainers continually work with the user community to identify requirements for improvements. Operational users also provided timely insights into new challenges as the operating environment evolved and the system was deployed to additional locations. At the beginning of each spin, there is a three-day planning cycle that uses this direct user input to prioritize and plan for the next build and 30-day development push.

One practice highlighted as particularly valuable was the forward deployment of system engineers, developers, and acquisition personnel for four to six month rotations. As they lived and breathed the user environment, they gained a deep understanding of why users require each tool and what were the biggest pain points that hinder their analytic flow. Developers on these rotations were asked by the program manager to think of themselves for the first few months as an "anthropologist"- understanding the questions and tasks that structure an analysts' work, who they interacted with, and what information they needed access to. Only after gaining the necessary understanding were they to attempt to improve the analysis with technology. This is a proven design thinking approach that meshes well with agile methods.[2] At home, they often were physically co-located with analysts in the parent organization. They were better able to put in context user input on future improvements and create, or identify, from emerging science and technology (S&T) efforts useful solutions beyond what the user could envision.

Another valuable practice was the program's innovative use of trainers in system development. In addition to their traditional training function for personnel preparing for deployment, trainers were available 24/7 by reach-back to analysts using the system in the combat zone. In this role, the trainers gained immense insight into the functions and analytic techniques challenging analysts. From these discussions, they also learned what emerging intelligence questions were being asked as the operational environment evolved. With this knowledge, trainers played a role in requirements discussions for future spins.

Additionally, trainers were included in beta version testing. They were able to highlight early to developers potentially non-intuitive interfaces. They also tailored their preparations for future training classes by understanding new system features in depth. For repeat deployers, they were able to highlight key differences between system versions which expedited spin-up.[3]

The program has benefited from continuous support from its agency's leadership, who minimized organizational barriers and pulled personnel from different organizations to work together with a problem solving mentality. Users, who often had multiple deployments, saw their feedback incorporated in new versions and continued to provide valuable feedback. The sponsor organization support was reinforced by very positive endorsements of the program's results by commanders in the field.[4]

The organization also had significant in-house experience with advanced technology and was able to forge a strong industry-government partnership. Promising technologies were rolled into the program during build cycles. The commitment to continuous time-boxed deliveries provided opportunities to on-ramp maturing technologies from S&T efforts.[5]

Key takeaways from this program's experience include the value of:

- Intense user collaboration with a focus on usability;
- Mission driven development – adapting to changing requirements, risk taking;
- Discipline with time-boxed iterations;
- Imbedded engineers with users in their operating environment;
- New thinking about linkage between trainers and developers;
- Direct on-ramps for applicable S&T;
- Senior leader commitment to break down process/policy/organizational barriers.

Unified Collections Operations Reporting Network (UNICORN)

The Unified Collections Operations Reporting Network (UNICORN) is used by the Air Force to track, manage, and retrieve intelligence, surveillance and reconnaissance (ISR) information.[6] The effort started eight years ago when a Senior Airman, working as an imagery analyst, became frustrated by his mission management workflow. These tasks relied heavily on e-mail and a cumbersome database entry process. On his own time, he created a new database at home. He then gained his unit leadership's support to present his innovative ideas up the chain. He was transferred to the headquarters, trained in more advanced programming, teamed with developers, and built a prototype, version 1.

His knowledge as a user informed the development of a system that began to address the most significant inefficiencies in the process. It allowed analysts to spend more time doing analysis and less on bookkeeping tasks.[7] Since that initial prototype, a small team of programmers has been added to the effort, and the version cycle progressed from four years for version 2 to three months between releases. Today, a new release occurs every 17 days.

The effort continues to actively obtain user feedback. Developers travel to sites world-wide to sit with users in their operations spaces. An on-line user feedback feature is also incorporated into the tool. This direct user feedback is incorporated with leadership direction to prioritize requirements for future iterations and is tailored as necessary for specific site needs.

The flexibility and maturity of this development effort was proven in 2011 when it responded to a requirement to provide a version for coalition forces in Afghanistan. A forward liaison officer deployed for the International Security Assistance Force (ISAF) identified a requirement for coalition partners to more easily discover and retrieve US Air Force ISR information. Based on the officer's conversations, developers at the 480th ISR Wing created a tailored version called Enhanced-UNICORN. Time between requirement and fielding was ten weeks. Enhanced-UNICORN improved coalition forces' access to USAF ISR mission status and ability to quickly retrieve ISR products, such as digital imagery.[8]

When the need arose in May of the same year to share information with NATO allies supporting Operation Unified Protector in Libya, the Wing again tailored the Enhanced-UNICORN system specifically for this operation. It took less than three days to field the system on the NATO network, in close collaboration with security authorities in the Office of the Undersecretary of Defense for Intelligence.[9]

Key takeaways from the UNICORN experience include the value of:

- Openness to innovation on the edge…embracing solutions from lead users;

- Maintaining developer/user collaboration through temporary imbedding of developers with users;
- Decreasing development timelines to deliver usability in manageable spins;
- Tailoring to specific needs for different operations or sites…mission driven development;
- Forging relationships with security and other key stakeholders.

As in the case of Program A, UNICORN benefitted from consistent leadership support and gained traction with users who saw their feedback incorporated in new releases. Members of the program also attribute their success to the ability to stay focused on a discrete capability set and remain relatively small, allowing them to understand requirements in depth and react quickly.

Expeditionary Processing Exploitation and Dissemination (ExPED)

Expeditionary Processing Exploitation and Dissemination (ExPED) is an Air Force effort to provide a common forward intelligence, surveillance, and reconnaissance PED system capable of managing data from a variety of ISR capabilities. To maintain 90-day cycles, the program has taken full advantage of a very integrated organization including software development, security, testing, and configuration management expertise. They routinely team with other Air Force program offices, research labs, other services, and agencies to leverage expertise and technology.

As with other agile examples, team members emphasize the role of the user in directing requirements and focus on user needs to drive schedule discipline. To maintain user collaboration, they hold weekly requirement status teleconferences with all stakeholders to prioritize upcoming week efforts. Members value direct input from the field and take pride in being responsive to end user input.

The agile principle-based team culture was evident in discussions about similarities and differences in experiences with other acquisition organizations. Team members cite the need for all members to be flexible and not wedded to strict functional boundaries. They work beyond their core skills and help the team as needed to stay on schedule. They also highlight their consistent focus on time to delivery, being user-driven, not just user focused. As with other agile organizations, once on the team, individuals who share these values routinely want to stay in the organization. Similarities were noted to another agile team, the Air Force Big Safari program, particularly, the importance of having the right team members who fit the culture.[10] Leaders in the field, in turn, praise the responsiveness of the ExPED team and their ability to get things done.[11]

Direct support to ongoing combat operations has given the effort leadership support and resources. The high priority given their effort has also allowed them to bypass

some time- and document-intensive processes that are used for other programs. Still, some critical processes, such as security authorization, have not fully adapted to time-based deliveries.

Key takeaways from the ExPED experience include the value of:

- Building an organization with individual and team values that support agility;
- User-directed requirements and built-in flexibility to adapt to changes;
- Integrated organizations containing key functions such as security, testing, and configuration management;
- Actively seeking and embracing outside solutions and building on-ramps for S&T insertion.

Case Summary

In these three examples, warfighters engaged in, or supporting, combat demanded better tools. Leaders focused on rapid delivery. Though of different scale and complexity, in each case, teams delivered operational capabilities, actively sought user feedback, and committed to time-boxed cycles of successive improvements. Core agile principles were applied.

Teams eagerly highlighted other organizations or initiatives that were also using agile principles. Clearly, there is contemporary experience within Defense organizations with agile methods. There are successful practitioners with years of experience that can coach others. These experiences and personnel should be sought out as the need to be agile becomes increasingly important. These practices have value beyond responding to urgent combat requirements.

In each case, leadership support enabled teams to bypass low-value added processes and documentation. They focused multifunctional teams on delivering value to users and they accepted risk. Expanding these practices to more programs is not without challenges. Significant foundational adaptations are discussed in the next section.

Notes

[1] Interview with NSA/T12/T1212, November 10, 2011.
[2] Tim Brown and Barry Katz, *Change by Design*, Harper Collins, New York: 2009: 41-55.
[3] Interview with NSA/T121/T1211, November 10, 2011.
[4] Ibid.
[5] Interview with NSA/T12/T1212, November 10, 2011.

[6] "480th ISR Wing Improves Coalition Forces Information Sharing." Air Force ISR Agency news. August 3, 2011. http://www.afisr.af.mil/news/story.asp?id=123266468. Accessed March 7, 2012.

[7] For further reading on the value of this type of innovation, see Defense Science Board, "Report of the Defense Science Board Task Force on Defense Intelligence Counterinsurgency (COIN) Intelligence, Surveillance, and Reconnaissance (ISR) Operations", Washington, DC: February 2011. http://www.acq.osd.mil/dsb/reports/ ADA543575.pdf. Accessed November 21, 2011: 37. "To free up the analyst to problem-solve and strategically plan, automated methods must be developed (or improved) to focus the analyst more quickly on questionable activity and automated tools built to accomplish routine bookkeeping tasks."

[8] "480th ISR Wing Improves Coalition Forces Information Sharing." Air Force ISR Agency news. August 3, 2011. http://www.afisr.af.mil/news/story.asp?id=123266468. Accessed March 7, 2012.

[9] Ibid.

[10] Interview with Mr. William Roberts, USAF AMC WR-ALC/GRCEA, January 12, 2012.

[11] Interview with 495 EIS/CC, January 26, 2012.

CHAPTER SIX
Institutional Adaptations to Scale Agile

Analysis of historical cases, contemporary experience, and commercial lessons point to three foundational areas that will challenge DoD organizations adopting agile methods. They are: user involvement in all stages of development, collaborative multifunctional teams, and matching measures and incentives with agile values. Addressing each of these areas is imperative. It is important to note that these are not limited to acquisition organizations. They must be addressed by a wide range of organizations in concert.

Insist Upon User Collaboration in Development

"Access to end users can be complex and difficult." [1] -- Carnegie Mellon Software Engineering Institute, 2010

How is the user brought into the development process? Who speaks for the user to developers? In more traditional defense programs, the users, or organizations representing the users, spend significant time refining and documenting requirement statements up front. Through document staffing and user group meetings, requirement statements are refined. Once requirements are approved and documented, acquisition organizations then serve as the proxy for the end user until operational testing and evaluation is conducted on the completed system.[2]

In contrast, agile approaches require that the system users be involved in the entire development process. As Chris Gunderson of the Naval Postgraduate School explains, this level of user involvement "isn't something that government programs typically do."[3] For IT systems specifically, research covering 400 organizations shows that behind executive sponsorship, user involvement is the second most important factor for program success.[4]

There is a range of options that successful agile efforts have used to involve the user of the system to the level required.[5] More important than the specific method is the value commitment to collaborate with the user for the entire process. A few examples demonstrate the range of options available:

- Co-locate developers with users in the user's operational workspace. This technique is recommended when the program is specialized for a discrete user

set and/or there is a high level of requirement discovery. The Program A and UNICORN cases exemplify this option.

- Identify a core group of users who are available to developers to participate virtually or in-person at team meetings and participate in demonstrations to provide user feedback. This requires that the user community value these responsibilities and provide easy access to expert users. The Army Network Integration Evaluation (NIE) and the commitment of 2nd Brigade, 1st Armored Division to evaluating new network technologies in realistic operational scenarios is an example of this option in practice.[6]

- Assign expert users with recent user experience within the program office. In addition to providing operational expertise, these members can reach into the operational community to tap expertise when needed. This technique is used, for example, by the Big Safari program and within some national intelligence agencies. Specifically, Big Safari is noted for its imbedded operational expertise and for aggressively seeking feedback for the operator and end user of each system.[7] It takes significant leadership commitment to ensure these types of assignments for operational personnel last long enough to provide value to the program and also remain professionally rewarding enough to draw top quality personnel.[8]

- Designate a product owner with extensive operational experience to speak for the user with the responsibility to continuously collect user requirements through user groups or other venues. This approach has been used successfully when there are multiple users with different priorities, high interdependence between different efforts supporting the same product owner, and/or a high need to weigh user feedback against strategic or enterprise goals, standards, architecture constraints, or other factors not likely considered by line users. It requires a commitment by the product owner to make users accessible as the developers need hands-on evaluation during development.

Operational communities will need to show commitment to support this higher level of user participation, which DoD has demonstrated when faced with the urgency of combat requirements. The Department has many examples of user and acquiring organizations teaming successfully on top mission priorities. However, this is not the norm for non-urgent capability development. In these programs the operational users and acquisition professionals described earlier assume traditional roles. Operational users focus on executing their mission and normally do not seek out an active role in future capability development.

Without the same sense of urgency it may be difficult, but no less important, to continue and expand this practice. Ongoing efforts by DARPA may help inform the

normative practice of user collaborative development. For example, the Transformative Apps program seeks to deliver mobile software applications "based on a direct collaboration between a vibrant and highly competitive development community and involved communities of end users."[9] The program receives feedback directly from users in their operational environment and evaluation events to drive rapid innovation to meet user needs.[10] A stated objective of the program is to "aggressively explore business models that can…provide alternatives to the traditional acquisition paradigm."[11] User collaborative development is a key aspect of these models.

It is understandably challenging to gain and maintain a high level of user involvement. Even programs that emphasize user involvement need to continuously work at it. The GCSS-J program, introduced earlier, is committed to user involvement. Nevertheless, they found it challenging to keep the user engaged in development and compete with daily operational responsibilities.[12] The program has instituted online collaboration and other tools to increase user involvement, recognizing the centrality of the user in system success.[13]

Another important aspect of user involvement is the concept of user innovation. Users often innovate themselves and find solutions to vexing problems. Creating a culture that encourages, seeks out, and embraces user developed solutions, as exemplified in the UNICORN program and was often seen in counter IED innovation, is essential.[14] There is significant research to support the role of lead users in innovation.[15] Lead users are characterized as those expecting substantial benefit from a solution to their need so they are motivated to innovate. They also experience a need earlier than a majority of users.[16]

Engaging with lead users has shown great value in a wide variety of industries from banking to medicine.[17] The crux of the lead user approach is to seek out these user innovators and not just ask them for their requirements but ask for their ideas as well because they may have already prototyped a solution.[18] Identifying lead users and letting them add to the potential solution space may help drive the pace of innovation. Including lead users in other activities, such as R&D briefings, can also help expedite the need to solution cycle.

Research shows that users and producers (acquirers) develop different types of innovation.[19] Users generally create functionally novel innovation based on their detailed understanding of their needs. Producers often offer innovations based on their insights into emerging technologies or known solutions. In organizations where lead users and producers are combined or lead users are actively sought out, they tend to offer solutions with more advanced features and end up with products that have more success.[20]

Understanding user needs, quickly responding to changes in the user environment, and bringing new technologies or concepts quickly to the user to evaluate are core to being agile. Creating the conditions to make available the right user representative(s) is also critical. At the start of the program there will not be a detailed set of user requirements. Instead, an approved definition of top-level mission capability will guide development, as commander's intent guides military planning. Then, specific requirements will be iteratively refined based on operational user feedback. This is a foundational principle for agile. Without the appropriate user involvement, the approach is hollow.

With end users not normally in acquisition organizations and acquisition experts not normally in operational organizations, making this relationship sustainable will take thought and effort.[21]

Questions leaders must ask:

- How are users involved in the development process end to end? Is that enough?
- How often are workable capabilities provided to users for their evaluation and feedback? Can it be faster?
- Do we seek out lead users for their input on solutions? Where would we likely find a lead user for this capability?

Create and Invest in Cross-Functional Organizations

In traditional waterfall processes, functions such as user operational evaluations, interoperability certification, security accreditation, training, and testing all have their "turn" in the process and fall predominantly near the end of the project. Agile requires much tighter collaboration and continual integration across functional boundaries throughout the process. It may simply be too difficult to build projects around self-forming teams of motivated individuals in a Defense Department context. It is possible, however, to support new thinking about the role of functional stakeholders, such as testers, security certifiers, and enforcers of interoperability standards in agile programs.

As with user involvement, there are a variety of options for achieving integrated functional teaming:

- Maintain existing organizational boundaries and cross-matrix personnel to programs/projects with the ability to quickly bring together small multidisciplinary teams including users, developers, acquisition professionals, financial analysts, security experts, testers, and others as necessary.

- Expand organizations that already integrate multifunctional teams and have an agile culture. The DSB 2010 Summer Study, for example, proposed that each

service transition their various rapid acquisition organizations to a single organization similar to the Air Force Big Safari program with a "small, very capable, and experienced staff."[22] However, growing existing organizations too large or with too diverse a portfolio brings with it the risk of diluting their agility.

- Fill in missing functional expertise within existing multifunctional organizations. Organizational constructs such as Combined Test Forces currently used for some programs could be the core of an organizational construct that adds developers and other experts for continuous collaboration.[23]

- Create or spin-out new multifunction organizations designed from the ground up to lead agile programs.

In lean budget times, there is little appetite for creating new organizations, but this option should be considered nonetheless. Depending on the scale with which agile is applied, it might be the preferred option for certain mission areas.

The research on disruptive changes that challenge longstanding organizational processes and values suggests standing up focused organizations whose size and interest are aligned with the new need. This approach has been more effective than forcing an existing organization to change the way it does things.[24] Harvard University Professor Clayton Christensen outlines three courses of action for organizations that face this process/value mismatch:

- Create new internal capabilities within an existing organization. Form teams dedicated to the new challenge capable of breaking old boundaries and creating new processes. Use when a new challenge requires different people in the organization to interact differently than in the past.[25]

- Spin out an independent organization from an existing organization and develop within it the new processes and values required to solve the new problem. Use when the existing organization is unable or unwilling to accommodate new processes and values. Independence is required to get the priority needed when competing for resources.[26]

- Acquire a different organization whose processes and values closely match the requirements of the new tasks.

The choice of approach should be based on an assessment of existing organizational processes and values as compared to those needed to support the degree of required integrated functional teaming.[27] It should be noted that existing organizations will have difficulty where there is a large process and value mismatch.

Specific organizational solutions to achieve effective cross-functional teams may vary for different mission areas.

The DoD has made these types of organizational assessments and choices in the past. For example, the Big Safari program office was created in 1952 in response to Soviet weapons development. It was designed to work differently and address inadequacies with existing processes to quickly and comprehensively respond to new threats.[28] It still provides a quick reaction capability for acquiring, modifying, and managing special purpose weapons and communications systems, using streamlined acquisition processes. It has sustained these processes and values for decades.

More recently, in 2008, then Secretary Gates determined it was necessary to stand-up a dedicated, multifunctional team within the Office of the Undersecretary of Defense for Intelligence to quickly respond to warfighter intelligence needs. The ISR Task Force leads department-wide coordination and delivery of ISR support to the warfighter. It includes personnel from a variety of organizations who have a mandate to foster new processes and values to maximize support to combat operations. The ISR task force "identifies and recommends new ISR initiatives, coordinates funding solutions, provides acquisition oversight, coordinates system deployment and synchronizes their operational integration in support of combat operations."[29] According to the director of the Task Force, Lt Gen Koziol, "The ISR TF continues to be a small, flat, responsive organization. Our structure and focus evolve as necessary to meet emerging warfighter requirements." The TF is deeply engaged with users and advocates theater ISR needs. It has the ability to accelerate decisions, align resources, and remove traditional obstacles.[30]

Many commercial companies conducted the same internal assessments as they transitioned to agile processes. In 2007, the multimedia product unit of Ericsson, a provider of technology and services to telecom operators, initiated a transition to agile practices and mindset. It began with a few top-down directed pilot programs and has since expanded to other compatible teams.[31] Before the introduction of agile, functional expertise was stove-piped into separate departments, such as development, testing, integration, and verification. Projects passed serially from one department to the other. With agile, multidisciplinary teams were created that crossed department boundaries. Software designers, functional testers, and integration and verification engineers work together from the start of a project.[32] This change was cited as critical for the transition and stimulated knowledge spreading.[33] In their experience, testers had to adapt the most as they became continuously integrated with developers and were not delivered a black box product following development.

Unlike the gradual approach taken by the Ericsson unit, in early 2010, Unisys Cloud Engineering adopted agile throughout its entire organization simultaneously. [34] While starting with pilot programs and then scaling up is usually recommended, the

Unisys experience provides lessons for an organization-wide rollout. Unisys Cloud Engineering entirely redesigned their organization, which previously had supported a waterfall model. Their new structure was designed to support agile implementation across their geographically separated centers.[35] It was purposely built with the flexibility to form and adjust teams based on the expertise required and the priorities of the organization.

Experience and theory converge in predicting that existing organizations will have a hard time making wholesale adjustments when adopting agile. The predominant processes and values for injecting functional expertise in traditional programs do not easily support agile program needs. It will also be difficult for both traditional and agile cultures to coexist within one organization. Creating integrated multifunctional teams to work at the pace of agile will challenge existing DoD processes, structures, and values. An assessment of the extent of the challenge and identification of options for different mission areas is needed.

Questions leaders must ask:

- How do we provide an environment that encourages and allows the creation of dynamic cross-functional teams in a culture that is accustomed to well-defined functional organizational structures and tasks?

- How do we ensure stakeholders that care/need to care about a given capability are identified and involved early and throughout?

- Do we have time to change organizational cultures accustomed to traditional processes, or would a different organizational approach be more effective for the scale of change that is needed?

Measure and Incentivize what you Value

If the DoD commits to a different acquisition mindset for more systems and mission areas that is based on agile principles, it will need to adjust what it measures and where it puts its resources.[36] Aligning metrics and incentives to drive desired behaviors and values will be critical. Agile places more value on speed of delivery and usability. It values adaptability to changing operational conditions and technological advances. It places less value on process-compliance, detailed up-front analysis, and comprehensive documentation. Agile approaches value cross-functional team contributions to an overall outcome over individual performance or excellence in a single function process.

Deliberate thinking about adjusting measures and incentives has started. The previously referenced DARPA program, Transformative Apps, aims to match rewards

and metrics with agile processes. These include: "rewards for the developers that are based on number of downloads, usage statistics, or other measures of value to end users."[37] The National Research Council also provides a substantive list of candidate metrics for agile programs.[38] Organizations that have been successful with agile provide other sources for innovative metrics and incentives for teamwork and project failure that is learned from.[39] Metrics that do not include value to the end user will not create the required organizational change.

Commercial experiences with agile transitions also provide valuable insights into the importance of value change. Experiences of business units within three companies making the transition to agile practices - Ericsson, Unisys, and Cisco - were selected due to the large organizational size and the complexity of their development efforts. In each experience, the businesses cite the need for training and coaching to reinforce the agile values even when the need for change was widely recognized and supported. Additionally, leadership support and understanding of agile values and outcomes were identified as critical factors in their success.[40]

In Cisco's Voice Technology Group, members realized that they urgently needed to move away from lengthy, rigid waterfall processes based on their market and customer needs.[41] Nevertheless, they faced the challenge of scale, implementing agile processes across hundreds of teams building highly interdependent products. Their experience highlighted a need for upfront training to give a deeper understanding of the fundamental value changes. Leadership focused on improving delivery of value to the customer. In the end they cite measurable benefits in terms of delivering value in shorter timelines.[42]

In the Ericsson case, the unit used experienced agile coaches to help teams understand new concepts and practices. Coaches helped teams apply the new practices with discipline and focus on continual learning. In addition to bottom-line measures, leadership measured team motivation, initiative, and learning. In their experience, it took three iterations before teams transitioning to agile felt comfortable with the change. After that point, measures of motivation, initiative, and learning significantly increased.[43] They conclude that having an experienced agile coach is a pre-requisite for success if experienced developers and managers are lacking.[44]

Cisco's Unified Communications Business unit was one of the first organizations in Cisco to use agile methods, with projects starting in 2008.[45] After seeing value from their pilot programs, they adopted agile organization-wide in 2010. Cisco, too, focused on early training and coaches but wanted to provide more support for teams and to make sure the new culture took hold across the organization. They committed resources and created a separate Agile Office to strengthen the team and organizational culture needed for the long-term. The office engages with teams across the organization and provides training and coaching for particular needs. They ensure the basics of agile,

such as a user engagement strategy, are in place and tailor best practice sharing.[46] The organization continues to resource a dedicated office and cites a growing number of successful agile teams.[47]

For Unisys Cloud Engineering, the workforce was receptive to change and was supported by full-time agile coaches who worked across teams and shared best practices.[48] In retrospect, they cited the need for more formal training ahead of implementation to established needed baseline knowledge. As in other cases, Unisys cited executive sponsorship and expectation management as critical. Importantly, their organization's leader was certified in agile methods and had the full support of higher leadership. He personally coached teams and individuals through rough points in the transition and had the patience and commitment required to make a change of this magnitude.[49] Leadership allowed teams to learn, fail, and practice. They recognized that cultural shifts take time and estimated it would take nearly a year to be fully functional. During that time, delivery deadlines were purposely set to accommodate the transition to new processes and relationships. After a year, the pace, variety and number of completed complex products were measured as successful. Based on success measurements, these methods were spread to other business units.[50]

In these self-reported commercial successes attention was given to culture change and underlying values. This was evidenced by new organizational structures, leadership communication, emphasis on training and coaching, discipline in applying new practices, and the selection of appropriate measurements.

A Carnegie Mellon Software Engineering Institute (SEI) report describes in some detail the expected characteristics or values of development and user organizations based on their observations of successful agile efforts.[51] The comprehensive listing reiterates common themes of delivering value to the customer, supporting iterative delivery, adopting time-boxed approaches, and supporting end user interaction throughout development.[52] They conclude that the first step in affecting the required culture change in DoD is "to understand the difference in assumptions, shared values and artifacts that makeup up the cultures of agile projects and those of more traditional projects as executed in the DoD."[53] From that understanding, mechanisms for affecting culture change, such as training and aligning metrics and incentives, can be applied.[54]

This scale of value change requires senior leadership commitment until organizations achieve consistency between what the organization says it values (agility and adaptability) and what the organization measures and rewards. In the commercial world, Harvard's Christensen and his co-author Michael Overdorf observe they "have never seen a company succeed in addressing a change that disrupts its mainstream values without the personal, attentive oversight of the CEO."[55] OSD and Service leaders will need to want this change and drive it. Leaders will need to explain the new values to internal and external audiences. Selected metrics will need to be linked to the

behavior that the department desires. The cycle of congruence between vision, metrics, intended behavior, and reward will create new organizational cultures. These cultures can be considered mature when they operate by standard processes without requiring senior leader intervention to bypass institutional obstacles. There will clearly be difficult risk decisions and a need to balance policy compliance, security, reliability, and assurance, with agile values.

Questions leaders must ask:

- Is our training sufficient to support and reinforce the value change required?
- How are organizations rewarded for contributing to speed of delivery?
- How well do we measure usability and actual use?
- How do we quickly transfer resources from efforts that are not performing as expected to those that are showing more promise than expected after a few iterations?
- How do we reward failure that produced actionable feedback?

Notes

[1] Mary Ann Lapham, et al, "Considerations for Using Agile in DoD Acquisition," Carnegie Mellon, Software Engineering Institute: April 2010, Technical Note CMU/SEI-2010-TN -002. http://www.sei.cmu.edu/library/ reportspapers.cfm. Accessed January 10, 2012: xv.

[2] Ibid, xv, 39.

[3] Buxbaum, 3.

[4] Jennifer Lynch, "The Standish Group News." Posted February 20, 2012 07:21. http://blog.standishgroup .com/news. Accessed February 27, 2012.

[5] Larman, 287.

[6] Claire Schewerin, "Soldiers at the core of Network Integration Evaluation," Army news. April 18, 2012. http://www.army.mil/article/78048/Soldiers_at_core_of_Network_Integration_Evaluation. Accessed April 25, 2012.

[7] Defense Science Board, "2010 Summer Study: Enhancing Adaptability of US Military Forces," Washington, DC: January 2011. http://www.acq.osd.mil/dsb/reports/ADA536755.pdf. Accessed November 29, 2011: 27.

[8] Interview with Mr Kim High, Deputy Director 645 AESG--Big Safari Program, January 27, 2012.

[9] Dr. Regina E. Dugan, "Statement Submitted to the Subcommittee on Terrorism, Unconventional Threats and Capabilities," House Armed Services Committee, United States Congress, United States House of Representatives. Washington, DC: March 23, 2010. http://websearch.darpa.mil/search?q=argus&btnG= Search&entqr=0&ud=1&sort=date:D:L:d1&output=xml_no_dtd&oe=UTF-8&ie=UTF 8&client=default frontend&proxystylesheet =default_frontend &site = default_collection. Accessed April 25, 2012.

[10] Henry Keyon, "DOD's move to Android started with DARPA apps program," *Government Computer News*. January 31, 2012. http://gcn.com/Articles/2012/01/31/DARPA- apps-program-DOD-Android-smart-phones.aspx?Page=2. Accessed April 25, 2012.

[11] Dugan.

[12] Interview with Mr. Tim Yeager, JS/J4 Knowledge Based Logistics Division, March 27, 2012.

[13] Ibid.

[14] Danzig, 24.

[15] G.L. Lilien, G. L., P.D. Morrison, K. Searls, M. Sonnack, & E. von Hippel, "Performance Assessment of the Lead User Idea-Generation Process for New Product Development." *Management Science*, 48(8), 1042-1059, April 2002. http://stuff.mit.edu/people/evhippel/papers/Morrison%20et%20al%202002.pdf. Accessed November 8, 2011.

[16] Lilien, 3.

[17] P. Oliveira, P. & E. A. von Hippel, "Users as Service Innovators: The Case of Banking Services," Research Paper, MIT Sloan School of Management. October 20, 2009. http://papers.ssrn.com/sol3/papers.cfm? abstract_ id= 1460751. Accessed November 8, 2011 and Lilien, 19.

[18] Lilien, 3.

[19] Oliveira, 8.

[20] Oliveira, 8-9 and Lilien, 28.

[21] Lapham 2010, 12.

[22] Defense Science Board, "2010 Summer Study: Enhancing Adaptability of US Military Forces," Washington, DC: January 2011. http://www.acq.osd.mil/dsb/reports/ADA536755.pdf. Accessed November 29, 2011: viii.

[23] Interview with Col Shahnaz M. Punjani, Assistant Professor, Acquisition Dept, Industrial College of the Armed Forces, February 2, 2012.

[24] Clayton M. Christensen, *The innovator's dilemma: when new technologies cause great firms to fail*, Harvard Business School Press, Boston, Massachusetts: 1997: xxxi and Clayton M. Christensen, and Michael Overdorf, "Meeting the Challenge of Disruptive Change," *Harvard Business Review*, Apr 2000: 6-10.

[25] Christensen and Overdorf, 6.

[26] Ibid, 8.

[27] Christensen and Overdorf, 7 and Lapham 2011, 65-73.

[28] Defense Science Board, "2010 Summer Study: Enhancing Adaptability of US Military Forces, Part B. Washington DC: January 2011. http://www.acq.osd.mil/ dsb/ reports/ Enhancing AdaptabilityOf US MilitaryForcesB.pdf. Accessed November 29, 2011: 26-27.

[29] Jeff McKaughan, "Q&A with Lt. Gen. John C. Koziol, ISR Coordinator: Evolving ISR Structure and Focus to Meet Emerging Warfighter Requirements." *Tactical ISR Technology*, September 2011.

[30] Ibid.

[31] Jasper Goos and Alfo Melisse, "An Ericsson Example of Enterprise Class Agility," Agile 2008 Conference, IEEE computer society: 154.

[32] Ibid, 155.

[33] Ibid, 157.

[34] C. Lynn Cowan,, "When the VP is a Scrum master, you hit the ground running," 2011 Agile Conference, IEEE computer society: 279.

[35] Ibid, 279, 281.

[36]Chris Gunderson and Mark Pullen, "If Only Einstein Were Still Around to Help the Government Fix Information Technology Acquisition," *Defense AT&L*, November-December 2011: 12.

[37] Dugan.

[38] National Research Council, 45-46.

[39] Jo Ann Lane, et al, "Critical Success Factors for Rapid, Innovative Solutions. New Modeling Concepts for Today's Software Processes," Lecture Notes in Computer Science Springer Berlin / Heidelberg: 2010: 57-60.

[40] Goos; Cowen; Hubert Smits and Kathleen Rilliet, "Agile Experience Report Transition and Complexity at Cisco Voice Technology Group," 2011 Agile Conference, IEEE computer society; Ken Power, "The Agile Office," 2011Agile Conference, IEEE computer society.
[41] Smits and Rilliet, 274-277.
[42] Ibid.
[43] Goos, 155, 157.
[44] Ibid, 158.
[45] Power, 203.
[46] Ibid, 208.
[47] Ibid, 203, 205, 208.
[48] Cowan, 281.
[49] Ibid, 279, 281.
[50] Ibid, 279,282, 283.
[51] Lapham 2011, 66-68.
[52] Ibid.
[53] Ibid, 21.
[54] Ibid, 18-22.
[55] Christensen and Overdorf, 8.

CHAPTER SEVEN
Conclusions

For the past decade, delivering capabilities to protect troops and fight our wars required a host of professionals not often the subject of policy discussions. Collectively, they often defied status quo defense processes and bypassed existing institutions. They included software developers deployed at the tactical edge and innovative program managers and contract officers. Soldiers, sailors and airmen who showed exceptional creativity improving capabilities locally and the tenacity to get their ideas heard. Leaders who accepted risk and set conditions for success. They delivered tailored solutions to forces faced with dynamic and evolving adversaries and operational conditions. Many continue to innovate, and deliver, valuable capabilities today.

Often responding to urgent security needs, experience with agile methods has grown in pockets within Defense organizations. Defense guidance and leaders state the need to build agile, adaptive processes to speed fielding of capabilities.[1] Responding to Congressional guidance, a number of initiatives to reform processes are underway. These are all positive indicators.

However, as our active warfighting commitments draw down, and budgets tighten, we risk losing momentum for these efforts. We also risk losing important lessons and the experience of skilled practitioners. The challenges of scaling-up agile practices are significant. Deepening the involvement of user communities in development, creating flexible multifunctional teams, and shifting how we measure value may be difficult.

Agile approaches are not advisable for all programs. There are significant and legitimate tensions between speed of delivery on the one hand and no-fault testing and security accreditation processes on the other. There are tensions between detailed specifications and tailored usability. Defense programs face constraints, to varying degrees, that most commercial enterprises do not face in areas such as system security, acquisition security, mission assurance, and legislative oversight. Conventional processes have been optimized to deal with the extremes of these constraints.

However, the balance between systems requiring conventional approaches, and those that would be better suited with an agile approach is arguably shifting toward a need for more agile approaches. This requires creating the supporting institutional foundations to coexist with conventional processes.

Taking on these challenges is necessary. This period of declining budgets and internal procedural scrutiny provides a window of opportunity in which to act on recommendations and address core issues. The importance of being agile for the Department is growing. Agile practices and the cycle of deliver, learn, adapt, and improve need to expand beyond urgent combat needs. They need a solid, enduring, institutional foundation.

Notes

[1] U.S. Department of Defense, "Quadrennial Defense Review Report," February 2010: http://www.defense.gov/ qdr/images/QDR_as_of_12Feb10_1000.pdf. Accessed November 29, 2011: 80.

BIBLIOGRAPHY

"480th ISR Wing Improves Coalition Forces Information Sharing." Air Force ISR Agency news. August 3, 2011. Accessed March 7, 2012. http://www.afisr.af.mil/news/story.asp?id=123266468.

"A different game." *The Economist*. February 27, 2010, 6, S.8. ProQuest Research Library. Accessed March 7, 2012.

Beck, Kent, et al. *Manifesto for Agile Software Development*. Accessed October 3, 2011. http://www.agilemanifesto.org/.

Boland, Rita. "Military Enhances Supply Tracking," *SIGNAL online*, AFCEA: April 2010. Accessed March 20, 2012. http://www.afcea.org/signal/articles/templates/Signal_Article_Template.asp?articleid=2252&zoneid=292.

Brown, Tim and Katz, Barry. *Change by Design*. Harper Collins, New York: 2009.

Brown, Tim and Wyatt, Jocelyn. "Design Thinking for Social Innovation." *Stanford Social Innovation Review*. Winter 2010. Accessed April 30, 2012. http://innernorthfoundation.org.au/downloads/design_thinking.pdf.

Buxbaum, Peter. "Getting Agile on Software." *Military Information Technology 2012*, Vol 16: Issue: 1: February 2012. Accessed March 20, 2012. http://www.military-information technology. com/mit-home/379-mit-2012-volume-16-issue-1-february/5168-getting-agile-on-software.html.

Brown, Jason M. "Rethinking the network." *C4ISR Journal*, March 2010.

Christensen, Clayton M. and Overdorf, Michael. "Meeting the Challenge of Disruptive Change." *Harvard Business Review*, Apr 2000.

Christensen, Clayton M. *The innovator's dilemma: when new technologies cause great firms to fail*. Harvard Business School Press, Boston, Massachusetts: 1997.

Cowan, C. Lynn. *When the VP is a Scrum master, you hit the ground running*. 2011 Agile Conference, IEEE computer society.

Danzig, Richard. *Driving in the Dark: Ten Propositions about Prediction and National Security*. Center for a New American Security, Washington DC: Oct 2011.

"Data, Data Everywhere." *The Economist*. February, 27 2010: 3,S.5. ProQuest Research Library. Accessed March 7, 2012.

"DARPA Calls for Advances in "Big Data" to Help the Warfighter." DARPA website. March 29, 2012. Accessed April 11, 2012. http://www.darpa.mil/NewsEvents/Releases/2012/03/29.aspx.

Defense Acquisition University. *Defense Acquisition Guidebook*. January 10, 2012. Accessed January 18, 2012. https://acc.dau.mil/adl/enUS/350719/file/49150/DAG_01-10-2012.pdf and https://dap.dau.mil/aphome/das/Pages/Default.aspx.

Defense Science Board. *2010 Summer Study: Enhancing Adaptability of US Military Forces*. Washington, DC: January 2011. Accessed November 29, 2011. http://www.acq.osd.mil/dsb/reports/ADA536755.pdf and http://www.acq.osd.mil/dsb/reports/EnhancingAdaptabilityOfUSMilitaryForcesB.pdf.

Defense Science Board. *Report of the Joint Defense Science Board Intelligence Science Board Task Force on Integrating Sensor-Collected Intelligence*. Washington DC: November 2008.

Defense Science Board. *Report of the Defense Science Board Task Force on Department of Defense Policies and Procedures for the Acquisition of Information*. Washington DC: March 2009. Accessed March 5, 2012. http://www.acq.osd.mil/dsb/reports/ADA498375.pdf.

Defense Science Board. *Report of the Defense Science Board Task Force on Defense Intelligence Counterinsurgency (COIN) Intelligence, Surveillance, and Reconnaissance (ISR) Operations*. Washington, DC: February 2011. Accessed November 21, 2011. http://www.acq.osd.mil/dsb/reports/ADA543575.pdf.

Defense Science Board. *Report of the Defense Science Board Task Force on the Fulfillment of Urgent Operational Needs*. Washington DC: July 2009. Accessed April 11, 2012. http://www.acq.osd.mil/dsb/reports/ADA503382.pdf.

Defense Science Board. *Report of the Defense Science Board Task Force on Military Software*. September 1987. Accessed February 21, 2012. http://handle.dtic.mil/100.2/ADA188561

Donnelly, Harrison. *Intel Technologist: Developing Great Technology to Address Key Intelligence Challenges, Dawn Meyerriecks, Deputy Director of National Intelligence Acquisition and Technology*. GIF 2011 Vol: 9 Issue: 6. Accessed January, 8 2012. http://www.geospatial-intelligence-forum.com/mgt-home/345-gif-2011-volume-9-issue-6-september/4647-qaa-dawn-meyerriecks.pdf.

Donnelly, Harrison. "Interview with Terri Takai, Enterprise Architect: Strengthening the Ability to Share Information Quickly and Securely." *Military Information Technology 2011*, Vol: 15 Issue: 10. Accessed April 13, 2012. http://www.military-information-technology.com/mit-home/367-mit-2011-volume-15-issue-10-november/4993-qaa-teri-takai.pdf.

Dugan, Dr. Regina E. *Statement Submitted to the Subcommittee on Terrorism, Unconventional Threats and Capabilities, House Armed Services Committee*, United States Congress, United States House of Representatives. Washington DC: March 23, 2010. Accessed April 25, 2012. http://websearch.darpa.mil/search?q=argus&btnG=Search&entqr=0&ud=1&sort=date:D:L:d1&output=xml_no_dtd&oe=UTF-8&ie=UTF 8&client=default _frontend&proxystylesheet=default_frontend &site = default_collection.

Flynn, Michael T. Maj Gen, Pottinger, Matt, and Batchelor, Paul D. *Fixing Intelligence: A Blueprint for Making Intelligence Relevant in Afghanistan*. Center for a New American Security, Washington, DC: January 2010.

Franke, N., von Hippel, E., and Schreier, M. "Finding Commercially Attractive User Innovations: A Test ofLead-User Theory." *Journal of Product Innovation Management*, 23(4), 301-315. April 2005. Accessed November 8, 2011. http://web.mit.edu/evhippel/www/papers/Franke%20et%20al%202006.pdf.

Gates, Robert. M. "A Balanced Strategy: Reprogramming the Pentagon for a New Age." *Foreign Affairs*, 88(1), January/February 2009, 28-40. ProQuest Research Library. Accessed January 12, 2012.

Gertler, Jeremiah. *U.S. Unmanned Aerial Systems*. Congressional Research Service, Washington DC: January 3, 2012.

Goos, Jasper and Melisse, Alfo. *An Ericsson Example of Enterprise Class Agility*. Agile 2008 Conference, IEEE computer society.

Government Accountability Office. *Information Technology, Critical Factors Underlying Successful Major Acquisitions*. Washington DC: October 2011. Accessed November 22, 2011. http://www.gao.gov/new.items/d127.pdf.

Gunderson, Chris and Pullen, Mark. "If Only Einstein Were Still Around to Help the Government Fix Information Technology Acquisition." *Defense AT&L*, November-December 2011.

Hartman, Josh. "NGA's Shifting Analysis: Challenges and Opportunities of the New Direction." *Imaging Notes*, Winter 2011, Vol 26, N 1. Accessed March 1, 2012. http://www.imagingnotes.com/go/articleJ.php?mp_id=249.

Houghton, R.S. *Major trends of the fourth age of computing: New pressures for growing educational capacity*. Accessed February 24, 2012. http://www.wcu.edu/ceap/houghton/readings/technology_trends.html.

"iPhone." Apple. Accessed April 25, 2012. http://www.apple.com/iphone/from-the-app-store/.

"iPhone." Wikipedia. Accessed April 25, 2012. http://en.wikipedia.org/wiki/IPhone.

Jobs, Steven. *Keynote speech introducing the new iPhone*. Uploaded by mclane76 on Jan 10, 2007. Accessed February 27, 2012. http://www.youtube.com/watch?v=ASkis57blsc.

Kenyon, Henry. "DOD's move to Android started with DARPA apps program." *Government Computer News*. January 31, 2012. Accessed April 25, 2012. http://gcn.com/Articles/2012/01/31/DARPA-apps-program-DOD-Android-smart-phones.aspx?Page=2.

Kundra, Vivek. *25 Point Implementation Plan to Reform Federal Information Technology Management*. The White House, Washington DC: December 9, 2010. Accessed October 7, 2011. http://www.cio.gov/documents/25-Point-Implementation-Plan-to-Reform-Federal%20IT.pdf.

Lapham, Mary Ann, et al. *Agile Methods: Selected DoD Management and Acquisition Concerns*. Carnegie Mellon, Software Engineering Institute: October 2011, Technical Note CMU/SEI-2011-TN-002. Accessed February 27, 2012. http://www.sei.cmu.edu/library/reportspapers.cfm.

Lapham, Mary Ann, et al. *Considerations for Using Agile in DoD Acquisition*. Carnegie Mellon, Software Engineering Institute: April 2010, Technical Note CMU/SEI-2010-TN -002. Accessed January 10, 2012. http://www.sei.cmu.edu/library/reportspapers.cfm.

Lane, Jo Ann, et al. *Critical Success Factors for Rapid, Innovative Solutions*. New Modeling Concepts for Today's Software Processes. Lecture Notes in Computer Science Springer Berlin / Heidelberg: 2010.

Larman, Craig. *Agile and Iterative Development: A Manger's Guide*. Addison-Wesley, Boston: 2004.

Larman, Craig and Basil, Victor R. *Iterative and Incremental Development: A brief history*. IEEE Computer, June 2003.

Lehman, Tobin and Sharma, Akhilesh. *Software Development as a Service: Agile Experiences*, 2001 Annual SRII Global Conference, IEEE computer society.

Lilien, G. L., Morrison, P. D., Searls, K., Sonnack, M., & von Hippel, E. "Performance Assessment of the Lead User Idea-Generation Process for New Product Development." *Management Science*, 48(8), 1042-1059, April 2002. Accessed November 8, 2011. http://stuff.mit.edu/people/evhippel/papers/Morrison%20et%20al%202002.pdf.

Lockheed Martin. *Kelly's 14 Rules & Practices*. Accessed January 11, 2012. http://www.lockheedmartin.com/us/aeronautics/skunkworks/14rules.html.

Lockheed Martin. *Skunk Works*. Accessed January 11, 2012. http://www.lockheedmartin.com/us/aeronautics/skunkworks.html.

Lynch, Jennifer. *The Standish Group News*. Posted February 20, 2012 07:21. Accessed February 27, 2012. http://blog.standishgroup.com/news.

Martin, Jim. *Disruptive Technologies, Innovation or Disruption? The Impact of Changing Technology upon ISR Capabilities*, 11 Oct 10. Accessed January 18, 2012. http://www.dtic.mil/ndia/2010disrupt/Jim_Martin.pdf.

McKaughan, Jeff. "Q&A with Lt. Gen. John C. Koziol, ISR Coordinator: Evolving ISR Structure and Focus to Meet Emerging Warfighter Requirements." *Tactical ISR Technology*, September 2011.

McKinsey Global Institute. *Big data: The Next Frontier for innovation, competition and productivity*. McKinsey & Company, June 2011.

National Research Council. *Achieving Effective Acquisition of Information Technology in the Department of Defense*. The National Academies Press, Washington DC: 2010. Accessed December 1, 2011. http://www.nap.edu/catalog.php?record_id=12823.

Northern, Carlton, et al. *Handbook for Implementing Agile in Department of Defense Information Technology Acquisition*. The MITRE Corporation. 15 December 2010.

Oliveira, P. & von Hippel, E. A. *Users as Service Innovators: The Case of Banking Services*. Research Paper, MIT Sloan School of Management. October 20, 2009. Accessed November 8, 2011. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1460751.

Panetta, Leon. *Defense Priorities: Today and Tomorrow*. Given at the Woodrow Wilson International Center for Scholars. October 11, 2011. Accessed October 18, 2011. http://www.wilsoncenter.org/event/defense-priorities-today-and-tomorrow-secretary-leon-panetta#field_files.

Peters, Katherine McIntire. "Air Force leaders describe plan to improve ISR capabilities." GOVEXEC.com. July 6, 2009. Accessed April 12, 2012. http://www.govexec.com/defense/2009/07/air-force-leaders-describe-plan-to-improve-isr-capabilities/29502/.

Power, Ken. *The Agile Office*. 2011 Agile Conference, IEEE computer society.

Petraeus, David H. "Adaptive, Responsive, and Speedy Acquisitions." *Defense AT&L*, January-February 2010.

Pontius, Ronald W. *Acquisition of Information Technology: Improving Efficiency and Effectiveness in Information Technology Acquisitions in the Department of Defense*, Given at the Association for Enterprise Information, Agile in Defense Conference, March 21, 2012. Accessed April 10, 2012. http://www.afei.org/events/2A01/Documents/ Pontius_Ron_IT% 20Acquisition %20Brief%20(17).pdf.

Reagan, Rex B. and Rico, David F. *Lean and Agile Acquisition and Systems Engineering, A Paradigm Whose Time Has Come*. Defense Acquisition University, Defense AT&L, Nov-Dec 2010.

Rich, Ben R. and Janos, Leo. *Skunkworks: A Personal Memoir of My Years at Lockheed*. Little, Brown and Company, Boston: 1994.

Schewerin, Claire. "Soldiers at the core of Network Integration Evaluation." Army news. April 18, 2012. Accessed April 25, 2012. http://www.army.mil/article/78048/Soldiers_at_core_of_Network_Integration_Evaluation.

Smits, Hubert and Rilliet, Kathleen. *Agile Experience Report Transition and Complexity at Cisco Voice Technology Group*. 2011 Agile Conference, IEEE computer society.

Takai, Teri. *DoD CIO's 10-Point Plan for IT Modernization*. DoD CIO. Accessed April 26, 2012. http://dodcio.defense.gov/Portals/0/Documents/ITMod/CIO%2010%20Point%20Plan%20for%20IT%20Modernization.pdf.

United States Joint Forces Command. *The Joint Operating Environment (JOE) 2010,* February 8, 2010. Accessed November 29, 2011. http://www.dtic.mil/dtic/tr/fulltext/u2/a518100.pdf.

U.S. Congress. Public law 111–84 National Defense Authorization Act for Fiscal year 2010 Sec. 804. *Implementation of new acquisition process for information technology systems*. October 28, 2009. Accessed January 23, 2012. http://www.gpo.gov/fdsys/pkg/PLAW-111publ84/pdf/PLAW-111publ84.pdf.

U.S. Department of Defense. *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*. Office of the Secretary of Defense, Washington DC: Jan 2012. Accessed January 8, 2012. http://www.defense.gov/news/Defense_Strategic_Guidance.pdf.

U.S. Department of Defense. *Quadrennial Defense Review Report*. February 2010. Accessed November 29, 2011. http://www.defense.gov/qdr/images/QDR_as_of_12Feb10_1000.pdf.

Weckerleing, Julie. "ROVER gives joint force new vision." Air Force Print News, December 16, 2005. Accessed April 12, 2012. http://www.af.mil/news/story.asp?id=123013585.

APPENDIX

Review of Recommendations From Reports on Federal/Department of Defense Information Technology

Report Title	Summary of Recommendations
Report of the Defense Science Board Task Force on Department of Defense Policies and Procedures for the Acquisition of Information Technology, March 2009 (Memo for Chairman, Defense Science Board, p. x-xvii, p. 60-68)	**Recommendation 1. New Acquisition Process for Information Technology**. A new acquisition process for information technology should be developed—modeled on successful commercial practices, for the rapid acquisition and continuous upgrade and improvement of IT capabilities. The process should be agile and geared to delivering meaningful increments of capability in approximately 18 months or less—increments that are prioritized based on need and technical readiness. **Recommendation 2: Roles and responsibilities of the Assistant Secretary of Defense for Networks and Information Integration/DOD Chief Information Officer (ASD (NII)/DOD CIO).** The ASD (NII)/DOD CIO should have strong authorities and responsibilities for enterprise-wide information policy vision, architecture, infrastructure, metadata and other standards, spectrum, interoperability, information assurance, and system engineering. **Recommendation 3: Acquisition authorities and organization.** Acquisition authority and expertise in OSD is currently spread across several organizations, resulting in a lack of enterprise-wide architecture and coordination. Consolidate all acquisition oversight of information technology under the USD (AT&L) by moving into that organization, those elements of the ASD (NII)/DOD CIO and Business Transformation Agency organizations responsible for IT acquisition oversight. **Recommendation 4: Acquisition expertise.** Today, the subject matter competencies required for successful enterprise IT system acquisition are too often missing in government managers responsible for program execution. Acquisition leaders need proven and relevant business experience in the appropriate areas of acquisition, product development, and management. Similarly, program managers and program executive officers need track records of proven success.
"Achieving Effective Acquisition of Information Technologies in the Department of Defense", National Research Council, 2010 (p. 5-16)	**Recommendation 1. Adopt a new acquisition process tailored for IT systems.** For IT systems, the acquisition processes, which are currently defined by the 5000 series of DOD regulations, should be replaced with a new process designed specifically for the timely and effective acquisition of IT systems. **Recommendation 1.1. Emphasize timeliness and end user mission success in the DOD IT acquisition culture rather than rigid oversight and process compliance.** **Recommendation 1.2. State IT systems requirements as top-level mission expectations (that is, "big-R" requirements) rather than as detailed processes or technical solutions; develop the details ("small-r" requirements) by iterative refinement with users.** **Recommendation 1.3. Leverage flexibilities within IT acquisition funding to achieve speed and agility in the new acquisition process.** **Recommendation 1.4. Provide IT systems acquisition professionals with education in modern IT systems and establish minimum**

	competency standards. **Recommendation 1.5. Use pilot programs to institutionalize the new IT acquisition process recommended in this report.** **Recommendation 1.6. Propose legislative and regulatory changes (1) to codify a new agile process for acquiring IT systems and (2) to revise dollar thresholds for the oversight of IT systems acquisition in order to foster decentralization.** **Recommendation 2. Adopt an iterative, incremental approach for acquiring information technology systems.** **Recommendation 2.1. Establish iterative, incremental development (IID) processes based on agile software development and related approaches as the default for IT system development.** **Recommendation 2.2. Allocate top-level DOD mission expectations (i.e., big-R requirements) across increments and use each increment to define and satisfy detailed requirements (i.e., small-r requirements).** **Recommendation 2.3. Establish separate and distinct strategies and processes for acquiring custom versus off-the-shelf IT systems.** **Recommendation 2.4. Establish, employ, and report measures of success that emphasize the end-user experience, including timeliness to field.** **Recommendation 2.5. Provide a stable budget profile across multiple increments for iterative, incremental development of IT programs.** **Recommendation 3. Perform continuous testing, with early involvement from end users, in acquiring DOD information technology systems.** **Recommendation 3.1. Adopt continuous testing in DOD IT systems development, and insist on the use of metrics, especially emphasizing measures of end-user satisfaction.** **Recommendation 3.2. Emphasize the needs of end users by having the acceptance team play a lead role in recommending deployment decisions.** **Recommendation 3.3. Test with users in their actual work or field environment (sometimes referred to as a beta deployment).** **Recommendation 3.4. Accept certification and functional IT system component test results across organizational boundaries.**
Information Technology, Critical Factors Underlying Successful Major Acquisitions, GAO, Oct 2011 (p. 19)	Department officials identified nine common factors that were critical to the success of three or more of the seven investments. Common Critical Success Factors: **1. Program officials were actively engaged with stakeholders.** 2. Program staff had the necessary knowledge and skills. 3. Senior department and agency executives supported the programs. **4. End users and stakeholders were involved in the development of requirements.** **5. End users participated in testing of system functionality prior to formal end user acceptance testing.** 6. Government and contractor staff were stable and consistent. 7. Program staff prioritized requirements.

	8. Program officials maintained regular communication with the prime contractor. 9. Programs received sufficient funding. Implementation of these critical factors will not necessarily ensure that federal agencies will successfully acquire IT systems because many different factors contribute to successful acquisitions. Nonetheless, these critical factors support OMB's objective of improving the management of large-scale IT acquisitions across the federal government, and wide dissemination of these factors could complement OMB's efforts.
25 Point Implementation Plan to Reform Federal Information Technology Management", the U.S. Chief Information Officer, December 2010 (p. 5-32)	**A. Apply "Light Technology" and Shared Solutions** **B. Strengthen Program Management** **C. Align the Acquisition and Budgets Processes with the Technology Cycle** **D. Streamline Governance and Accountability** **E. Increase Engagement with Industry**
Report of the Defense Science Board Task Force on Military Software, September 1987 (p. 14-41)	**Recommendation 12: Use evolutionary acquisition, including simulation and prototyping, as discussed elsewhere in this report, to reduce risk.** **Recommendation 13: The Undersecretary of Defense (Acquisition) should adopt a four-category classification as the basis for acquisition policy.** We see vast differences in the software systems that DoD buys and builds. We recommend that these differences should be explicitly recognized by an official classification into four major classes according to uniqueness and novelty. **Recommendation 15: The Undersecretary of Defense (Acquisition) and the Assistant Secretary of Defense (Comptroller) should direct Program Managers to assume that system software requirements can be met with off-the-shelf subsystems and components until it is proved that they are unique.** **Recommendation 17: DoD should devise increased productivity incentives for custom-built software contracts, and make such incentivized contracts the standard practice.** **Recommendation 18: DoD should devise increased profit incentives on software quality.** **Recommendation 21: DoD should examine and revise regulations to approach modern commercial practice insofar as practicable and appropriate.** **Recommendation 23: The Undersecretary of Defense (Acquisition) should update DoD Directive 5000.29, "Management of Computer Resources In Major Defense Systems", so that it mandates the Iterative setting of specifications, the rapid prototyping of specified systems, and Incremental development.** **Recommendation 26: Each Service should provide its software Product Development Division with the ability to do rapid prototyping in conjunction with users.** **Recommendation 27: Each Service should provide its software Using Commands with facilities to do comprehensive operational testing and life-cycle evaluation of extensions and changes.** **Recommendation 28: The Undersecretary of Defense (Acquisition) and the Assistant Secretary of Defense (Comptroller) should by directive spell out the role of Using Commands in the evolutionary and incremental development of software systems.** **Recommendation 29: The Undersecretary of Defense (Acquisition) should**

	develop economic incentives, to be Incorporated into standard contracts, to allow contractors to profit from offering modules for reuse, even though built with DoD funds. **Recommendation 30: The Undersecretary of Defense (Acquisition) should develop economic incentives, to be incorporated Into all cost-plus standard contracts, to encourage contractors to buy modules and use them rather than building new ones.** **Recommendation 34: Do not believe DoD can solve its skilled personnel shortage; plan how best to live with it, and how to ameliorate it.** **Recommendation 37: Structure some officer careers to build a cadre of technical managers with deep technical mastery and broad operational overview.** **Recommendation 38: Enhance education for software personnel.**

About the Author

Colonel Lourdes Duvall is an Air Force intelligence officer with over 18 years experience in intelligence, surveillance, and reconnaissance operations and all-source analysis. She supported numerous combat and humanitarian operations while assigned to special operations aviation units, intelligence squadrons, operations centers, the Air Staff and the Joint Staff. While serving in the Joint Staff Directorate of Intelligence, Future Capabilities Division, she led assessments of warfighter requirements and intelligence acquisition programs, advising Defense Department decisions on future programs. She most recently commanded an intelligence squadron in South Korea, conducting combined operations with the Republic of Korea Air Force.

Colonel Duvall graduated from the United States Air Force Academy with a Bachelor of Science in political science. She holds a master's degree in military operational art and science from Air University and a master's degree in public policy from the John F. Kennedy School of Government, Harvard University. She served on the faculty of Air Command and Staff College, Department of International Security and Military Studies.