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Where Have All the **Nunn-McCurdys** Gone?

**Innovation in the Defense
Acquisition Enterprise**

by the Under Secretary of Defense for
Acquisition, Technology, and Logistics

**Top Performing PMs
How DAU Develops Them**

Leadership 101

CONTENTS



2 From the Under Secretary of Defense for Acquisition, Technology, and Logistics **Innovation in the Defense Acquisition Enterprise** *Frank Kendall*

7



Where Have All the Nunn-McCurdys Gone?

Mark Husband, Dr. Eng.

There has been a sharp reduction over recent years in the number of critical and significant cost, schedule and performance shortfalls in defense programs. Defense analysts have strong opinions about why.

10



Top Performing PMs

How DAU Develops Them

Owen C. Gadeken

Critical thinking is a crucial part of the specialized executive-level training for managers who head the most expensive and critical major acquisition programs.

16



Leadership 101

Scott Reynolds

The characteristics and cultures of extraordinary teams are examined, along with those who manage them.

21



Getting the Best Value in a Source Selection

Brian Schultz and David Dotson

Competition is a key element in acquisition, but greater value is not always tied to lower prices or cost savings.

26



A Contract Requirement Rule for Program Managers

Paul Solomon

The Project Management Body of Knowledge is weighed against an approach integrating systems engineering and risk management with the Earned Value Management System.

32



Delphi, Dice and Dominos

Techniques to Understand and Mitigate Technical Risk

David L. Gallop

Three simple techniques can be used separately or together to avoid common logic traps in managing technical risk.

36



If Your Technology Works, Will It Matter?

Ryan Umstattd, Ph.D.

It is important to go beyond groundbreaking research and develop credible paths for commercializing advanced technologies.

40



Bridging the Technology Valley of Death

in Joint Medical Development

Anthony E. Pusateri, Ph.D.; Victor W. Macdonald, Ph.D.; Michael B. Given, Ph.D.; Scott F. Walter, P.E.; and W. Keith Prusaczyk, Ph.D.

Planning is needed so research can provide improved military capabilities.



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Under Secretary of Defense for Acquisition, Technology, and Logistics
Frank Kendall

Assistant Secretary of Defense for Acquisition
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Some photos appearing in this publication may be digitally enhanced.

46



The Myth of Data Rights

Peter A. Czech

Industry now is the leading source of research and development funding, and this requires a new government consciousness of intellectual property rights.

51



Early Birds in Korea

"Exporting" Defense AT&L Has Far-Reaching Impact

DT Tripp and Hwa Yu

A South Korean defense agency uses a U.S. Department of Defense magazine to improve acquisition.

56

Airborne, All The Way, 3D From the Sky

Approach for an Air Drop Capable, Medium Tactical Vehicle
CPT Peter F. Syverson, USA

61

"This Is Your Brain ..."

A Decision-Making Machine
Roy Wood and Patrick Barker

ALSO

24 MDAP/MAIS Program Manager Changes

30 The Loss of a Leader in Defense Acquisition
Claude M. Bolton Jr., 1945-2015

31 Statement of Ownership



Innovation

in the Defense Acquisition Enterprise

Frank Kendall



Innovation has become a very popular word lately. Former Secretary of Defense Chuck Hagel announced the Defense Innovation Initiative about a year ago. At about the same time, the draft Better Buying Power 3.0 set of initiatives, focusing on technical excellence and innovation, were published for comment. Deputy Defense Secretary Robert O. Work has led the effort to develop an innovative “Third Offset Strategy.” Most recently, Secretary of Defense Ashton Carter announced the opening of the Defense Innovation Unit—Experimental, or DIU-X, in California’s Silicon Valley. President Obama has led the administration’s successful opening of several Manufacturing Innovation Institutes, most of which are sponsored by the Department of Defense (DoD). And more institutes are on the way.

Today it is possible to obtain advanced degrees at major universities in the fields of innovation and entrepreneurship. Many books and articles have been written on innovation, perhaps none more well-known than Clayton Christianson’s “The Innovators Dilemma.” I would like to add a few thoughts to that body of work by making some very unscientific (meaning unsupported by data) comments on the ingredients needed to foster and encourage innovation—and on the extent to which the DoD acquisition enterprise has or does not have those ingredients today.

The first and absolutely necessary ingredient is knowledge. Technical innovation is itself, almost by definition, a new idea. But new ideas are rooted in the knowledge that makes the new idea conceivable and practical. Part of Better Buying Power 3.0 involves increased support for education in STEM (science, technology, engineering, and mathematics). Our educational system provides the foundation of our knowledge, but that is just the beginning. Experience, exposure to a wide and diverse range of technical fields, and continuing in-depth study are all important. For the more exciting areas of technical innovation today, this knowledge is increasingly highly specialized

and deep. I recently visited the Massachusetts Institute of Technology and spoke to researchers in the fields of biological process-based materials production, novel computational architectures, and autonomy. These are areas in which it is not possible to enable innovation unless one has a deep knowledge of the science and associated technology. I believe that we are in the early stages of some explosive growth in the products that these and other technologies will make possible, but some very specialized advanced technology work will have to be accomplished to achieve that potential. Once that occurs, innovative applications of these technologies will be created at an exponential rate. In many cases today, the DoD is not the primary financial supporter of the relevant work. Nevertheless, the DoD's basic research program still represents an important contributor, and it provides a basis by which the DoD can shape and capitalize on new technical knowledge as it is created. By reaching out to nontraditional sources, such as through the DIU-X, the DoD intends to increase its knowledge of the possibilities that commercial cutting edge technology can offer to DoD.

My second ingredient is freedom. By this, I mean the freedom to have a new idea and to take action in pursuit of that idea. I mean the freedom to fail and start again. I also mean freedom from bureaucratic constraints. Our free enterprise system provides this ingredient on a national scale, and it is the most powerful economic engine ever created. The United States stands out as a place where it is amazingly easy to start a new business. I've done it a couple of times.

Within the DoD, one of our most effective and successful institutions—the Defense Advanced Research Projects Agency (DARPA)—is a living testament to the value of freedom. I zealously guard DARPA's freedom from the many parts of the DoD that see DARPA's budget as an opportunity to fund something they need. The whole concept of DARPA is that the organization has the freedom to choose its own high-risk but high-payoff investments.

In DoD more broadly, we set strategic goals for technology investment, require a certain fraction of the Services Science and Technology work to be in these areas and leave those organizations the freedom to choose their own priorities for the balance of their work. Within DoD, we also allow our contractors to pursue Independent Research and Development (IR&D) as an allowable overhead cost with very little constraint.

I made industry a little nervous recently by proposing in Better Buying Power 3.0 to increase the DoD's oversight of this work. The fundamental concern of industry partners has been the possible loss of freedom to make their own IR&D investment decisions. That was never my intent. I once ran a major

defense contractor's IR&D program, and I appreciate industry's perspective. I appreciate the value, to industry and the DoD, of allowing industry to place its own bets on technology that might increase a firm's competitiveness.

After carefully considering several alternatives, the policy I propose would merely require industry to brief an appropriate DoD officer or official prior to and after concluding an IR&D project, and to document that the meeting occurred as part of the accounting for the project. This policy would not require sponsorship or approval of an IR&D project by a DoD official, but it would require industry to communicate directly with appropriate DoD personnel and to obtain feedback on the proposed work and to communicate the results when the work is complete. This should not constrain industry's freedom in any way that current regulations and statutes don't already require, and it will provide the benefit of ensuring more frequent and effective communication between industry and government.

Human Intangibles

My next two ingredients enter the area of what I will call subjective human intangibles. These intangibles also are manifested in what we call organizational cultures. One could generate a pretty long list of the human qualities needed for successful innovation. The list might include innate intelligence, creativity or the ability to think "out of the box" and curiosity, to name just a few such qualities. These address the capacity to have a new idea. A great deal of work has gone into structuring organizational environments to encourage and foster creativity. This can include physical arrangements, workplace layouts, and a range of approaches intended to foster cultural norms that support creativity.

Some companies use problem-solving tests to identify candidates with high creativity. I believe all this work has merit, but I also think its goal is to select creative people and to draw out the inherent creativity that people either do or do not possess. I'm only going to mention two human qualities that I think have great importance, and that DoD managers at all levels should be especially conscious of: risk tolerance and persistence.

Accepting Risk

I was asked by a reporter during an interview 2 or 3 years ago if the DoD was taking too much risk in its programs. My response was that we are not taking enough risks. With respect to our major programs, I find myself pushed in two directions simultaneously by the political winds in Washington. At the same time that I am told the expectation for all our programs is to have no schedule slips or cost overruns, I also am told that we should go much faster in our programs and not have so much oversight. I'm sorry, but you can't have it both ways.

My observation is that the politicization of these decisions does not generally lead to better results. We also have frequent leadership changes—which makes persistence in the face of difficulties more problematic.

To me, both perspectives miss the point. Development of new products, particularly a new generation of cutting-edge and militarily dominant systems, cannot be made risk free. If we want risk-free defense acquisition, we should just buy fully developed products from other countries. If, on the other hand, we want the best military in the world, and one in which our warfighters always have innovative and dominant equipment, then we are going to have risk in our programs.

One of our program managers' most important responsibilities is to understand and proactively manage the risk inherent in any development program. (I wrote about that responsibility in an article in the July-August 2015 issue of *Defense AT&L* magazine.) To borrow a line from the movies, the secret of life is balance. We have to balance risk against urgency and resource constraints. If we are too cautious, our programs will take forever and be too modest in their ambitions. If we gamble wildly, we will waste precious resources and not meet our objectives.

At the enterprise level in DoD today, there is strong support for accepting the risk of embarking on a number of what I will call advanced technology demonstration programs. The recently completed Long Range Research and Development Planning Program has recommended several advanced technology demonstration programs for consideration in the Fiscal Year (FY) 2017 budget. Similarly, the Strategic Capabilities Office is proposing demonstration programs based on novel applications of currently fielded systems or those in development. In the FY 2016 budget, I was able to secure funding for the Aerospace Innovation Initiative that will culminate in X-plane-type and propulsion technology demonstrators that will create options for the systems subsequent to our current Joint Strike Fighter program. This fall, all of these demonstration proposals will collide with budget reality at the President's Budget request level. Needless to say, if sequestration occurs, that collision will be even more violent. In some cases, we could reasonably accept more risk and move directly into Engineer-

ing and Manufacturing Development (EMD) programs instead of pursuing concept demonstration programs, but we simply don't have the resources to conduct those EMD programs.

Persistence

The other intangible characteristic successful innovators demonstrate is persistence. When innovators encounter obstacles, they find ways through or around them. Two obvious historical examples are Thomas Edison and his quest for a practical light bulb, and the Wright brothers and their pursuit of controlled, powered flight. (David McCullough has written a new book chronicling the Wright brothers' tenacious pursuit of powered and controlled flight.)

The DoD has sometimes been criticized for sticking with programs that encounter problems. The F-35 fighter is a current example. Earlier ones in my experience include the C-17, the Advanced Medium-Range Air-to-Air Missile, and the F-18E/F fighter. In all those cases, we persevered and achieved good results. In other cases, we have stopped programs that, in retrospect, we probably should have continued. In still other cases, we kept going for far too long on programs that should have been canceled earlier. In general, my sense is that, for most programs, we can get to a product that meets our requirements if we have the patience and persistence to continue. There are exceptions, however.

There is an important difference between the persistence applied to commercial innovation and that applied to innovative products in DoD. For commercial products, both in start-ups and large corporations, the decision to continue product development when problems are encountered is driven by the judgment of the management (influenced by persistence and risk tolerance) and by the resources available to the firm. In DoD's case, these decisions have a high political content—both internally and externally. My observation is that the politicization of these decisions does not generally lead to better results. We also have frequent leadership changes—which makes persistence in the face of difficulties more problematic. I have no solution to offer for all this other than to continue the work of the last several years to ensure we don't start unaffordable programs, and to manage risk professionally and proactively in our development programs. The DoD spends taxpayer-provided money; we will always be under close public scrutiny, and we will always have internal competition for resources.

Collaboration

Innovation, in the commercial and the DoD context, tends to be based on collaboration. Multiple technical disciplines often have to come together, and the synergy between multiple disciplines may be the central feature of the innovative idea. In the DoD, technical ideas only reach the

market when the using military Service decides to embrace the new concept or new product. This is not quite the same as the commercial market where “early adopters” from a large customer base may help a technology establish a foothold and gain credence. Commercial entrepreneurs build the better mouse trap first and expect customers to come. In DoD the customers, the military Departments, ask for fairly specific products and then budget the resources to pay for the development of those products.

The DoD also uses a formalized requirements process that is based on the perception of “gaps” in capability. Requirements are generated to fill these perceived gaps. This approach tends to be self-limiting and to discourage new concepts and innovative approaches that deviate from existing paradigms. Henry Ford’s famous quip that if he had asked his customers what they wanted it would have been a better horse has some relevance here. The fact is, however, that despite our formal process, requirements are often based on the priorities of senior Service leadership. For this reason, I welcome the initiative from the U.S. Senate to increase Service leadership involvement in acquisition.

A strong collaboration between Service leadership and the technical acquisition community, starting as early in the product life cycle as possible, is essential to effective innovation in the DoD, and it is a component of Better Buying Power. I would also add that close collaboration with the intelligence community is critical as well: Potential adversaries are moving very quickly to develop products clearly designed to defeat U.S. capabilities. The DoD must be both innovative and quick to market in responding to these emerging threats. Achieving these objectives requires strong and continuous collaboration between operators, the intelligence community and the technical acquisition community.

Funding Is Fundamental

There is one more necessary ingredient that I have not discussed yet. That ingredient is capital. Small start-ups and large businesses alike depend on capital to survive and to bring new products to market. So it is for the DoD, and this is my greatest concern today. Our capital comes from the budgets we receive from Congress. As long as we remain trapped in the grip of sequestration and as long we continue to prepare budgets that are far out of alignment with the funds we may receive, we will not be able to innovate effectively.

Innovation isn’t just about thinking outside the box, or about demonstrating new technologies and operational concepts. It is about developing, producing, fielding and training with those new capabilities. Today I believe our pipeline of new products in development is inadequate to deal with emerging threats.

We are facing a major recapitalization bill for the strategic deterrent that is about to come due. There is nothing that I or the DoD can do to improve our productivity and efficiency that will fully compensate for inadequate capital. All the efficiencies I can even imagine will not make up this shortfall. By conducting well-chosen demonstrations, we can reduce the lead time to acquiring real operational capability, we can keep an essential fraction of our industrial base gainfully employed, and we can position ourselves for changes in threat perceptions and the availability of additional funds. But, without relief from the specter of sequestration, we cannot increase the relative combat power of the United States against our most capable potential adversaries.

I can point to numerous places in DoD where we are taking steps to improve our access to and use of each of these ingredients: knowledge, freedom, risk tolerance, persistence, collaboration and capital. For the last few years, we have worked hard to emphasize and increase the professionalism of the government acquisition workforce. Secretary Carter’s “Force of the Future” initiative is specifically intended to bring high knowledge people into our workforce. With help from the Congress through the Defense Acquisition Workforce Development Fund and a number of internal actions, we have continued to build on our strong foundation in this area despite budget constraints.

We are protecting and emphasizing the freedom of our managers to find creative solutions to technical and managerial problems. Last year, I tasked each of our program managers to communicate directly with me about problems, issues and recommended solutions. The result was a huge testament to the creativity, dedication and professionalism of our workforce.

The demonstrations that I mentioned, if they can be funded, show our willingness to take risk on new and nontraditional approaches to operational problems. Deputy Secretary Work’s “Third Offset” strategy, by its very nature, will require the DoD to accept the risk associated with new operational concepts and the technologies that enable them. Our ability to persist in bringing all of these initiatives to fruition remains to be seen, but the closely aligned leadership in the DoD—including the Secretary and Deputy Secretary of Defense, myself, and the new Joint and Service uniformed chiefs—makes me optimistic that we can collaborate to do so.

From their inception, the Better Buying Power initiatives, in every edition, have been about getting the most value possible from our available capital. With that possible exception—which is in the hands of the Congress—we possess or can obtain all the ingredients we need to bring innovative solutions to our warfighters. 



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Where Have All the Nunn-McCurdys Gone?

Mark Husband, Dr. Eng.



More than 2 years ago, I left a job I loved—teaching at the Defense Acquisition University—for an opportunity to work in the Office of Performance Assessments and Root Cause Analyses (PARCA). My primary responsibility is to conduct root cause analyses of troubled DoD acquisition programs—those that have undergone a critical Nunn-McCurdy breach, or others as assigned by the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]) or by the Secretaries of the Military Departments.

Many colleagues asked why I would want to work in the Pentagon, and there was one main reason: Odd as it may sound, I am fascinated by acquisition cost growth. Believe it or not, cost analysts actually get together and debate these kind of things—very passionately!

Husband is the Senior Advisor for Root Cause Analyses in the Office of Performance Assessments and Root Cause Analyses (PARCA), part of the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics. He is a retired Air Force officer with a doctorate in chemical engineering from Germany's Karlsruhe Institute of Technology.

A close-up photograph of a rose where the petals are made from folded US dollar bills, primarily \$100 bills. The rose is set against a clear blue sky with a few wispy white clouds. The stem and leaves of the rose are green.

**There
are three
relatively new
forces in play that have had
profoundly positive
influences on
acquisition program
results: one statutory, one
regulatory, and one force
related to DoD culture.**

It is impolitic to say so publicly, but I looked forward to the opportunity to examine Nunn-McCurdy programs and determine what caused their cost, schedule and performance shortfalls. Conducting such analysis is challenging and intellectually stimulating, and for a defense analyst it is a treasured opportunity to use analytical skills and expert judgment to create a product that will be scrutinized intensely (particularly by those responsible for program execution, who may take issue with the conclusions). Products of these reviews also can have a positive impact, through the dissemination of lessons learned. In 2013, a commonly expressed fear “inside the building” was that sequestration would result in a plethora of Nunn-McCurdy breaches due to the impending reduction of production quantities and stretched-out schedules.

So what has happened in the last 2 years? The Department of Defense (DoD) has had a total of two critical Nunn-McCurdy programs for which a root cause analysis is required (and one other that resulted from program termination). This compares to an average of 4.5 *per year* from 2006 through 2011. Counting all Nunn-McCurdys (both critical and significant breaches), the DoD had an average of 2.3 *per year* from 2012 through 2014, compared to an average of 6.3 *per year* from 2006 through 2011.

Coming up with explanations for causes of improvement is even trickier than coming up with root causes of problems. While opinions abound, it is difficult to ascertain that a given action or set of actions is responsible for an observed result, particularly for something as complex as DoD acquisition programs, which have so many internal and external influences. Analytical rigor notwithstanding, I, like many defense analysts,

have strong opinions about key factors that may be responsible for recent improvements.

In my view, there are three relatively new forces in play that have had profoundly positive influences on acquisition program results: one statutory, one regulatory, and one force related to DoD culture. The Weapon Systems Acquisition Reform Act (WSARA) of 2009 is a statutory change that has been lauded by most defense experts as extremely positive. WSARA made sweeping changes that have strengthened accountability of acquisition execution and oversight officials and ensured that programs are started with more realistic cost and schedule baselines, performance expectations, and mature technologies. In particular, several WSARA-related changes have led to increased focus on assessing a program’s readiness for initiation *prior* to Milestone (MS) B, including requirements for an Independent Cost Estimate for major programs at MS A, a Preliminary Design Review prior to MS B, and measures to ensure adequate competition, including competitive prototyping, dual sourcing, and modular open architectures, among others. WSARA also strengthened test and evaluation and systems engineering functions that are critical to Engineering and Manufacturing Development by establishing statutory directors of those offices appointed by the Secretary of Defense.

WSARA improved the DoD’s assessment of troubled acquisition programs by establishing the PARCA office, which conducts root cause analyses of critical Nunn-McCurdy breach programs and follow-on performance assessments of those programs in an effort to prevent future cost and schedule growth. Finally, WSARA increased the penalty on critical Nunn-McCurdy programs by rescinding those programs’ most recent milestone approval and adding a “presumption of termination” unless the more stringent certification criteria are met. Changes instantiated by WSARA could not be expected to have immediate impacts (because of the number of pre-WSARA programs in the pipeline), but I believe the positive impacts of WSARA now are clearly evident, particularly for programs initiated since 2010.

Second, regulatory changes that I believe have had demonstrably positive impacts on program results are the Better Buying Power (BBP) initiatives begun by Secretary of Defense Ashton Carter in 2010 when he was the USD(AT&L). Acquisition insiders are aware of the broad scope of the BBP initiatives, which have the overarching goal of strengthening the DoD’s buying power, improving productivity, and providing more affordable products to the warfighters. Carter and his successor as USD(AT&L), Frank Kendall, have emphasized that BBP is not acquisition reform but instead a continuous process of improving how we acquire goods and services based on proven methods and analysis of data.

Because two successive Defense Acquisition Executives have demonstrated such a clear and lasting commitment to improving the acquisition system through BBP, I think that BBP concepts and principles have been successfully infused into

the acquisition workforce. In my view, while the individual initiatives provide important guidance about key principles, an equally important contribution of BBP has been the dialogue it has fostered within the workforce, engaging the entire defense acquisition community to think about what works and how to do things better.

Finally, while those outside the DoD may not have seen it, I believe a third key factor responsible for improved acquisition performance is that DoD culture has changed (or at least shifted). More than at any time in my career, cost and affordability are emphasized by leadership as key considerations for the goods and services that the DoD procures.

All acquisition professionals are aware that three things are supposed to be balanced (or traded) in an acquisition program—cost, schedule and performance. For many decades, performance was king; system requirements and designs pushed the performance envelope toward development of what former Secretary of Defense Robert Gates called “exquisite systems,” at the expense of cost and schedule. Beginning in the late 2000s, that mentality began shifting, and cost considerations entered into discussions more than before. I

think congressional changes in 2006 to the Nunn-McCurdy law were an early stimulator of this change: No longer was it possible to simply rebaseline troubled programs without penalty. Further changes to the law that increased the stringency of the Nunn-McCurdy process made congressional intent crystal clear—lawmakers have lost patience with programs that don’t keep their cost and schedule promises. I believe the DoD’s shift to a more “cost-conscious” culture also is a byproduct of the WSARA reforms and BBP. Not only is it a specific BBP initiative, it also is woven throughout BBP’s overarching goals of providing more affordable products and improving productivity.

Obviously, looking at Nunn-McCurdy programs through the prism of the last 2 years is not an analytically rigorous basis for drawing hard and fast conclusions. And it could well be that continuing budget gridlock ultimately will cause more programs to scale back, retrench and stretch out. As the DoD’s “Maytag repairman” for root cause analyses looking for work, I can only hope. But for the American taxpayer’s sake, we must instead wish that the DoD’s trend of decreasing numbers of Nunn-McCurdys continues. 

The author can be reached at david.m.husband.civ@mail.mil.

Where Can You Get the Latest on the Better Buying Power Initiatives?

- BBP Gateway (<http://bbp.dau.mil/>) is your source for the latest information, guidance and directives on Better Buying Power in defense acquisition
- BBP Public Site (<https://acc.dau.mil/bbp>) is your forum to share BBP knowledge and experience



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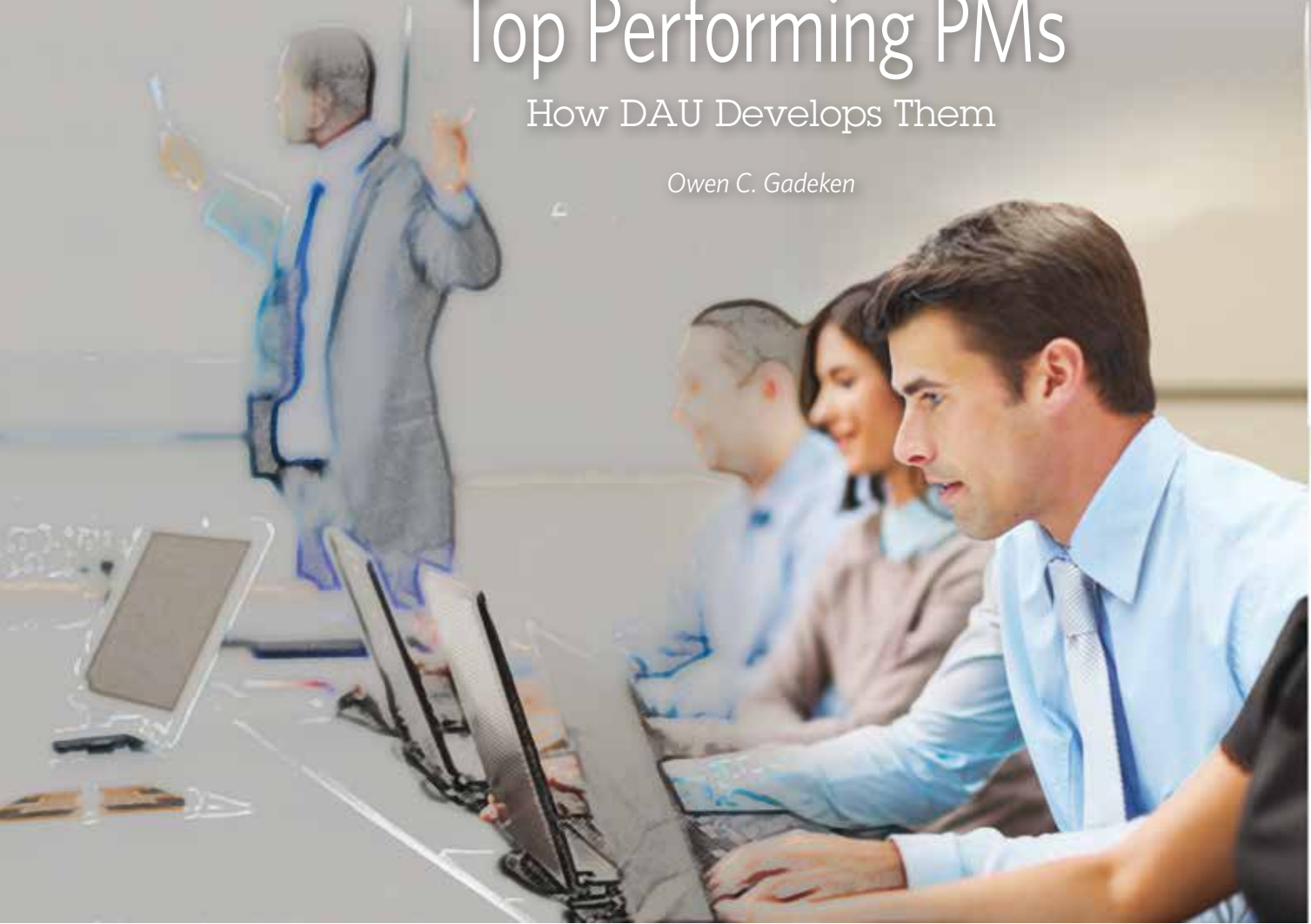
Acquisition, Technology, and Logistics



Top Performing PMs

How DAU Develops Them

Owen C. Gadeken



The Defense Acquisition University (DAU) has been training Department of Defense (DoD) program managers (PMs) for more than 40 years. During that time, the training requirements have changed considerably. Most basic courses are now done online, while intermediate courses feature a combination of online prerequisites followed by classroom training. Advanced PM courses use teams of students to discuss current acquisition issues, analyze and prepare case studies, share lessons from their experience and provide feedback to their colleagues.

Over the years, the duration and content of DoD's PM training has evolved from the initial 5-month program management course to a series of shorter courses taken along a PM's career path. The current PM training framework is shown in Figure 1. To reach Level III certification requires 346 hours of online instruction and 27.5 classroom days. For major acquisition PMs, 70 additional classroom days of specialized training (PMT 401 and PMT 402) are required. The higher levels of certification require significant training along with relevant education and work experience.

Gadeken is a Professor at the Defense Acquisition University at Fort Belvoir, Virginia. His current interest is helping program managers become effective leaders. Gadeken received his doctorate in engineering management from the George Washington University.



This article concentrates on the executive-level courses (PMT 401 and 402) used to train PMs who will lead the most expensive, critical and highly visible programs in the DoD. These training programs are conceived, developed and taught by DAU faculty with only infrequent use of vendors or outside resources.

Designed to improve DoD acquisition outcomes, the 10-week Program Manager's Course (PMT 401) seeks to:

- Enhance critical thinking and decision-making skills.
- Develop the capability to lead cross-functional integrated product teams in an acquisition environment.
- Embed the habits of reflection, feedback and continuous learning.

The PMT 402 Executive PM Course is an assignment-specific course for students being assigned to lead major acquisition programs. The crux of this course is for each student to present an analysis of the student's new program and then work with a team of students and faculty to develop an action plan once they are

assigned. With this in mind, the remainder of this article concentrates on how DAU implements the three PMT 401 core themes of critical thinking and decision making, leadership skills, and habits of learning.

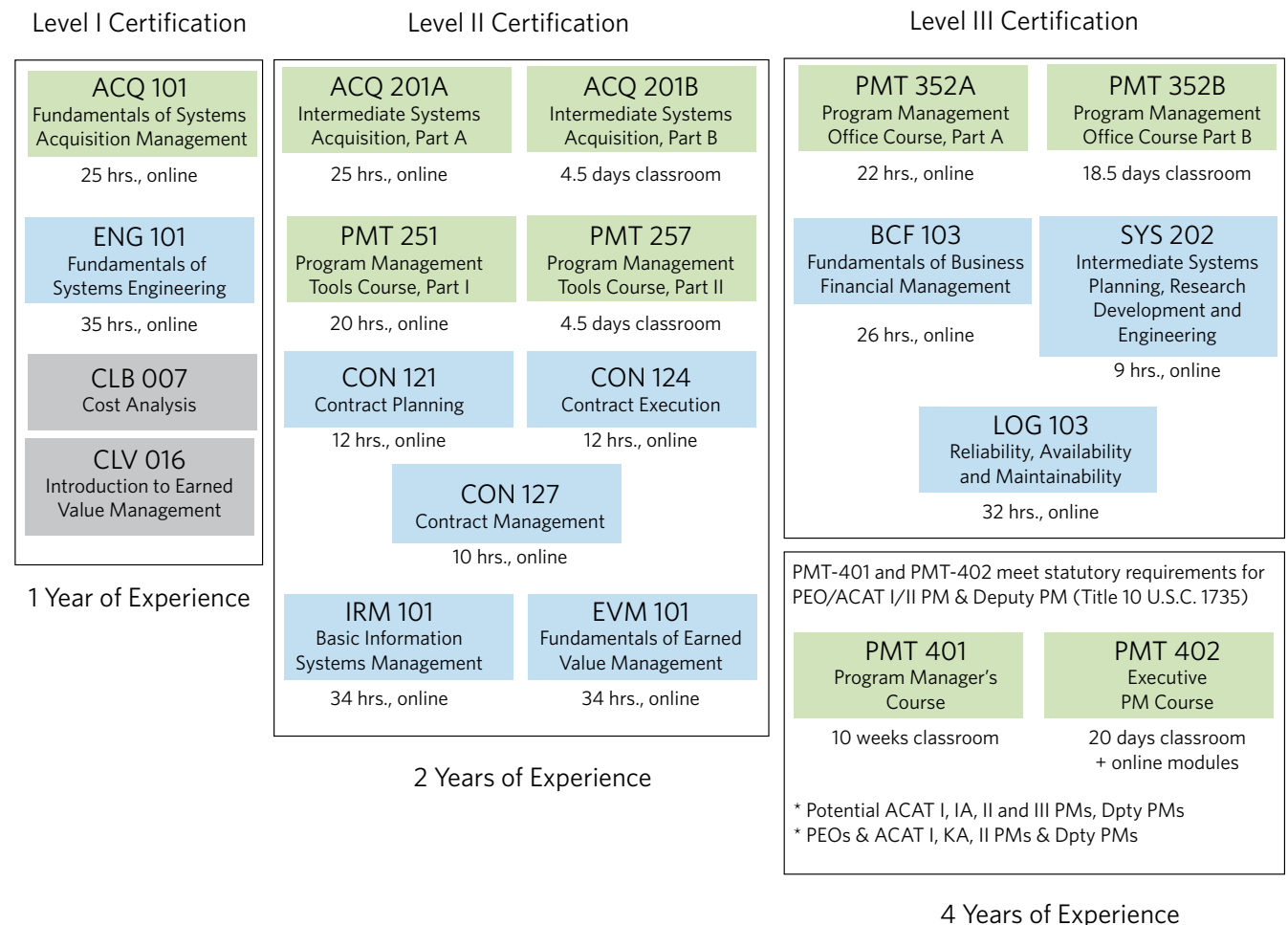
Critical Thinking Skills

Managing complex defense programs requires both subject-matter expertise and disciplined thinking. As stated by our current Defense Acquisition Executive, Frank Kendall:

The first responsibility of key leaders in the acquisition workforce is to think. One of the many reasons that our key leaders have to be true professionals who are fully prepared to do their jobs by virtue of their education, training and experience is that creative, informed thought is necessary to optimize the structure of a program.

DAU embeds principles of critical thinking in each of our PM courses, and the executive courses use critical thinking elements, standards and intellectual traits from Richard Paul and Linda Elder's "Aspiring Thinker's

Figure 1. DoD Program Management Certification Requirements



Guide to Critical Thinking.” As an example, standards of critical thinking include clarity, accuracy, significance, completeness and fairness.

Applying the proven doctrine of “train as you fight,” the PMT 401 curriculum uses program management case studies to develop critical thinking and decision-making skills. These case studies are prepared by faculty and students and are based on real defense programs. The 10-week PMT 401 course includes more than 80 case studies that cover a broad spectrum of acquisition life-cycle development and sustainment issues. Each case provides the background on a program and then presents the students with a dilemma (or problem) that the PM needs to address. Students analyze the case and then present and debate alternatives for how the PM should respond.

A very significant part of the case learning process is the four-stage learning model shown in Figure 2. Following this sequential process is quite important if one is to learn as much as possible from each case. The first step of individual preparation occurs when students read the case—normally during the evening prior to the class. Second, small groups of five to seven students meet in the morning before class starts and briefly discuss each case with a faculty facilitator. Third, all students convene in the classroom for a facilitated discussion led by the

faculty sponsor for the case, who often is the case author as well. After class, students have an opportunity to reflect on what they learned and are given a learning journal in which to record their reflections. Faculty small group advisors prompt students to share their reflections as the course proceeds.

Faculty members are encouraged to “not teach” but to facilitate their cases. Case studies normally have no “right” answer, so the emphasis is on the analysis and critical thinking skills demonstrated by the students. The case studies also are used to apply a variety of management tools and frameworks such as stakeholder analysis, interest-based negotiations, polarity thinking, appreciative inquiry and action learning.

Near the end of the course, each student team prepares its own case study based on one of the team member’s real-world dilemmas and then facilitates the case with the rest of the class. This is not only a very popular part of the course but has become our leading approach for new case development.

Leadership Skills

If case studies are the heart of the Program Manager’s Course, leadership is the soul of the course. Students arrive in class

with a portfolio of technical and management skills, so it is often their leadership skills that most need development. This is illustrated in the career development timeline in Figure 3. Technical and management skills are still required for these PMs, but it is the leadership skills that will most influence their ultimate success.

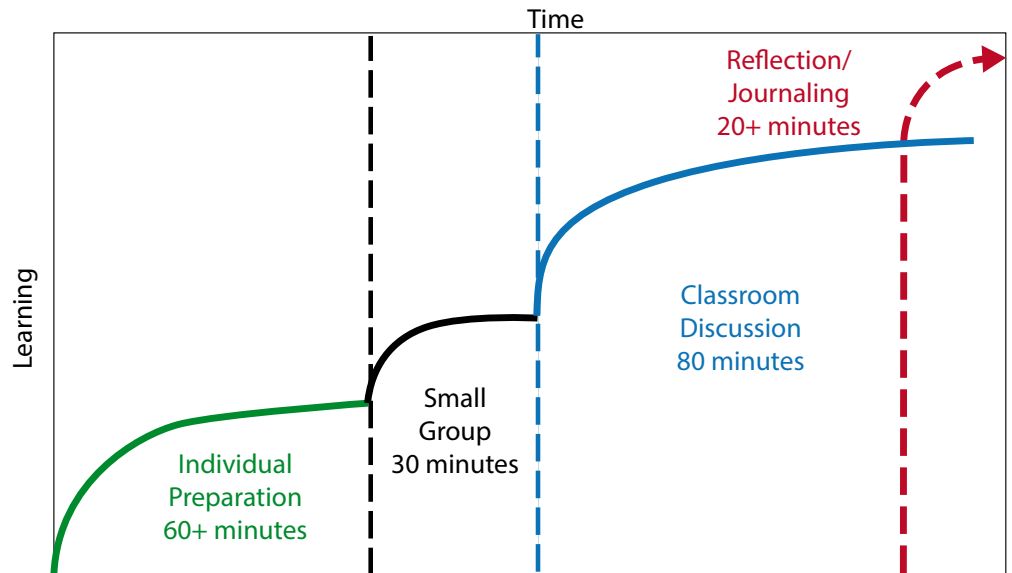
In “Marching an Army Acquisition Program Toward Success” (*Defense AT&L*, November-December 2012), the authors found that “the first characteristic that separates the really successful PMs is their leadership. They set the tone, they should be decisive, and have a vision.”

The leadership theme also was stressed by Kendall in the May-June 2013 issue of *Defense AT&L*:

Having seen more than 4 decades of defense acquisition policy changes, I am absolutely convinced that nothing matters as much as professional leadership. Once you have that, the rest is details.

At DAU, an assessment-based approach fosters leadership development: Instead of teaching leadership skills, the course focuses on assessing these skills so our students can work on their own development while they are with us and after they return to the workplace. Various assessment tools and team exercises are employed to highlight students’ strengths as well as their leadership development needs.

Figure 2. Case Study Four-Stage Learning Process



The assessment starts before students arrive by having them complete online personality type, emotional intelligence, and workplace (360-degree) assessments. The reports then are provided to students early in the course along with the opportunity to share and discuss them with both peers and selected faculty. The key is to integrate these assessments into a framework to encourage further skill development.

The assessment continues with observation of students in small- and large-group case discussions. How effectively do students communicate their thoughts, build on others’ comments, and help the group reach consensus on how to address each case dilemma? In addition to facilitating, faculty members must observe student performance and provide feedback to students both individually and in scheduled small group sessions.

Team exercises and simulations are used to place students in a team environment where they get additional feedback. One example of this is “Looking Glass,” an organizational simulation that DAU’s Defense Systems Management College licenses from the Center for Creative Leadership. Here, class members take the key leadership positions in a commercial glass manufacturing company and are challenged to run the company for an entire day. After the simulation, a second day is dedicated to feedback on how each team and individual performed in the exercise and how the feedback supports their personal leadership development goals. There also is a media workshop in which each student is

Figure 3. Career Development for Program Managers

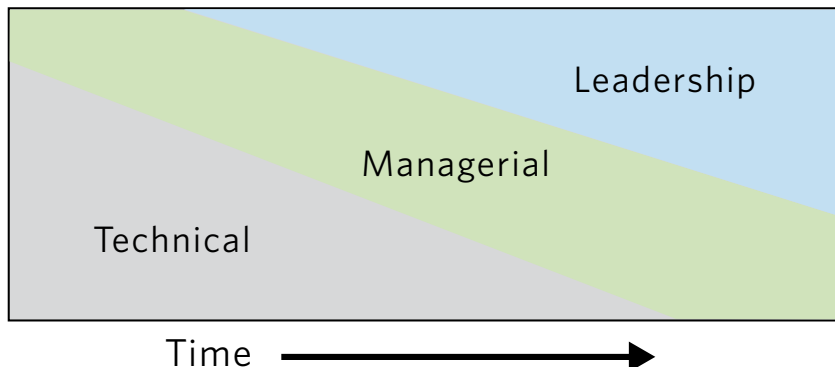
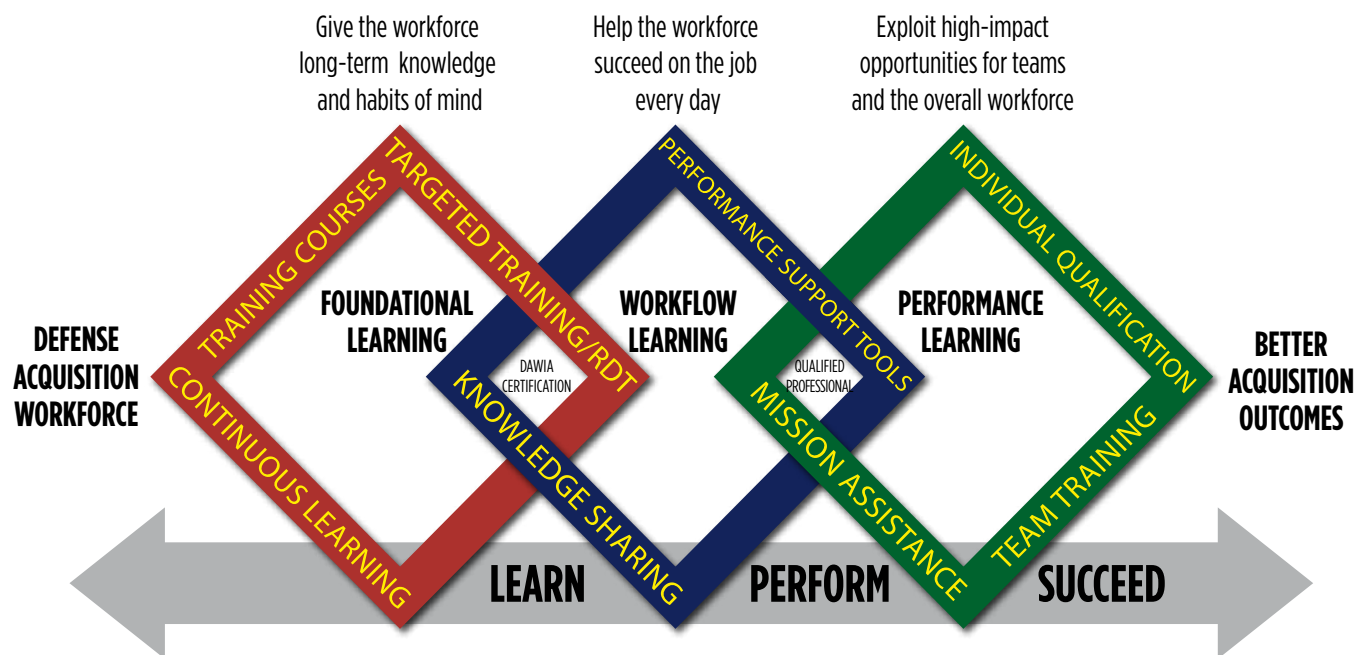


Figure 4. DAU Acquisition Learning Model



given a PM role from one of the case studies and required to explain and defend his or her program to members of the press (with the press role performed by faculty members). These media interviews are videotaped and analyzed for learning points by groups of students.

The crux of the leadership development approach is that, before students can lead a program or team, they must be able to both understand and lead themselves.

Reflection, Feedback and Continuous Learning

Effective PM training is more than a series of course modules filled with content. There are key learning processes that literally make or break a training event or program. The first of these is establishing a positive learning climate both inside and outside of the classroom. Nothing can be more counterproductive to learning than for students not to want to be there or to be distracted constantly by outside events. At DAU, various approaches are used to create a collegial atmosphere and keep the focus on learning. These include icebreaker exercises, class lunches and socials, and even cookouts and competitive games in the evenings. The goal is to have students enjoy being together and learning together while developing personal and professional relationships to draw on during the remainder of their careers.

The second key learning process is team learning. Defense programs are managed with cross-functional teams; therefore, the learning approach also features cross-functional teams. Students work all of their case studies in teams

(called small groups), and these teams are remixed halfway through the course so students can work with new peers and faculty members. Experience demonstrates the teamwork approach to be very beneficial during the courses. Students frequently add these peers to their professional network and often consult with them on program issues once they return to the workplace.

The third key learning process is peer feedback. In DAU's senior PM courses, there are no tests, no term papers and no grades. The key process for student evaluation is feedback given to each student by both peers and faculty using a simple process developed by the Center for Creative Leadership called Situation-Behavior-Impact (SBI). As outlined in the Center's publication *Feedback That Works*, the SBI process seeks to overcome conversational feedback, which often is vague or judgmental. Instead of feedback like "great job on that report," one might say, "The program status report you submitted yesterday [Situation] contained all the requested data and your analysis was so thorough [Behavior] that the boss has cited it as an example for others to follow [Impact]."

To implement the feedback, students share their personal learning goals with their small group and have fellow students hold each other accountable for working on their goals. After the SBI process is explained early in the course, peer feedback sessions are scheduled every few weeks to provide students feedback on their development goals while allowing them to practice providing feedback to others. This increases the likelihood they will use the SBI feedback process with their real project teams when they return to work.

For PM training to have the greatest impact, its benefits must continue after students return to the workplace. Over the years, DAU has expanded its focus from being just a training provider to becoming a broad-based performance support organization. This is reflected in DAU's Acquisition Learning Model illustrated in Figure 4.

Today, attending a training program is just the starting point in developing an ongoing relationship with DAU. After returning to the workplace, graduates have a network of faculty members they can call on to assist them with emerging program issues. DAU also has a large set of online references, tools and learning modules that are available to its graduates. For larger problems, a faculty team can be assembled to provide onsite team training or mission assistance.

Executive coaching also is in DAU's repertoire of support tools. With more than 50 faculty members formally trained as executive coaches, DAU recently won a national award for the outcomes achieved by its enterprise-wide executive coaching program.

What this means for PMs is that, once they complete an executive course, they can request an executive coach to help them with their newly assigned program. The coach provides the ideal "sounding board" to help the new PM think through a variety of program issues, including developing a program plan, reorganizing or dealing with difficult program stakeholders.

Comments from PMs who have used DAU executive coaches include, "A catalyst for change. My coach challenged me to think creatively and systematically. I couldn't lead the way I was used to leading. My coach helped my me adapt and try on new behaviors," and "A strategic thinking partner. Helped me go to the strategic perspective. At my level, I really appreciated having someone who knew the ropes and path, but didn't tell me what to do." Customer demand for the coaching program continues to grow.

Summary

With the return of troops from overseas deployments, the defense budget is shrinking and likely will be lower in future years. Nevertheless, defense programs continue to demand highly talented PMs who can deliver needed products and services to our military customers. The DAU's challenge is to make its training and program support tools even more effective in this resource-constrained environment. Anchor points for the training approach are enhancing the PMs' critical thinking and decision-making skills, developing their portfolios of leadership skills, and embedding the habits of reflection, feedback and continuous learning. In evolving to meet the demand for effective training, DAU must continue to adapt and change so it can develop top performing PMs who will meet our warfighters' even more stringent demands to keep our nation safe and secure. 

The author can be reached at owen.gadeken@dau.mil.



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Leadership 101

Scott Reynolds





For the last 8 years, I have been a faculty member in the Defense Acquisition University's Executive Leadership and Coaching programs, and I thought it would be worthwhile to share our students' definition of the leader's role in establishing and running extraordinary teams.

The journey to gather the data started with a classroom discussion. I had arranged for a guest speaker who had led several successful programs, and during my introduction I started to tell a story about when he assumed command of a failing missile program. One of his first acts was placing PowerPoint slides in every cubicle that read, "Be on contract by July." He continued to emphasize this point over the next few days, individually asking each team member, "How is what you are working on right now helping this team get on contract by July?" At this point, a Marine Corps colonel stopped me and said: "Scott, this is Leadership 101. Please don't tell me that is what we will be focusing on this morning."

This colonel was a decorated war hero, and in only one week had earned the respect of his peers and the faculty. He was a leader beyond leadership 101. Or was he? I then asked him what his program's purpose was. Somewhat flustered, he gave an answer. Next I asked, "Who are three people on your program who report directly to you, and what are their phone numbers?" You can see where I was going. When I called the direct reports and asked them the same question, none of them articulated the same purpose as the colonel and none of them aligned with each other. It seems leadership 101 is easy to identify but hard to implement.

Reynolds is a faculty member at the Defense Acquisition University's Executive Programs, Fort Belvoir, Virginia. He previously held several positions with the U.S. Coast Guard, including director of logistics, deputy chief information officer, and research and development program director.

In addition to having clear and rational goals, leaders must provide goals that touch emotional needs. To do so, you do not use data. You use stories and pictures.



That experience made me realize that we had been assuming a level of leadership self-awareness that did not exist in our students. They were successful, and their success was directly related to their leadership qualities. But in many cases they couldn't connect their actions to leadership traits they possessed. This was very disconcerting. Without understanding their leadership strengths, how could they effectively mentor their subordinates? To encourage self-awareness, I started a program in which students in small groups define the characteristics of extraordinary teams. This often takes several sessions. After they have defined an extraordinary team, I then ask, "What roles does a leader play on those teams?" I've done this many times with many different groups. While their answers vary, the following points have consistently been identified as the traits a leader must possess to lead an extraordinary team. I'm calling them Leadership 101.

The first role a leader must fill is to set direction and establish goals. But my colonel friend thought he had done

this. So the deeper question is how to set a direction and establish goals that lead to extraordinary teams. Our learners have come to agree on two points that must be present. The first point is that the leader must know and define the "Why" of the organization. As an executive coach, I was working with the PM of the F-22 Raptor program. This program had existed for years. Yet I discovered in the program's information briefs it was common to list the features of the aircraft—advanced avionics, stealth and super aerodynamics. The question leadership must be able to answer and articulate is why we need those features—the benefits, if you will. Or said another way, what defense problems does the F-22 program solve? We created two PowerPoint slides that did just that (Figures 1 and 2).

The leader's messaging on direction and goals also must address both the rational and emotional elements within people. People are not like Spock from the Starship Enterprise. We are emotional. So in addition to having clear and rational goals, leaders must provide goals that touch emotional needs. To do so, you do not use data. You use stories and pictures. One Army officer in charge of installing computer cabling on Army bases used the PowerPoint slides in Figures 3 and 4 to highlight that his organization was responsible for connecting the Army to the world. When showing the slides, he told engaging stories about how the connectivity they provided saved lives in battle and let soldiers overseas communicate with family back home. He closed by listing several tangible and very rational goals for the next year. He touched the emotional and rational buttons of his team.

Manifestation of Culture

The second role of a leader is to set the team's culture. Culture is the way a team behaves based on the values, rituals, heroes and symbols they accept and which are passed along by imitation from one generation to the next. Values tend to range along continuums—for example, transparency, secrecy; collaboration, isolation; empowerment, micromanagement, etc.

Figure 1. Raptor's Unique Attributes

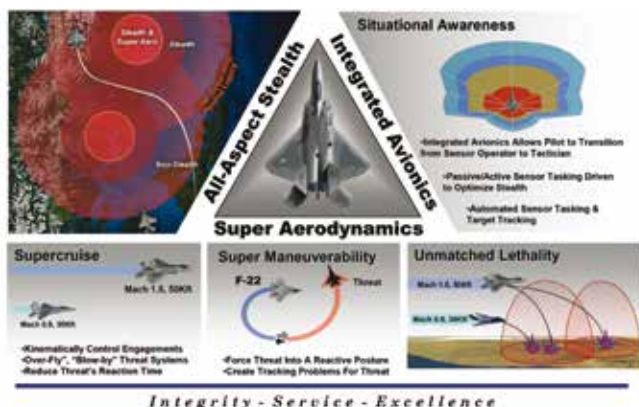


Figure 2. The Synergy of Stealth and Super Aerodynamics



Figure 3. Connecting the Army . . .



Figure 4. . . . to the World



Many values remain unconscious and unwritten to those who hold them. Therefore, those values often cannot be discussed nor directly observed by others. Values can only be inferred from how people behave under different circumstances. Symbols, heroes and rituals are the tangible or visual aspects of the practices of a culture. The true cultural meaning of the practices is intangible: This is revealed only when the practices are interpreted by the insiders. If a team's direction is set through a combination of rational and emotional arguments, setting culture is an emotional pull.

Hands down, I believe the military Service that has done the best job of setting its culture is the Marine Corps. All four Services attend our program, but I've found the only Service whose members can articulate their culture—values, rituals, symbols and heroes—is the Marine Corps. People in other Services struggle to explain their cultural norms, but ironically they usually can define the Marine Corps culture. How have the Marines achieved this? First, they have defining slogans: (1) Every Marine is a rifleman, (2) officers eat last, (3) with the sun comes the guns, and (4) the Few, the Proud, the Marines. These have not changed over time. Second, their rituals and rewards reinforce the slogans. For example, during their annual "birthday" celebration, Marines will travel many miles to attend a ceremonial cake cutting in which the oldest Marine in the room will serve the youngest and the Marine Corps commandant, via video messaging, will remind everyone of the proud traditions of Marines. There are no ex-Marines! Extraordinary teams have leaders that don't let culture happen by itself. They drive the culture needed for the team to excel.

The third role of a leader is to provide a winning environment. When discussing this role, our learners' initial focus often is on resources. That is, does the team have the right people, enough money, workable schedule, the proper materials and access to information? In times of austere budgets, studies have suggested leaders often take on too much risk in schedule, performance and cost commitments. So teams every day arrive to work with data suggesting they are failing in their

primary duties. In many of those instances, the leaders failed their teams.

As our students progress into a deeper analysis of what it means to provide a winning environment, they feel the leader must build spheres of influence that allow him or her to have sway with key stakeholders and their own chain of command. In "Empowering Yourself," Harvey Coleman suggests the formula for successful leaders is PIE—Performance, Image and Exposure. They must perform exceptionally well, cultivate the proper image and manage exposure so that the right people will know them. It is important to note that leaders are not doing this for personal satisfaction or gain, but to provide a winning environment for their teams by having the influence needed to get things done. The author weighted the three elements as follows: Performance, 10 percent; Image, 30 percent; and Exposure, 60 percent. These interesting ratios suggest that having a good reputation is only part of the equation; one must make sure there is a wide exposure of that reputation.

In addition, our students believe a leader must create an environment for the team to evaluate and learn as it performs (some students listed this trait under culture). In the book "Clear Leadership," Gervase Bushe says the rapid rate of change in the world today often means our internal mental models for addressing challenges no longer apply. I believe this is what Under Secretary of Defense for Acquisition, Technology, and Logistics Frank Kendall means when he asks us to "think." He is asking us to design our way forward. To design your way forward, your team must constantly work to improve. After meetings, reviews and decisions, a leader must hold timely discussions on what worked and on what could be improved in the next meeting, review or decision process. You are not assigned as a leader to maintain the status quo.

The fourth role of a leader is to provide mentorship—that is, to grow the team. The last paragraph was about improving the synergy amongst team members. This is about the

As for setting standards of performance, our students feel “one gets what one accepts.” Leaders must set and enforce standards of performance that drive results.



performance of individual members of the team. All leaders claim to care about their teams. What separates the leaders of extraordinary teams is that they go beyond saying they care to developing plans and strategies for demonstrating their concern for their employees' growth and well-being. It is on their calendar. For example, one of my coaching clients built people growth into his strategy and measurement system. He received quarterly reports that measured: (1) promotions, both internal and external, (2) training hours, (3) overtime hours, and (4) awards related to improved performance. Discussions then would be held to capture what drove good numbers and which areas needed improvement. This created a culture in which all members of the senior leadership team saw growing the next generation of leaders as part of their primary duty.

The fifth and final role of a leader as defined by the students is to set the standards of performance and boundary conditions. Our learners often struggle in their talks on what makes good and bad boundary conditions. Let me explain using a shipping lane metaphor to describe how bad boundaries can limit team success. Those who have been to sea on a military vessel are familiar with the Captain's Standing Orders. These orders set the boundary conditions for when the captain should be informed of shipboard conditions. They usually include comments on how close another vessel can approach or when a weather condition change requires the captain's notification.

Picture the entrance to any major port of the United States. We have shipping lanes, and some distance from the shipping lanes there is shoal water. Navy doctrine allows Navy ships to enter ports outside the shipping lanes. To reduce the risk of a mishap, the Navy provides doctrine on the size of the buffer the Navy vessels must give both the shipping lanes and the shoals. In a way, they have provided a box in which the vessels can operate. Vessel Commanding Officers (COs), not wanting

to get in trouble, write their Standing Orders so that the buffer on each side is larger—to make sure they stay in the box. This means the box the Navy ship can operate in is now much smaller. The Officer Of the Deck (OOD), not wanting to get in trouble with the CO, issues orders to the helmsman increasing the buffer given to both the shoals and shipping lanes. The box for the ship to operate in has once again been reduced.

The poor helmsman, not wanting to get in trouble with the OOD, stays on a straight line. There is no room for movement. Soon these boundaries are not considered discretionary but are required operating procedures. My students have concluded that the key for successful boundary condition setting is for leaders to adjust the boundaries to match the talents of their people, not to constrict them. The boundaries should change as the people change and grow.

As for setting standards of performance, our students feel “one gets what one accepts.” Leaders must set and enforce standards of performance that drive results. One of my first coaching clients stressed his team should deliver what it promises across the spectrum of cost, schedule and performance. One of his commanders made bold projections about his product and stuck with them even after careful and detailed questioning. My client then created a large poster that highlighted the next scheduled milestone on the commander's program. As the date approached, the commander came forward and admitted he couldn't deliver on his promise. In response, my client held an all-hands meeting and made the failure public and stressed how this example counters all this team stood for as the warfighter's trusted provider of capability. The culture of that organization changed that day as new heroes were identified and new stories described the team. My client expected excellence, and, in holding his team to that standard, he received it, and that excellence became a key element of team pride. The team members saw their standards of performance as differentiators from other teams.

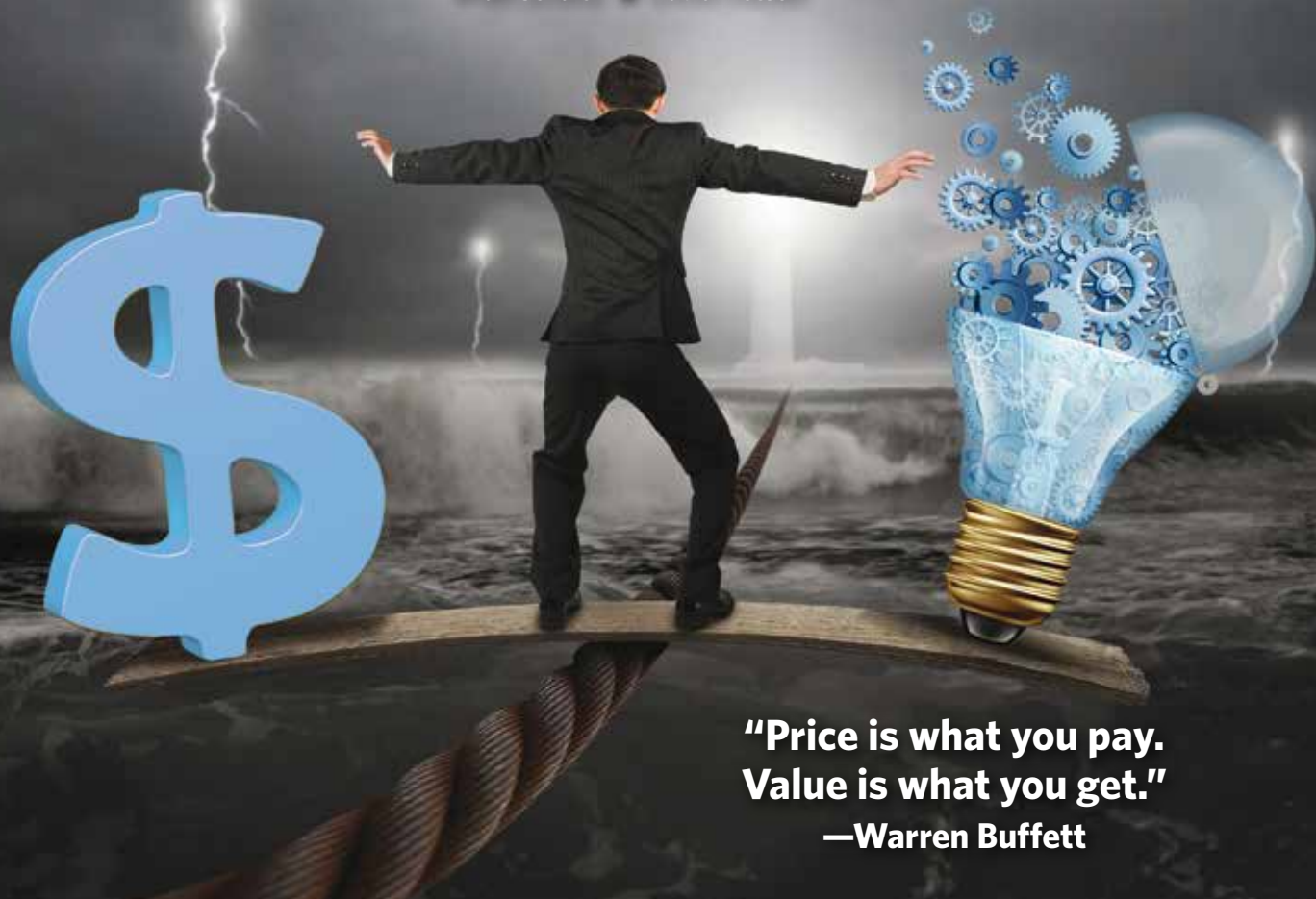
In summary, we've asked the senior executives chosen to lead DoD's most difficult acquisition challenges to reflect on the roles leaders must undertake to build extraordinary teams. Their consensus opinion is that a leader sets a direction and makes sure the team knows why. A leader sets team values, rituals and symbols and identifies and rewards those heroes modeling them. A leader provides a winning environment in which the resources are right, external influences are controlled and teams constantly grow and improve. A leader cares about and grows each team member. Finally, a leader sets and enforces standards of performance.

My experience is that few leaders reach the 101 level of performance. They let the tyranny of today's challenges distract their focus on fulfilling their leadership responsibilities. I challenge you to review your calendar and see how much of your time is committed to Leadership 101. 

The author can be contacted at scott.reynolds@dau.mil.

Getting the **Best Value** in a Source Selection?

Brian Schultz ■ David Dotson



**"Price is what you pay.
Value is what you get."
—Warren Buffett**

Competition in acquisition is an important topic and has been since the Department of Defense (DoD) started acquiring systems from the defense industry. The key premise is that DoD will get greater value for the price paid as a result of competition. Some studies suggest savings in the 15 percent to 25 percent range and even greater under some conditions as a result of competition. However, greater value is not always tied to lower prices or cost savings. Greater value can be realized through a superior technical solution as part of a trade-off of price and other factors in a source selection.

This article addresses our thoughts in the best value discussion, including the use of the Lowest Price Technically Acceptable (LPTA) method. According to the Government Accountability Office's Report 14-884 (*Factors DOD Considers When Choosing Best Value Processes Are Consistent with Guidance for Selected Acquisitions*) dated July 2014, use of LPTA on contracts valued at more than \$25 million has increased 10 percent while full trade-offs decreased by 9 percent over the last few years. This increased use of LPTA has generated a lot of discussion and interest from industry. The following is just a small sample of some recent news articles and blog titles that discuss use of LPTAs versus the trade-off for best value source selections:

Schultz is a professor of Program Management, at the Defense Acquisition University (DAU) Capital Northeast Region, Fort Belvoir, Virginia.
Dotson is a professor of Contract Management at the DAU Mid-Atlantic Region in California, Maryland.

- “Five Factors Plaguing Pentagon Procurement,” American Enterprise Institute, Dec. 13, 2013.
- “Executive Slams ‘Lowest Price, Technically Acceptable’ Acquisition Regimes” *National Defense Magazine*, Jan. 16, 2014.
- “Eliminate LPTA and staff augmentation contracting other than for commodity services with minimal mission impact,” *Defense Business Board Report*, July 24, 2014.
- “LPTA Contracts Stifle Government Innovation,” *InformationWeek*, Oct. 25, 2013.
- “Is the Government Starting to hate LPTA too?” *Washington Technology*, June 7, 2013.
- “Too Much Competition can Reduce Incentives for Innovation,” Lexington Institute, April 22, 2013.
- “Best Value or LPTA? One Size Does Not Fit All in Acquisition,” IntegrityMatters.com, Feb. 27, 2013.
- “Pentagon launching new review of LPTA contracts,” *Federalnewsradio.com*, Dec. 8, 2014.

The March-April 2015 issue of *Defense AT&L* magazine included articles on the use of LPTA, one (“Getting ‘Best Value’ for the Warfighter and the Taxpayer”) by Frank Kendall, Under Secretary of Defense for Acquisition, Technology, and Logistics and another article providing an industry perspective, (“Lowest Price Technically Acceptable Overrated, Overused?”) by Will Goodman. Both articles highlighted the concern that LPTA should be used only in limited cases. But they differed on the approach that should be used in assessing the suitability of an LPTA source selection (value gained from performance above an established minimum versus assessing the long-term impacts on capability areas and changing the Federal Acquisition Regulation [FAR]).

Goodman suggested that looking at the acquisition as a single transaction is deficient. He suggested that contracting officers should be directed to assess capability area outcomes over the course of multiple solicitations in determining whether LPTA should be used. “To address the deficiency, the FAR should point out that LPTA is ideal for commodities and commoditized services and note that contracting officers should consider the possible and probable long-term impacts of an LPTA source selection on the capability area addressed by the solicitation.”

While it is an innovative idea, we don’t believe the FAR suggestion above is practical. Program level contracting officers are not typically in a position to do this and should not be expected to make this kind of portfolio-wide assessment. Furthermore, it would be difficult, even for senior leaders who oversee large portfolios of programs, to tie one or even multiple actions to a future mission area or mission capability outcome. While forecasting and planning for future capability needs is an important and ongoing effort, it could be very difficult to determine long-term impacts based on the use of a source-selection method on any given contract. It would also raise questions about whether DoD is unnecessarily paying more for a product or service because of

future outcomes that are difficult to forecast and perhaps even more difficult to measure.

Complexity and Risk Framework

We suggest an alternative approach to choosing a source-selection method based on a complexity and risk framework intended for use by the government acquisition team. It would involve an integrated, multifunctional effort in close coordination with the contracting officer. This assessment would go beyond just looking at performance requirements, to assessing the following programmatic areas:

- Organizational landscape
- Mission and operational interfaces
- Industrial capabilities
- Deliverables or outcomes
- Risk and opportunity management

We would argue that this level and depth of assessment will provide a more stable foundation for making informed decisions about source-selection strategies through the life of the acquisition program.

The proposed framework is based on our past experiences in pre-Request for Proposal planning efforts and is consistent with the current statutory, regulatory and policy guidance. Note that while risk and risk management are well defined in DoD, this is not the case for complexity. The FAR and DoD guidance are clear that both complexity and risk of the requirements are relevant in assessing the relative importance of price and nonprice factors (e.g., technical) and value above a minimum performance level. This framework can help DoD teams assess both complexity and risk.

The following is a brief summary of each assessment area:

Organizational Landscape: The overall health and stability of an acquisition organization can have significant implications for its ability to plan, develop and execute acquisition efforts. Organizational issues can directly affect the ability to oversee and manage certain efforts (e.g., complex trade-off decisions), requiring greater contractor technical competence and increasing overall risk to the program. For example, less stable organizations with management challenges may need additional time and assistance to develop a performance work statement in response to a services acquisition requirement.

Such an unstable acquisition organization may be better served with more senior-level services support that can react quickly to changes in the environment and deliver advisory services with less oversight. Use of an LPTA in this example may not result in a good outcome as organizational risk and complexity are high.

Sample questions that should be considered for organizational landscape include: Is the program office staffed adequately?

"The bitterness of poor quality remains long after the sweetness of low price is forgotten."

—Benjamin Franklin

Is there high turnover in key personnel? Is there strong budget and advocacy support from stakeholders and/or sponsors? Is there strong alignment with the agency strategic plan? What is the availability of key organic resources to plan and manage the contractual efforts, both pre- and post-award? Has the organization accomplished its goals effectively?

Mission and Operational Interfaces: The operational environment of the system or organization can result in added risks and complexities. For example, some systems must integrate with complex communications and information networks that involve specialized technical expertise in order to be effective. These operational environments can rapidly change as new threats emerge and new technologies are introduced.

For example, we both worked on airborne command and control system programs that had to integrate into multiple networks and required interoperability with joint and coalition partners, some with very different system configurations and exchange requirements. This added great complexity to the program in order to support current operations and planned future capability upgrades.

Program teams should address how this system or program or service fits into the bigger picture. What other system interfaces, networks and information exchange requirements are needed? How well understood and stable are the requirements? What is the operational or organizational urgency? What kinds of emerging threats or new contingency operations are relevant?

Industrial Capabilities: The ability and track record of industry (including suppliers) in the relevant domains should be assessed as early as possible. Previous execution issues, poor incumbent performance, poor financial performance, and lack

of qualified suppliers are examples of indicators for possible high complexity and risk. Market research plays an important role in gathering information needed for this assessment.

For example, consider a complex air traffic control radar system that has matured to the point where it is considered a production commodity. This system capability has multiple companies whose product meets the mandated requirements. While the system design is fairly complex, the industrial capability could be rated as having low complexity and risk due to the nature of industry's ability to deliver this product and the track record of previous contracts.

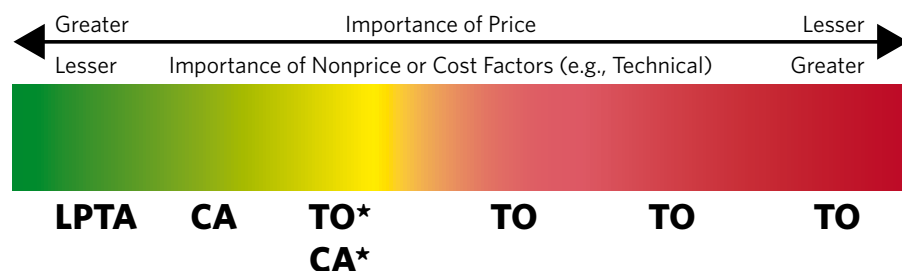
Sample questions to be considered include: What capabilities does industry offer to meet the stated needs? What is the past performance of previous contracts for similar efforts? What is the industry confidence level in estimating its costs to perform the work? What is the financial health and commitment to cover any overruns of interested companies? How much unique domain knowledge of the agency challenges is necessary to execute the contract? How will this knowledge be obtained? Is it the contractor's responsibility to have in-house expertise or will the government provide the support needed to ensure adequate knowledge? Note that, in some cases, the government team may need to dedicate staff to guide contractor efforts to ensure the product or service is tailored appropriately to meet the agency need. A good example of this is configuring software to meet a unique organizational requirement.

Deliverables and Outcomes: The product or service outcome, clarity and scope of requirements, and the amount of development involved should be assessed as well as the determination of the value of (and what we are willing to pay for) increased levels of technical performance.

Several questions should come to mind in assessing the deliverables and expected outcomes of the acquisition: What is the expected outcome and how is success defined? What products and deliverables are required and what are the acceptance criteria or acceptable quality standards for them? How much new development work is required? Is the product a commercial item (or commercial service offering)? If a legacy effort, what issues and challenges were encountered in previous contracts and how difficult were they to overcome? What is the value of performance above the minimum threshold? This is a question recently posed by Kendall. If a services acquisition, what skill levels and expertise are anticipated? What domain knowledge of the product or mission area is required?

Risk and Opportunity Management: After assessing the above, teams should identify risks to successful contract performance. Starting the analysis with the previous areas is recommended because doing so can assist in identifying risk areas and their probability and consequences. It is important to continuously manage risks—meaning actions will be taken to mitigate risks, and the organization will

Figure 1. Integrated Assessment Rating Scale



*Multiple approaches could be appropriate with moderate levels of risk and complexity

LPTA: Lowest Price Technically Acceptable

CA: Combination Approach

TO: Trade-off

Assessment scale not absolute—tailor to program circumstances

implement a process to govern the risk management efforts throughout the contract. This often occurs as part of a risk management review board that meets periodically to review risk management efforts. Opportunity management should be assessed for initiatives that can reduce costs and add greater value to the effort within the scope of the existing contract.

The culmination of this effort results in an integrated assessment of low, moderate or high complexity and risk based on the answers to relevant questions in each area. A roll-up of the areas to one color rating is a judgment call based on the relative importance of the different areas that are relevant for the program. The notional rating scale shows green as low, yellow as moderate, and red as high complexity and risk.

Closing Thoughts

As Franklin noted centuries ago, low price is not always the best deal, especially if either the quality or outcome of our acquisition is at stake. Source selection and use of an appropriate method to achieve best value is an important decision that should involve a deliberate process to ensure we have thought through what we need and how best to get it. A framework for assessing program complexity and risk may prove useful for some in making an informed decision about the source-selection method. The real value of using an assessment methodology similar to this is not an absolute answer but rather the critical thinking that supports good acquisition outcomes, both for DoD and industry—and ultimately for the taxpayer. 🧐

The authors can be contacted at brian.schultz@dau.mil and david.dotson@dau.mil.

MDAP/MAIS Program Manager Changes

With the assistance of the Office of the Secretary of Defense, *Defense AT&L* magazine publishes the names of incoming and outgoing program managers for major defense acquisition programs (MDAPs) and major automated information system (MAIS) programs. This announcement lists all such recent changes of leadership, for both civilian and military program managers.

Army

COL James C. Mills relieved **COL Gary D. Stephens** as project manager for the Precision Fires Rocket and Missile Systems (PFRMS) on July 15.

COL William D. Jackson relieved **COL Thomas H. Todd** as project manager for Utility Helicopters (UH) on July 15.

COL Shane N. Fullmer relieved **COL John Cavedo, Jr.** as project manager for Joint Program Office, Joint Light Tactical Vehicles (JPO JLTV) on July 31.

COL Gregory H. Coile relieved **COL Edward J. Swanson** as project manager for the Warfighter Information Network-Tactical (WIN-T) on July 15.

COL Donald W. Hurst, III relieved **COL Sandra L. Vann-Olejasz** as project manager for DoD Biometrics on July 16.

Air Force

Col. Michael Harm relieved **Col. Scott Owens** as program manager for the Theater Battle Control Systems program on Aug. 3.

Col. Darien Hammett relieved **Col. Carlin Heimann** as program manager for the RQ-4 Global Hawk System program on July 5.

Col. Steven Whitney relieved **Brig. Gen. William Cooley** as program manager for the Global Positioning System Program on July 8.

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A Contract Requirement Rule for Program Managers

Paul Solomon

The National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2016 (NDAA) includes many acquisition reforms. The Senate version included a provision that would have required the Secretary of Defense to develop standards, policies and guidelines based on nationally accredited standards for program and project management as well as policies to monitor compliance. *The Project Management Body of Knowledge (PMBOK Guide)* is the only qualifying standard. The provision was not adopted during conference with the House. However, if the *PMBOK Guide* were made a contract requirement to replace the Earned Value Management System (EVMS) standard (ANSI-748), any program manager (PM) finally would be able to identify and pinpoint emerging problems on a timely basis and act as early as possible to resolve problems. This article discusses the content and benefits of the *PMBOK Guide* but also includes guidance for integrating systems engineering (SE) and risk management with EVM independently of the *PMBOK Guide*.

PM Responsibilities, Needs and Tools

Per Department of Defense Instruction (DoDI) 5000.02, *Operation of the Defense Acquisition System*, PM responsibilities include achieving the cost, schedule and performance parameters specified in the Milestone Decision Authority-approved Acquisition Program Baseline (APB). Per the *Defense Acquisition Guidebook (DAG)*, the PM should require contractors and government activities to use internal management control systems that “properly relate cost, schedule, and technical accomplishment.” Also, per *DAG*, “risk management is most effective when fully integrated with the program’s SE and management processes.”

During the Engineering and Manufacturing Development (EMD) phase, the PM must develop, build and test a product to verify that all operational and derived requirements

Solomon is retired from Northrop.Grumman Corp. He is a Project Management Professional and co-author of ANSI-748 and the book “Performance-Based Earned Value,” published in 2007. Solomon is a 1998 recipient of the Defense Department’s David Packard Excellence in Acquisition Award. The author maintains a project management Website, www.pb-ev.com, and welcomes comments and questions.





have been met. The artifacts and tools that a PM needs, per DoDI 5000.02, DAG, and the SE Plan Guide (SEP), include:

- Capability requirements
- SEP
- Functional and physical characteristics of the system design integrated with the SEP
- Technical baseline
- Product baseline for all configuration items
- System baselines (functional, allocated, product)
- Requirements traceability between the system's technical requirements and work breakdown structure (WBS)
- Technical performance measures (TPM) and metrics to assess program progress

assertions that EVM "promotes an environment ... in which problems are identified, pinpointed, and acted upon as early as possible" and also that it is a "powerful program planning and management tool."

The title of ANSI-748 confirms that it is only designed to manage a statement of work and not a project that concludes with a product. Its title states that it is a "Guide" for "Coordination of Work Scope, Schedule, and Cost Objectives." "Product" or "technical" objectives are absent.

The purpose of EVM is stated in Office of Management and Budget (OMB) Circular No. A-11, *Planning, Budgeting, Acquisition and Management of Capital Assets*. Section 300-5 of OMB



In 2009, the DoD reported to the House and Senate oversight committees that the "utility of EVM has declined to a level where it does not serve its intended purpose."

- Risk management and tracking
- Earned Value Management (EVM)
- Performance Measurement Baseline (PMB)

Unfortunately, there are omissions in the acquisition process, regulations and guides that impede the PM's success. There are no requirements for contractors to use internal management control systems that properly relate cost, schedule and technical accomplishment with the following tools and artifacts: SEP; Requirements traceability between the system's technical requirements and WBS; system baselines (functional, allocated, product); incorporation of product baseline into PMB; TPMs; and risk management and tracking.

EVM Shortcomings

The use of EVM is not sufficient to provide the PM with valid information on cost, schedule and technical performance. Unfortunately, EVM, when implemented by ANSI-748, is not designed to provide performance toward achieving the technical or product baseline.

First, ANSI-748 cites only the "work scope" not the technical baseline or the product scope that is in the APB. Second, ANSI-748 measures only the "quantity of work performed" and not the quality of the system being designed and tested. Third, the use of TPMs in ANSI-748 is optional. Consequently, DoDI 5000.02 is not convincing in its

Circular A-11 states that performance-based acquisition management should be based on the EVMS standard and measure progress toward milestones, cost, capability to meet specified requirements, timeliness and quality.

However, in 2009, the Department of Defense (DoD) reported to the House and Senate oversight committees that the "utility of EVM has declined to a level where it does not serve its intended purpose." Per the report, the PM should ensure that the EVM process measures the quality and technical maturity of technical work products instead of just the quantity of work performed. The report stated that EVM can be an effective program management tool only if the EVM processes are augmented with a rigorous SE process and SE products are costed and included in EVM tracking.

Now, 6 years later, Congress still is considering EVM as a target for acquisition reform. For more information on the deficiencies of ANSI-748, including the "Quality Gap," see my article in the November-December 2010 issue of *Defense AT&L*, "Earned Value Management Acquisition Reform". (See <http://www.pb-ev.com/ndaa-.html> or <http://www.dau.mil/pubscats/ATL%20Docs/Nov-Dec10/Solomon.pdf>.)

A Project Management Standard

EVM, based on ANSI-748, is used primarily by federal contractors when contractually required. A more powerful tool is

the ANSI standard that voluntarily is used worldwide because it works, not because it is imposed by federal acquisition regulations. It is the Project Management Institute (PMI) *PMBOK Guide*.

The needs of the PM that are covered by the *PMBOK Guide* but absent in ANSI-748 include technical or product baseline; requirements management and traceability; and risk management. The *PMBOK Guide* contains many artifacts and tools that have no counterpart in ANSI-748, including:

- Product scope description documenting the characteristics of the product that the project will create. It progressively elaborates the product's characteristics ... described in the project charter and requirements documentation.
- Project scope involving the work that needs to be accomplished to deliver a product ... with the specified features and functions.
- Requirements documentation provides the requirements baseline; it is unambiguous (measurable and testable), traceable, complete, consistent, and acceptable to key stakeholders. Components include functional requirements, nonfunctional requirements, quality requirements and acceptance criteria.
- Requirements Management Plan includes product metrics that will be used.
- WBS Dictionary includes quality requirements, acceptance criteria.
- Scope Baseline includes product scope description, project deliverables and defines product user acceptance criteria.
- Control Scope or the process of monitoring the status of the project and product scope and managing changes to the scope baseline. Completion of the product scope is measured against the product requirements.
- Requirements Traceability Matrix (RTM) includes requirements to project (including product) scope/WBS objectives, product design, test strategy and test scenarios.
- Conduct risk management planning, identification, qualitative risk analysis, quantitative risk analysis, response planning and controlling risk.

The *PMBOK Guide* also covers EVM topics such as scheduling (including network diagrams), PMB, control accounts, work packages, earned value, variance analysis, estimate at completion, and management reserve.

PMBOK Guide Deficiencies

Some ANSI-748 guidelines have no equivalent in the *PMBOK Guide*. These relate to organization costs, material accounting and unit/equivalent/lot costs. It is recommended that, during the acquisition reform reviews of existing regulations, these guidelines be considered for elimination.

Use of TPMs also is optional in the *PMBOK Guide*. Consequently, any revision to the acquisition policies and regulations should require contractors to identify and use TPMs.

For practical guidance to implement the project management needs described above, with or without the *PMBOK Guide*, see the author's article in *CrossTalk*, the *Journal of Defense Software Engineering*, "Basing Earned Value on Technical Performance" (January 2013), <http://www.pb-ev.com/articles-and-tutorial.html>. The article includes recommended contract language and project monitoring techniques to ensure that contractors integrate technical performance and quality, including software functionality, with EVM.

This *Defense AT&L* article is a sequel to previous articles including "Integrating Systems Engineering with Earned Value Management" in the May-June 2004 *Defense AT&L* (http://www.dau.mil/pubscats/pubscats/atl/2004_05_06/sol-mj04.pdf) and "Path to EVM Acquisition Reform" in the May-June 2011 issue of *Defense AT&L* (<http://www.dau.mil/pubscats/ATL%20Docs/May-June11/Solomon.pdf>). These articles also are available at www.pb-ev.com.

Finally, if the *PMBOK Guide* is not utilized, guidance for integrating risk management with EVM is provided by an article in the *Measurable News*, "Integrating Risk Management with EVM (Risk Management Comes Out of the Closet)," (June 1998, page 11) (available at <http://www.pb-ev.com/articles-and-tutorial.html>).

PM Success

Acquisition reforms should include requirements for the PM and contractors to use *PMBOK Guide* for EMD contracts that are above specified threshold values. The PM finally will have valid information and tools needed to properly relate cost, schedule and technical accomplishment; manage risk and achieve the contract's cost, schedule and performance parameters.

A PM can ensure integration of technical performance with EVM even if the *PMBOK Guide* is not utilized. However, there must be a contractually required SEP with linkage of SE work products—such as the requirements in the RTM and TPMs—with the Integrated Master Schedule and work packages.

Acquisition Reform

Effective acquisition reform is a stated objective of DoD and of the chairmen of the Senate and House Armed Services Committees. The *PMBOK Guide* and SEP currently are "guidance." It is recommended that the actual reforms impose the "guidance" provided above as contractual requirements. 

The author can be contacted at paul.solomon@pb-ev.com.

CLAUDE M. BOLTON JR.

1945–2015



The Honorable Claude M. Bolton Jr., a retired U.S. Air Force (USAF) major general and former acquisition official for the USAF and the U.S. Army and the former commandant of the Defense Systems Management College (DSMC), died unexpectedly at home July 28 at age 69. He had a very distinguished 40-year career in the military and in Department of Defense acquisitions.

At the time of his death, Mr. Bolton was Executive-in Residence at the Defense Acquisition University, helping support the recruitment, training and education of the Defense Acquisition Workforce. Reflecting his lifelong dedication to the nation's defense, he once told an interviewer: "Our soldiers are the very best in the world, with the best training in the world. I figure the least we can do is make sure they have also got the best equipment in the world."

He served as mentor to a great many officers and civilians and often would officiate at promotion and retirement ceremonies. At these events, he amazed everyone by recollecting the honoree's family, career and personal interests—without the aid of notes.

A veteran of more than 32 years of active military service, Mr. Bolton retired as a USAF major general in 2002 and was Assistant Secretary of the Army for Acquisition, Logistics, and Technology from 2002 to 2008. In that position, Mr. Bolton served as the Army Acquisition Executive, the Senior Procurement Executive and the Science Advisor to the Secretary of the Army. He also was the senior research and development official for the Department of the Army and had principal responsibilities for all logistics-related matters. He provided oversight for the life-cycle management and sustainment of Army weapons systems and equipment, from research and development through test, evaluation, acquisition, logistics, fielding and disposition. In addition, Mr. Bolton oversaw the Elimination of Chemical Weapons Program and had oversight and executive authority in the Project and Contracting Office charged with Iraq's reconstruction.

In 2000–2002, he was commander of the Air Force Security Assistance Center and (2000–2001) assistant to the

SECTION 3685, TITLE 39, U.S.C. SHOWING OWNERSHIP, MANAGEMENT, AND CIRCULATION

commander for international affairs at the Air Force Materiel Command (AFMC) at Wright-Patterson Air Force Base in Ohio. There he oversaw more than \$90 billion in military equipment sales to foreign countries. In June 1998 to October 2000, he was program executive officer for fighter and bomber programs in the Office of the Assistant Secretary of the Air Force (Acquisition). In June 1996 to June 1998, he was director of requirements at the AFMC, where also had served he had previously served in September 1992 to March 1993 as inspector general. He was DSMC's commandant from March 1993 to March 1996.

Mr. Bolton was born in December 1945 in Sioux City, Iowa, and received his bachelor's degree in electrical engineering in 1969 from the University of Nebraska-Lincoln, where he also served in the Reserve Officers Training Corps. Upon graduating, he entered the Air Force as a second lieutenant, where he served as a fighter pilot and logged more than 2,700 hours in more than 30 different aircraft and 232 combat missions—40 of them over North Vietnam.

He studied acquisition management at DSMC, where he later was commandant. He earned a master's degree in management from Alabama's Troy State University in 1978, and a master's degree in national security and strategic studies from the Naval War College in Newport, Rhode Island, in 1991. He also was awarded honorary doctorates from the United Kingdom's Cranfield University in 2006, and from his undergraduate alma mater, the University of Nebraska-Lincoln, in 2007, and completed the course requirements for a Ph.D. in electrical engineering at the University of Florida.

He held the Defense Distinguished Service Medal, the Legion of Merit, the Distinguished Flying Cross with oak leaf cluster, the Meritorious Service Medal with two oak leaf clusters, the Air Medal with 16 oak leaf clusters, the Vietnam Service Medal with three service stars, the Republic of Vietnam Gallantry Cross and the Republic of Vietnam Campaign Medal.

Mr. Bolton was survived by his wife Linda and daughters Cindy and Jennifer, five grandchildren and five siblings, and his parents.

According to his family, Mr. Bolton was intensely dedicated to the tasks that he took on and was known for "dreaming big" and chasing his dreams with hard work. 🐶

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A woman in ancient Egyptian attire, including a gold headband with a cobra, large hoop earrings, and a gold necklace, is shown from the chest up. She is reaching out with her right hand towards two white dice and a long line of white dominoes. The background is a hazy, ancient stone temple with columns and a pediment.

Delphi, Dice and Dominos

Techniques to Understand and Mitigate Technical Risk

David L. Gallop

It is no secret that our programs are becoming increasingly complex and interdependent. With that complexity and interdependency come both opportunity and technical risk. There are three simple techniques any program can use to understand and mitigate technical risk.

These techniques take us beyond the common (yet important) “risk cube.” They can be used together or separately. They are designed to avoid three common logic traps: failing to account for additional perspectives; failing to account for uncertainty in data; and failing to account for interdependencies. The techniques are

Gallop is a professor at the Defense Systems Management College,

Fort Belvoir, Virginia. He is a Project Management Professional and a Certified Systems Engineering Professional.

**Consensus is not our goal.
Our goal is to understand the
uncertainty. This requires diverse
perspectives.**



commonly used in medicine, finance and manufacturing. The metaphors we use are Delphi, dice and dominos.

Delphi

“Delphi” refers to the Oracle of Delphi, where in ancient Greece someone (perhaps ancient program managers) went to receive prophecies about the future. Program success often depends on how well we forecast the future. We often rely on teams or committees to provide forecasts. While we know groups perform better than their best member, groups have their weaknesses. Powerful individuals (personality or position) can dominate and therefore limit or bias a forecast. The Delphi method seeks to aggregate independent perspectives from a diverse group. You can find Delphi practiced in a variety of fields such as environmental management, tourism, education and marketing. Program managers can use Delphi in situations of complexity, uncertainty and where no hard facts exist. Delphi can be used whenever the program manager needs to analyze disparate perspectives on a subject—contractor incentives, task durations, nonmateriel impacts, etc. In the following example, we will use Delphi to help us evaluate a Technology Readiness Level (TRL).

TRLs are an important part of the technical risk assessment process. TRL scores measure the maturity of a technology on a scale of 1 through 9 (with 9 being the most mature). TRLs

should be based on objective evidence instead of opinions. However, even the best available evidence can be incomplete and subject to interpretation. The Delphi technique can help us increase our knowledge and provide different perspectives. The classic Delphi technique involves using multiple rounds of feedback to drive the group toward consensus. This can be time and resource intensive. Classic Delphi also has been criticized for achieving consensus at the expense of the best ideas. We will use Delphi’s power to extract knowledge from experts while avoiding the mentioned disadvantages. Figure 1 summarizes our modified Delphi process.

Once the problem or topic area is identified, assemble the evidence file. This includes the objective data that will underpin the TRL score. The file should also contain information regarding the operational and systems context. To avoid confirmation bias, the file should not include an expected TRL score. The file should have plenty of “white space” to elicit information and opinions from the panel members. Possible questions include the following: What additional information should we seek about the subject technology? Where and how can we get that information? What laws, regulations and policies must we consider? What stakeholders will have an interest in this technology? What are the pitfalls and unintended consequences of this technology? What are some materiel and nonmateriel alternatives to this technology? What new ideas and opportunities will this technology offer? Finally, the file should ask the panel members to provide a TRL score and its justification.

Figure 1. Modified Delphi Process

Steps	Actions
1	Select the problem or topic for investigation.
2	Assemble the evidence/information file for the Delphi panel members.
3	Select the Delphi panel members.
4	Send the Delphi panel members evidence/information file to be reviewed independently.
5	Receive and analyze the findings from the Delphi panel.

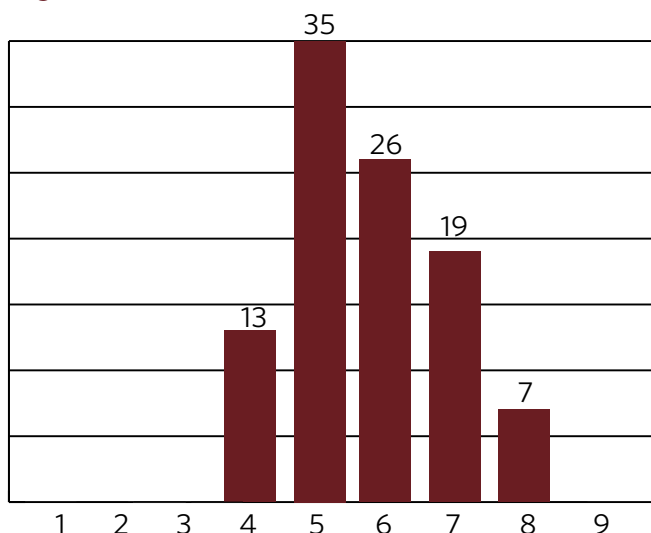
Continuing our TRL evaluation example, electing the Delphi panel members and distributing the evidence files to those members are the next steps. Conventional wisdom would have us seek out the most brilliant minds in the domain of the subject technology. This would be the “perfectly, perfect” panel and help drive panel members toward a consensus. But consensus is not our goal.

Our goal is to understand the uncertainty. This requires diverse perspectives. We should seek the “perfectly, imperfect” panel. Panel members should have collective expertise in the operational environment, defense acquisition process, technology development and the specific technical domain.

Figure 2. TRL Scores

	TRL-1	TRL-2	TRL-3	TRL-4	TRL-5	TRL-6	TRL-7	TRL-8	TRL-9
# of Delphi Panel Members	0	0	0	2	6	14	7	1	0

Figure 3. Monte Carlo Simulation



Delphi panels range in size from 10 to more than 1,000. The Delphi process does not call for the panel size to be representative samples for statistical purposes. However, 30 panel responses may be optimal in most cases. Each panel member responds individually and independently. If we were seeking consensus, we would perform the Delphi in many rounds. However, two rounds (initial feedback and follow-up clarification) should suffice. The process allows panel members the freedom to think reflectively and propose alternative viewpoints.

Finally, collect and analyze the findings. You are looking for new information, risks, stakeholders, ideas and opportunities. The increased knowledge and perspective from the Delphi method can lead to technical excellence and innovation.

Dice

Program managers frequently must assess quantifiable data—i.e., numbers. They often reach conclusions and make decisions without considering the uncertainty in the numbers. A Monte Carlo method typically runs a simulation many times to obtain the distribution of an unknown probabilistic entity. The Monte Carlo technique can be used in many situations such as cost estimates, corrective maintenance task durations or risk ratings. Our example uses the TRL scores from our Delphi process to assess the uncertainty.

Figure 2 is a table of the TRL scores from our notional Delphi panel. We can see that the scores range from a pessimistic TRL-4 to an optimistic TRL-8. The most common score is TRL-6. To arrive at a single score, we could simply take the

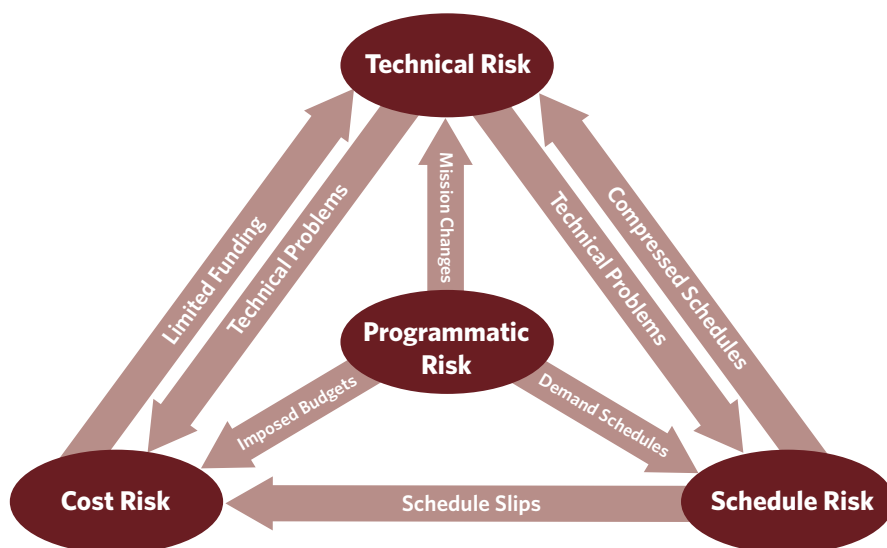
average of the scores. The problem is that decisions made based on the average are wrong on average (“The Flaw of Averages” by Sam L. Savage, John Wiley & Sons publishers). Since we are interested in understanding the uncertainty, we should consider the probability distribution. It’s time to roll the dice using a Monte Carlo simulation.

There are many powerful commercial software packages that will perform Monte Carlo simulations. These tools can be expensive and often require training. Program managers need not spend a great deal of money on tools, training or consultants. Excel is widely available and has built-in features to create a simulation. The Web has a number of articles and videos that provide detailed instructions on how to construct a Monte Carlo simulation in Excel. Thomas and Linda McKee’s article, “Using Excel to Perform Monte Carlo Simulations,” in the December 2014 issue of *Strategic Finance*, is a great resource.

We created a simulation in Excel that ran 100 iterations (Figure 3). In that simulation, we assigned random probabilities that the actual TRL lies somewhere between the minimum (TRL-4) and maximum (TRL-8), with a greater probability around the mode—or most frequent—(TRL-6). Many random processes follow a normal (bell-shaped) distribution, but some do not. Since we have a minimum, maximum and a mode, we used a triangular distribution. The McKee article mentioned earlier describes the steps to create several common probability distributions in Excel.

This simulation reveals a strong probability that the technology maturity actually is TRL-5. If we assume that the program manager expected the maturity to be TRL-6, there should be mitigation commensurate with the risk that the maturity actually is TRL-5. The mitigation could include gathering more information or exploring alternative solutions. So far, we have

Figure 4. Risk Interrelationships



Adapted from the INCOSE SE Handbook 3.3.2, page 222.

Our goal is to keep all the dominos standing ... but we never have the resources to monitor and control everything equally.



used the Delphi method to consider perspectives and the dice (Monte Carlo simulation) to consider uncertainty. Our next tool will allow us to consider interdependencies.

Dominos

Consider all the risks in a program. We can group those risks into four categories—cost, schedule, technical and programmatic. Figure 4, adapted from page 222 of the International Council on Systems Engineering's 2011 *Systems Engineering Handbook* (INCOSE-TP-2003-002-03.2.2), shows the typical relationships among the risk categories. Visualize these risks as groups of dominos standing on end. One domino falling may trigger a cascade of issues across the program. Our goal is to keep all the dominos standing ... but we never have the resources to monitor and control everything equally. It also is difficult to predict what other dominos will fall if a domino tips over. If only we had a tool that would help program managers focus their resources and predict where downstream issues could occur from a falling domino. An N-squared chart can help.

An N-squared chart can map interdependencies of functions, components, documents, organizations and budget lines ... just about anything that can be decomposed into smaller units and where those smaller units have exchanges. To build an N-squared chart, put the elements (to be designated by the letter "E" and given identifying numbers) in the diagonal blocks of a matrix. The exchanges between the two elements appear in the intersection of the corresponding row and column. In the generalized example in Figure 5, E1 receives an external input and an input from E2. E1 provides an external output and an output to E2.

Let's return to our domino analogy. If the E2 domino falls, the E1 domino could fall as well. The N-

squared chart's predictive power increases as we provide more detail on the interdependencies. From Figure 6, we can infer that E1 and E4 deserve our attention. E1 is the interface with an external system, outputs data for three elements, and receives inputs from five elements. E4 receives four inputs from three elements. We also can see that three elements depend on Data Item A. Data Item A also deserves our attention. The fact that E1 outputs Data Item A underscores the importance of the E1 domino remaining upright. As a predictive tool, a performance shortfall in E6 would predict a performance shortfall in E1 (and in turn shortfalls in E2, 3, 4, and the external system). All the dominos are important ... but some dominos are more important than others.

Conclusion

Understanding and mitigating technical risk requires casting a wide net for information and perspectives. The Delphi technique is useful in complex situations where there may be no clear choice. Monte Carlo simulation highlights the uncertainty in data. Knowing this uncertainty allows communication of the confidence in the data. The N-squared chart maps the interdependencies so we focus our monitoring and control. &

The author can be contacted at david.gallop@dau.mil.

Figure 5. The Elements Interact

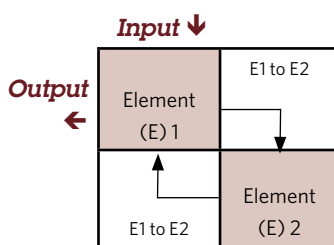
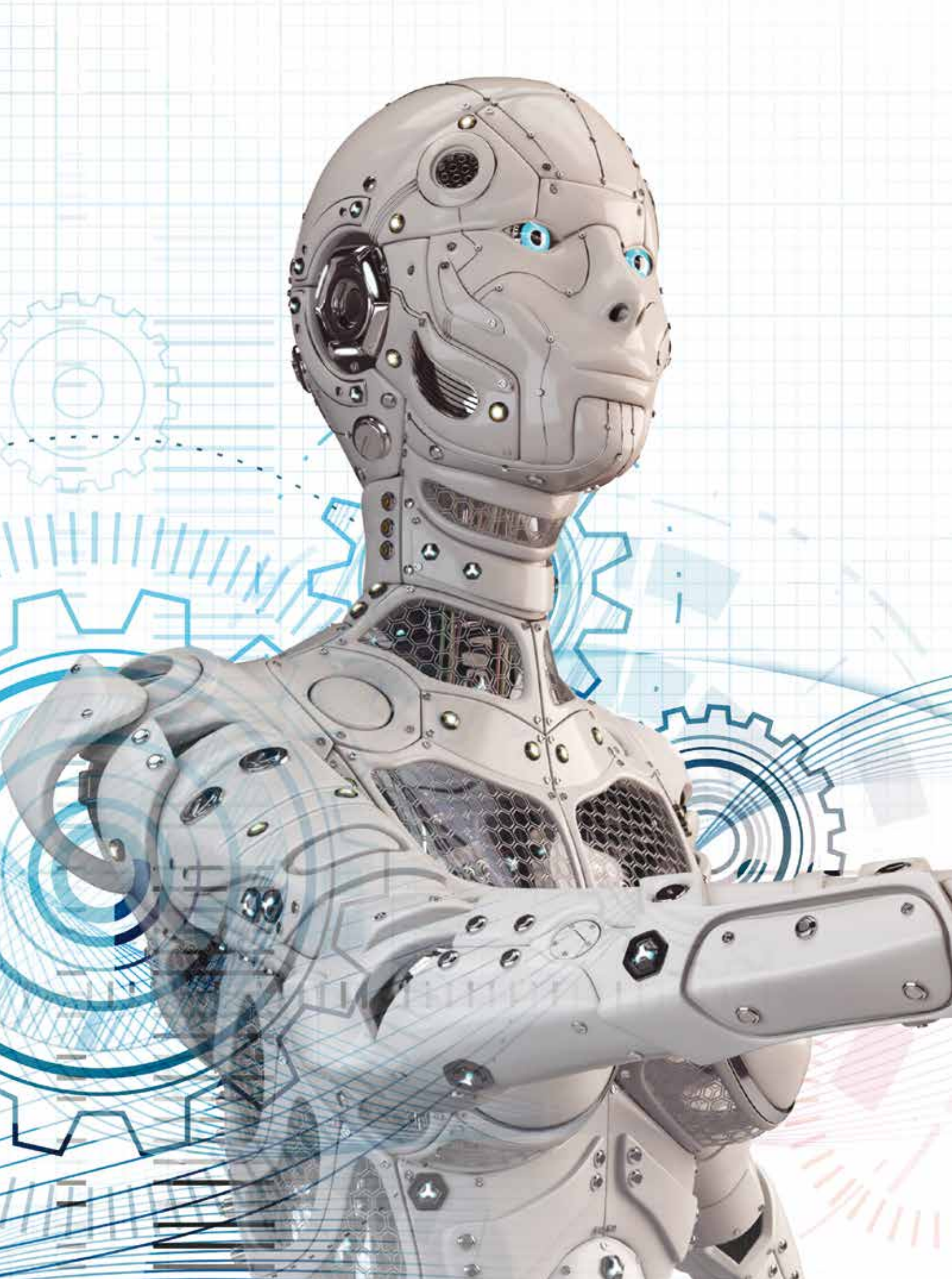


Figure 6. N-Squared Chart

Input ↓

Output ←	Element 1	Data Item A Data Item B	Data Item A	Data Item A		
	Data Item C	Element 2		Data Item D		
	Data Item L		Element 3	Data Item E Data Item F		
	Data Item K			Element 4	Data Item E	
	Data Item J				Element 5	Data Item H
	Data Item I					Element 6



If Your Technology Works, Will It Matter?

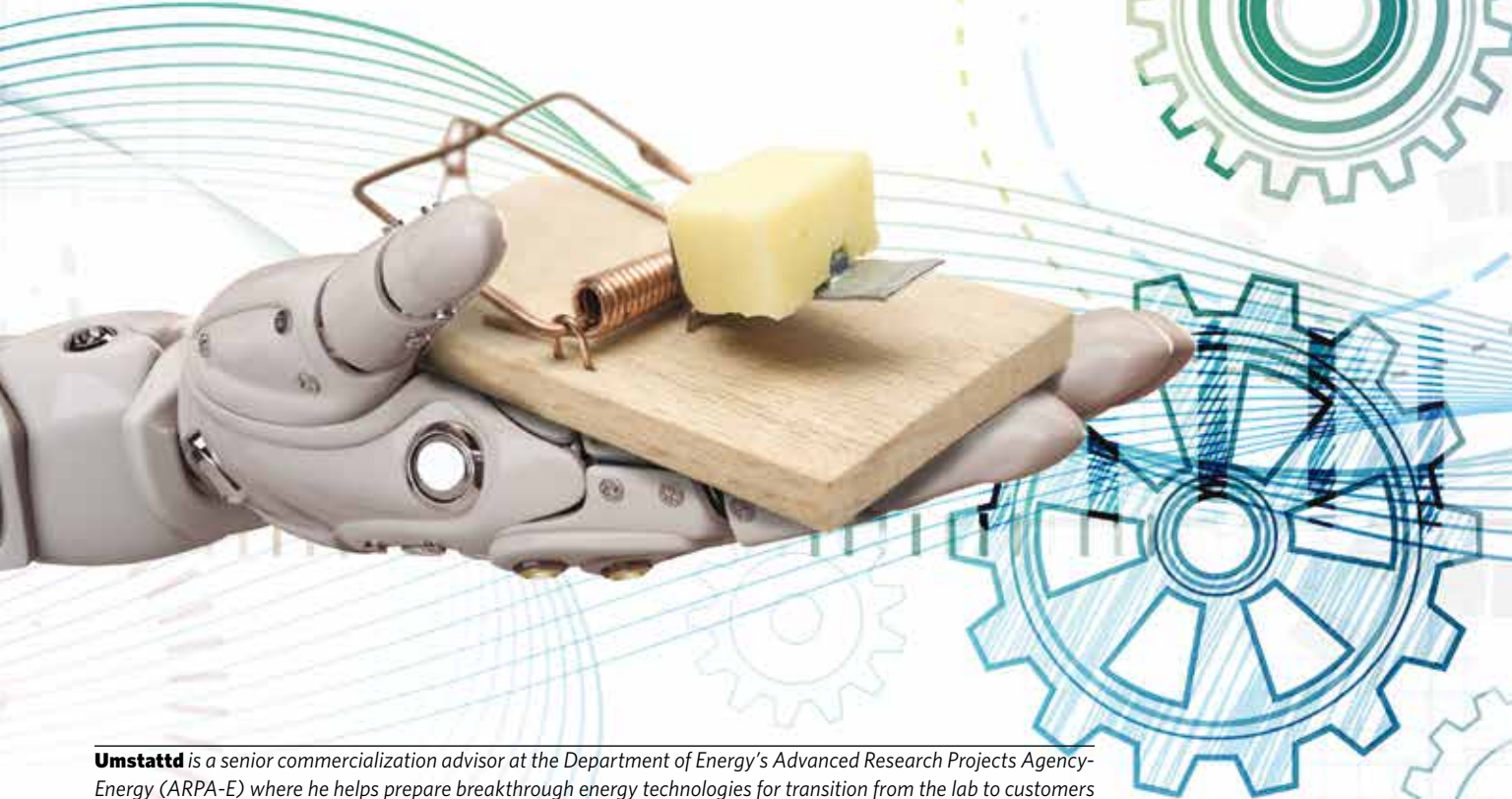
Ryan Umstattd, Ph.D.

The foundational question above is asked and then answered by our program directors before they launch any new focused initiative at the U.S. Department of Energy's Advanced Research Projects Agency (ARPA-E).

It's simply not good enough to perform groundbreaking applied research if we haven't also developed a credible path toward the commercial market for our technologies. While the U.S. Department of Defense (DoD) Research, Development, Test and Evaluation construct is not geared toward placing products in the broad commercial marketplace, many lessons learned from asking that foundational question remain valuable in managing the DoD's science and technology investments.

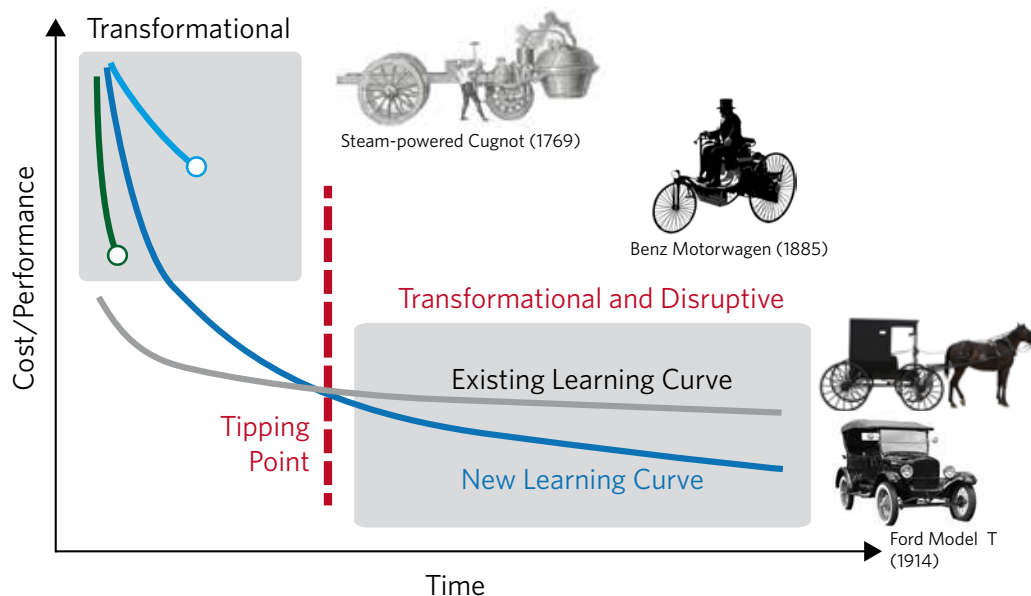
Managing More Than Technology Development

Our mission at ARPA-E is to catalyze and support the development of transformational, high-impact energy technologies. That said, a technological breakthrough by itself may not be sufficient to drive a transformation that becomes truly disruptive (see Figure 1). Bringing a new technology to the tipping point of disruption involves success on several fronts, including science and technology development, a viable business model and value proposition, favorable market



Umstattd is a senior commercialization advisor at the Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) where he helps prepare breakthrough energy technologies for transition from the lab to customers within the Department of Defense. Earlier, he spent 20 years developing and delivering technologies as a U.S. Air Force acquisitions officer. He has a Ph.D. in applied science (plasma physics).

Figure 1. Technology Transformation and Disruption



conditions, and financial support for scale-up and production. As a government agency that provides funding, we have the role of developing technologies until they are ready for market decisions; to prepare for that stage, we manage and guide our awardees in both technical and commercial development. We employ both program directors who manage the technology development of various projects as well as project-specific, dedicated technology-to-market advisors. Our tech-to-market advisors help our awardees plan and execute the many aspects of commercialization that go beyond successful technology development. As shown in Figure 2, the tech-to-market team provides a foundation that supports the program director's advanced technology effort as part of our strategy to increase the yield of good ideas that become impactful products. Our program directors and tech-to-market advisors work together to build a community of advocates ranging from the laboratory to the marketplace so that successfully demonstrated, transformative technologies have a better chance of being embraced by potential users.

There can be a natural, healthy tug-of-war between our program directors and our tech-to-market team over technical risk. While the program directors are asked to identify and fund high-risk, potentially game-changing research, the tech-to-market advisors will need to demonstrate that the associated technical risk has been driven low enough to capture the interest of potential commercialization partners. At the end of the day, because our program directors and tech-to-market advisors are both in hot pursuit of a positive response to our mantra, "If it works, will it matter?," they appreciate each other's perspective and remain unified by that common goal.

Supplementing Awardees' Skill Mix

Because our goal is to enable the project teams to manage their own paths to commercialization, our tech-to-

market efforts must extend beyond the ARPA-E program and tech-to-market team. As part of an ARPA-E award, each awardee is asked to assign a tech-to-market lead person who establishes the project's commercialization goals that drive the technology along the path to market. In fact, a portion of the award funding must be designated for performing technology transfer and outreach. A skilled tech-to-market lead on the awardee team can make the difference between a transforma-

tional idea that withers on the vine and a disruptive new technology that overtakes the competition and dominates the market (as per Figure 1). An effective tech-to-market lead must be intimately familiar with the technology landscape and the technical details of the project, so sometimes the tech-to-market lead also is the project's lead scientist or principal investigator. The skill set needed for performing bread-and-butter commercialization tasks is quite different, however, from that needed for performing world-class applied research. Thus, a principal investigator is encouraged to seek out a tech-to-market lead with a strong background in not just the technical area of the project but also in preparing business cases, value propositions and intellectual property protection strategies.

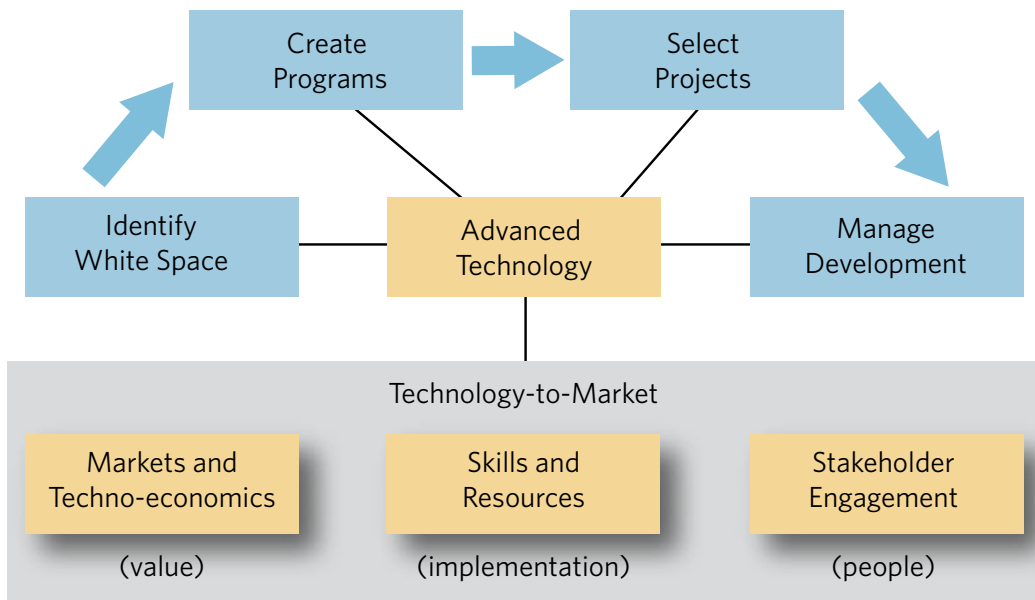
At each quarterly project review, the ARPA-E program director and tech-to-market lead actively engage with the awardee team to understand, direct and advise both technical and tech-to-market efforts. This government-awardee-combined team becomes a powerful force when each group is committed to making the technology matter.

Transitioning Technology

Each awardee's progress is monitored against carefully designed technical and tech transfer milestones—but meeting those milestones alone does not necessarily mean their technology will be commercialized. The government and awardee teams should work together throughout the project term to identify and connect with potential transition partners. As each of our projects come to a close, we aim to keep the successful technologies moving toward commercialization via several available paths, including:

- New company formation
- Strategic partnership with an existing company

Figure 2. Bringing Technology to Market



For the subset of ARPA-E projects that also have clear defense-specific applications, we encourage the awardees to forge partnerships with a defense customer—ideally by affordably addressing a formal requirement. It also is beneficial for the project team to consider a partnership with a commercial firm that has a proven track record of being able to contract with, manufacture for and deliver systems to the DoD.

Finally, as you have likely seen in your acquisition careers, the technologies with the greatest likelihood of making it through the defense acquisition

- Private investment
- Public development

When the awardee's team has a strong technical success, the right personnel and supportive market conditions, a new business may be spun off at the conclusion of the project as the path to commercialization. Another route leverages the experience and size of an existing company by attracting its interest in the new technology. If the technical risk remains too high for either of these two paths, the project team might seek out follow-on funding from private investors or another government agency in order to further mature the technology. Regular and open communication between the government and awardee teams is crucial to understanding the successes and stumbling blocks along a transition path. To date, projects funded by ARPA-E have resulted in the formation of at least 30 new companies, attracted more than \$850 million of private sector follow-on funding and led to more than 37 projects funded via partnership with other parts of federal, state or local government.

It also is important during transition to find the right partners who can add skills and resources beyond those of the original project team. Many ARPA-E projects focus on breakthrough, building-block technologies that will need to be incorporated into a larger system in order to fully commercialize, such as actuators for sun-tracking solar panels, cell-level battery diagnostics to improve energy management or higher current density superconducting wire. Thus, once a project team has identified that crucial first market, an important next step may be to find a transition partner who can help the team plan and execute the effort that takes the project beyond a lab prototype of a component to a full-blown system demonstration.

system are supported by a combination of both technology push and requirements pull. While ARPA-E does not have formally documented user requirements, our tech-to-market program includes activities designed to help awardees understand the current market needs, generate customer pull and increase their odds at having their new technologies matter.

Parting Thoughts

While we apply the tips above in managing, executing and partnering across our entire ARPA-E project portfolio, note that these insights are much more readily applied in defense science and technology development for applied research and beyond. The fundamental science research performed cannot benefit nearly as much, given that a market cannot be defined when the end-goal technology is still in flux. For each office that funds, manages or performs applied research, we encourage you to find your most natural and effective transition partners and keep them informed and engaged often!

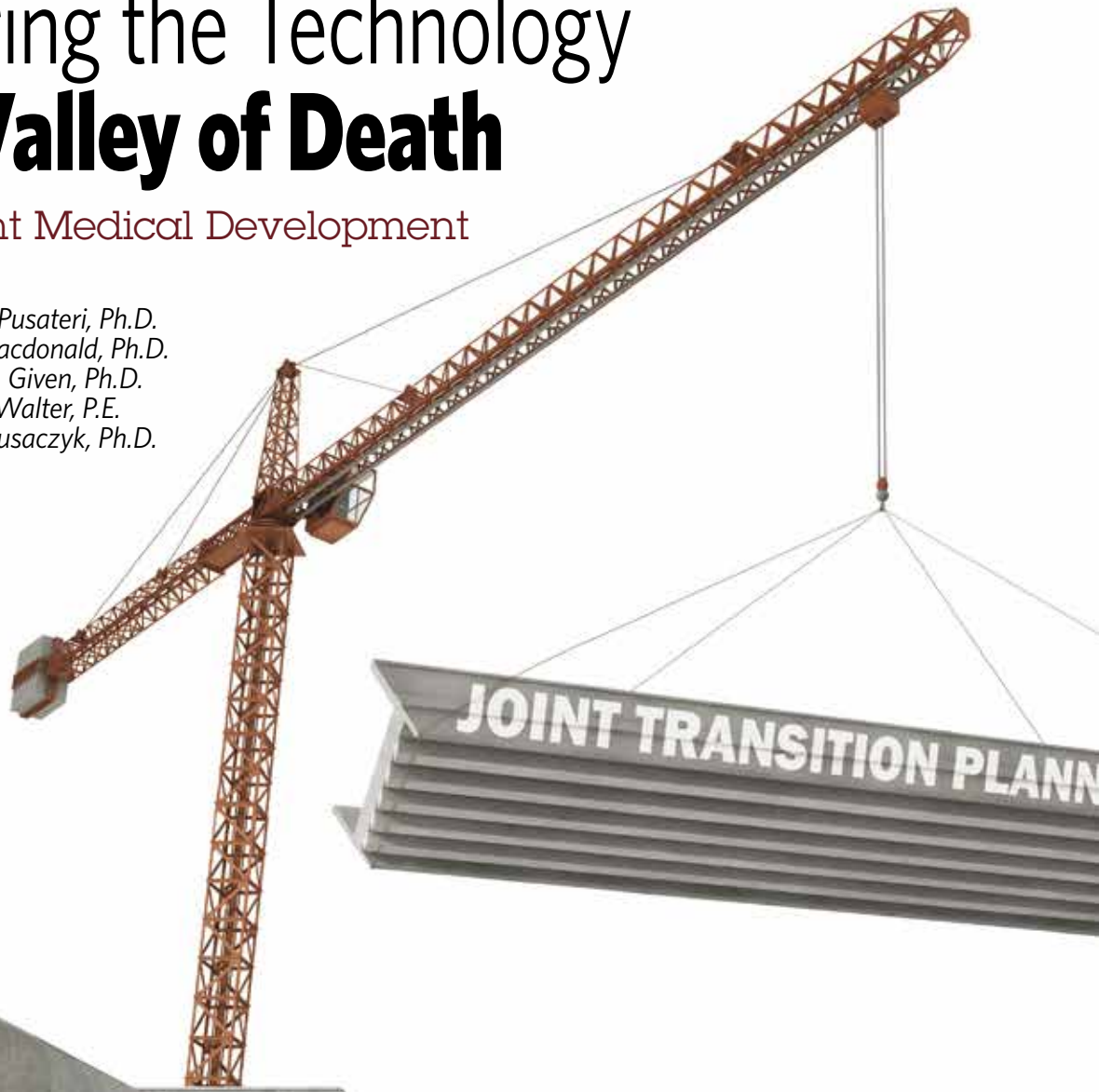
For ARPA-E, success lies in having effective partnerships not just internally between our program directors and tech-to-market advisors, but also externally with our counterparts on the awardee teams and potential transition partners. Of course, if achieving successful technology transition were as simple as following the guidelines above, there would be a straightforward checklist resulting in higher yields from lab to market. From what we have seen here at ARPA-E, these guidelines are executed by top-notch personnel attracted by an organizational environment that is transparent and eager to experiment with new approaches to developing and delivering energy technology that matters. 

The author can be reached at ryan.umstattd@hq.doe.gov.

Bridging the Technology **Valley of Death**

in Joint Medical Development

*Anthony E. Pusateri, Ph.D.
Victor W. Macdonald, Ph.D.
Michael B. Given, Ph.D.
Scott F. Walter, P.E.
W. Keith Prusaczyk, Ph.D.*



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One of the most difficult transitions in a product's life cycle is the transition from the science and technology (S&T) environment to advanced development (AD). Transition planning is necessary to bridge this technology "Valley of Death" in which promising technologies frequently are delayed or fail to make the transition. Without successful transitions, intellectual and financial investments in research do not translate to improved capabilities for the U.S. military. Early and thorough transition planning is key to success.

Transitions in medical product development traditionally have been conducted within the military Services, moving from a Service S&T program to its respective AD program. The launch of the Defense Health Program (DHP) in 2008 provided jointly managed resources to supplement and leverage existing individual Service research-and-development (R&D) investments and also provided the impetus to establish joint medical development portfolios.

In 2010, the Joint Program Committee for Combat Casualty Care established the Joint Hemorrhage and Resuscitation R&D Portfolio, which provided the first-ever comprehensive Department of Defense (DoD) view of the R&D pipeline for medical products that address bleeding, the leading cause of potentially preventable deaths on the battlefield (Eastridge et al., 2012). Initial pipeline review revealed several promising technologies in late S&T

Pusateri is Portfolio Manager for the Department of Defense Hemorrhage and Resuscitation Research and Development Program for the Combat Casualty Care Research Program at the U.S. Army Medical Research and Materiel Command in Fort Detrick, Maryland. **Macdonald** is Product Manager for Pharmaceutical Systems at the U.S. Army Medical Materiel Development Activity, Fort Detrick. He is a blood products expert. **Given** is a program officer in the Office of Naval Research in Arlington, Virginia. **Walter**, a retired U.S. Air Force lieutenant colonel, is the Air Force Medical Support Agency Advanced Development Liaison Field Engineer in Falls Church, Virginia. **Prusaczyk** is Director of Acquisition and Program Management at the Naval Medical Research Center in Silver Spring, Maryland.

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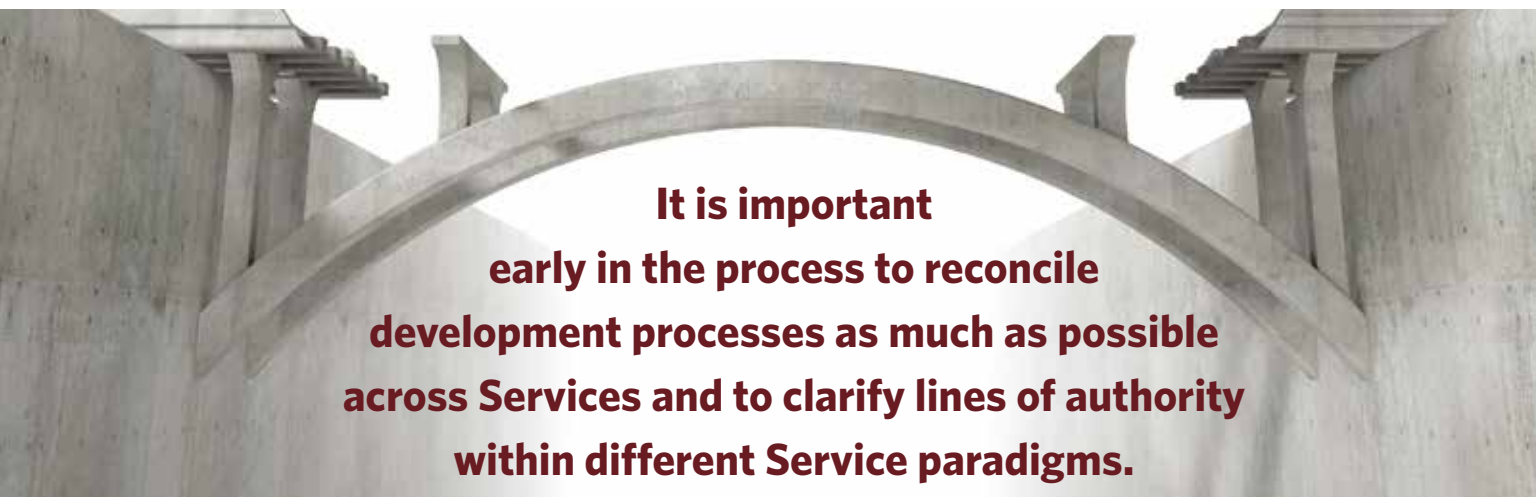
that did not have established transition pathways, Program Executive Office buy-in, or adequate funding. While there were significant opportunities to leverage funding and other resources across the DoD, no process had been established for joint transitions to medical AD. Therefore, our team, with input from a number of stakeholders and subject-matter experts (SMEs), developed a Joint Transition Planning Process that successfully facilitated transitions for seven programs.

Product Development “Valley of Death”

The transition from S&T to medical AD within DoD roughly parallels what has been termed the pharmaceutical or technology “Valley of Death.” The “Valley of Death” most frequently

FDA requirements. Some programs continue through Phase I clinical trials, while others may end before completion of preclinical development.

- Different Services have different procedures and expectations for transition.
- Stand-alone Service programs may not recognize opportunities to leverage funding or to fill joint (common) capability gaps.
- S&T teams often are not aware of the types of information and data needed for advanced developers to accept a program, or to enable entry into FDA regulated trials.
- Awareness, communication and coordination may be minimal among Service S&T and AD programs.



**It is important
early in the process to reconcile
development processes as much as possible
across Services and to clarify lines of authority
within different Service paradigms.**

refers to a lack of funding or development partners for a product to bridge the technology transition phase (Figure 1). This critical transition period spans from the late research, pre-materiel development decision (MDD) phase, through technology development. Specific activities during this phase for drugs or biologics products, for example, include: final proof of concept in relevant animal models; manufacturing development in accordance with Food and Drug Administration (FDA) Good Manufacturing Practices; analytical development; animal safety studies; initial clinical development planning; Investigational New Drug (IND) Application filing, first in human safety studies; and others. The proportion of these activities before transition to a chartered AD Integrated Product Team (IPT) depends on the Service sponsoring the S&T and the specifics of the program.

The most significant opportunity in developing a joint transition process for medical development programs is for Service S&T programs to directly transition into joint AD programs, with supplemental funding provided via the DHP. Joint programs provide an opportunity to systematically address capability gaps that are shared by all Services and to leverage Service funding and capabilities. A number of challenges also are apparent:

- S&T programs from various Services and agencies typically end at slightly different phases of research with respect to

Joint Transition Planning Process

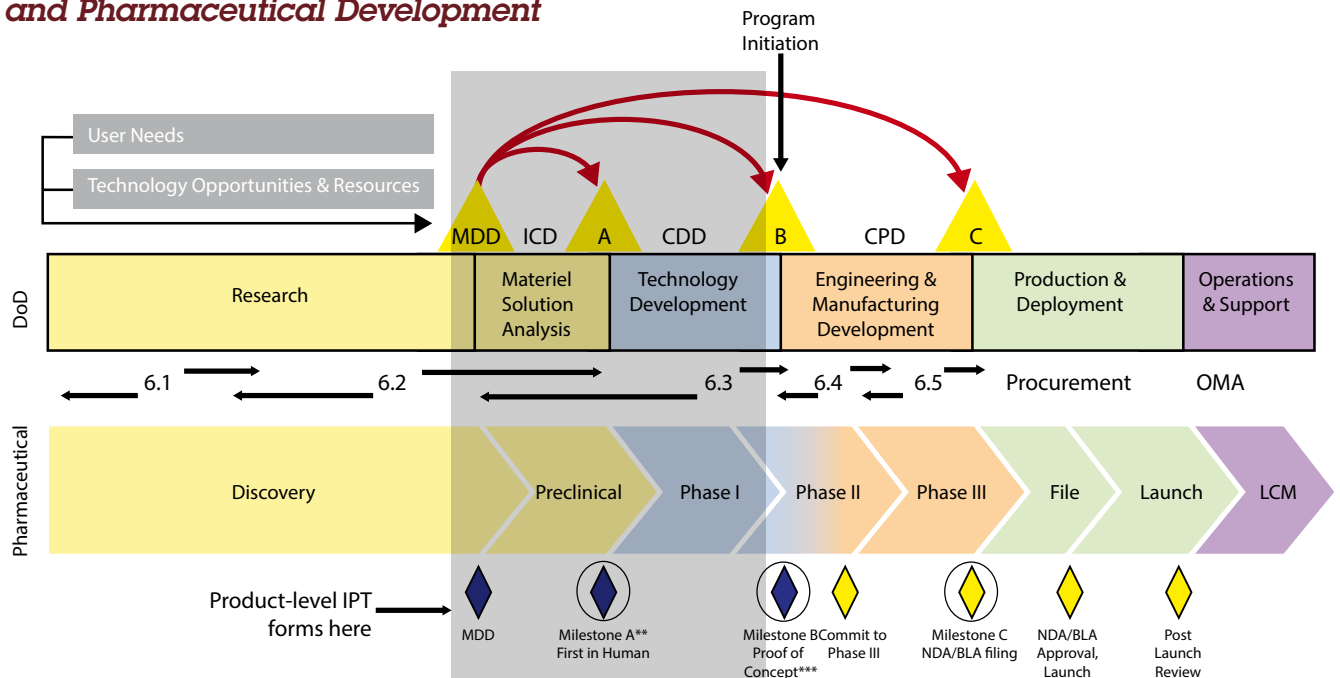
A Joint Transition Planning Process was developed to facilitate transitions involving different funding sources, different Service and agency paradigms for S&T, and different experiences with AD. This process helps bridge the technology development “Valley of Death” by facilitating and tailoring late-stage S&T to position the product for transition to AD and generating information useful in higher-level acquisition decisions. It complements but does not replace Service planning processes. It is important early in the process to reconcile development processes as much as possible across Services and to clarify lines of authority within different Service paradigms. Key components are the Joint Transition Planning Meeting and the Joint Transition Working Group (JTWG), and there is an overarching theme of communication.

Joint Transition Planning Meeting

The Joint Transition Planning Meeting provides a forum for S&T team presentation and a process for building advanced developer awareness. The meeting is structured to provide the following information and functions.

- Provide current product/program information.
- Provide information and assistance to the S&T team to prepare for transition.
- Assess potential for transition.
- Identify potential Service interest as AD lead.

Figure 1. DoD Medical Product Development Milestones and Pharmaceutical Development



Technology translation phase of “Valley of Death” is shown in the gray box.

Source: U.S. Army Medical Research and Materiel Command, Fort Detrick, Maryland, Decision Gate Office (Modified).

- Identify funding source(s).
- Understand Service(s) concurrence with importance of capability and approach.

Meeting preparation includes assisting and advising the S&T team and providing specific presentation content guidelines. The primary meeting outcomes are recommendations and may include identifying a lead advanced developer and funding commitment (subject to senior leader and milestone decision authority [MDA] approval) or formation of a JTWG to facilitate movement toward AD and a future reassessment. It also may be recommended that the S&T program continue in S&T or that it be discontinued due to lack of Service interest or funding.

The JTWG

A JTWG is formed to facilitate the transition of a promising S&T program to a joint AD program. The working group performs functions similar to those of an IPT for a limited period to bridge the gap until official designation of an AD lead, a chartered IPT and a formal AD program. The roles of the JTWG can be tailored to the needs of the specific program and transition situation.

Key functions and activities include the following as needed:

- Perform a detailed assessment of current program status (e.g., cost, schedule, regulatory, technical feasibility, risk analysis).
- Perform analysis of alternatives.
- Review the currently planned regulatory pathway and recommend potential changes.
- Determine status of requirements and acquisition documents and initiate production of documents.
- Assess current contracts and develop estimates for modifications and/or future contracts.
- Develop budget estimates and determine availability of funding.
- Develop an updated estimated timeline and work breakdown structure.
- Provide recommendations regarding a development decision.
- Assess relevant capability gaps, potential methods of employment and implications for an acquisition strategy.
- Assess relevance of the product for each Service.
- Assess security and/or status of intellectual property.
- Discuss the role of industry partners.

Early activities include an initial forming meeting, initiation of periodic meetings, an in-progress review (IPR) within 60 to 90 days, and establishment of electronic information sharing. Activities continue under the JTWG until either an advanced developer is designated and a chartered IPT formed or a decision is made not to continue the product into AD. Activities are tailored to provide the information needed to enable initial assessments, recommendations and decisions. The focus is on preparing for transition and enabling post-transition activities.

JTWG Membership

The JTWG is not an officially chartered body. Rather, it is a working group that technically functions as a subgroup of the joint portfolio-level steering committee. Core membership is augmented over time by additional experts and representatives. Membership includes representation from S&T team, Services or agencies, advanced developers, regulatory scientists and others as needed (e.g., requirements, budget, legal, contracting, cost estimating, scientific or user medical SMEs, logistics personnel).

Experience to Date

The process is flexible and structured sufficiently to ensure that the proper information is available to the appropriate groups to facilitate planning and decision making. Initially, there was significant controversy over what milestone decision process and what contracting and regulatory oversight office(s) to use, who would serve as MDA, and other variables. While these were legitimate and important issues, they were largely due to the fact that the Defense Health Agency (DHA) was being established and the potential impact on procedural requirements was not yet clear. Each Service has established processes for within-Service transitions. The goal was not to establish new requirements to which programs must conform but to develop a process to move programs forward in a way that makes transitions compatible with entry into the AD processes already in place for each Service. The process has facilitated the progress of several products and also a decision to discontinue a program. Our experience to date includes:

2011—The Red Cell Pharming Program: This S&T program was sponsored by the Defense Advanced Research Projects Agency (DARPA) to develop a technology to produce universal red blood cells in vitro and to eliminate the need to collect red cells from donors. This would reduce logistical constraints and enhance the safety of blood transfusions. At the Joint Transition Planning Meeting, it was concluded that the projected unit cost for the “Pharmed” red cells was prohibitive. The program was not moved into AD. This promising technology now is being explored for other applications.

2012—Solvent Detergent Spray-Dried Plasma: This S&T program was sponsored by the Office of Naval Research (ONR) and Marine Corps Systems Command to produce a dried plasma that would reduce dramatically the logistical constraints associated with current frozen plasma. A dried product that could be rehydrated when needed would make it possible to provide plasma transfusions for combat casualties



DoD Solvent Detergent Spray-Dried Plasma in Development

Photo (with permission) by Entegria, Research Triangle Park, North Carolina.

wherever medically needed on the battlefield or in transport, as opposed to only where freezers and thawing equipment are present. This program was transitioned as the first Joint Medical Advanced Development Program chartered by DHA. The program was guided through the transition by a JTWG for more than a year, until an IPT was chartered. It is now a Navy-led, Joint Advanced Development Program, funded by DHP and Navy, with significant program support from the Air Force. This is part of a three-product U.S. Government strategy to develop dried plasma, including programs that incorporate different technological approaches and that are sponsored by the Army and the Biomedical Advanced Research and Development Authority (BARDA). Coordination is facilitated by IPT cross-membership.

2013—The Wound Stasis System: This DARPA program was designed to develop an expanding foam that could be infused into the abdominal cavity to control internal bleeding until the injured Service member could reach a surgeon. The program successfully advanced under the guidance of a JTWG and is now an Army-led, Joint Advanced Development Program, funded by DHP and the Army.

2013—Platelet Derived Hemostatic Agent: There were two competing technologies and development programs—one S&T program sponsored by Army and DARPA, the other by ONR. The goal was a product that could be infused intravenously to help stop bleeding. The recommendation from the Joint Transition Planning Meeting was to move both products forward for a later down-select, under an Army-led Joint Advanced Development Program. Subsequently, our interagency



DoD X-Stat Dressing to stop bleeding in deep wound tracks.

Photo (with permission) by RevMedx Inc., Wilsonville, Oregon.

partner, BARDA, agreed to develop one product, while the Army continued development of the other. The two programs are progressing with close-coordination and cross-membership on the IPTs. The DoD program is funded by DHP.

2013—Valproic Acid: This S&T program was sponsored by ONR to develop a drug that could be injected into a combat casualty to stabilize affected tissues and increase survival time before reaching surgery and blood transfusion. Following the Joint Transition Planning Meeting, a JTWG was formed and continues to move the program forward until a Navy-led Joint Advanced Development Program is established. The program continues with DHP and Navy funding and significant program support from the Air Force.

2013—Surviving Blood Loss Program: The goal of this DARPA S&T program was to develop a low-volume treatment that could be administered to bleeding casualties to increase survival time after severe blood loss. The research program developed a new drug—ethinyl estradiol-3-sulfate. At the Joint Transition Planning Meeting, it was determined that additional work was needed before any Service would be willing to commit to leading a Joint Advanced Development Team. Currently, the program is proceeding under the guidance of a JTWG in close coordination with DARPA and the participating DoD lab. Funding is provided by DHP and DARPA, and the program will be reassessed in a year.

2013 —X-Stat Dressing: This product is the result of a S&T effort led by the U.S. Special Operations Command (US-SOCOM) to develop a hemostatic dressing to stop bleeding from deep wound tracts in areas difficult to reach with standard dressings or tourniquets. A JTWG was formed and rapidly transitioned to a chartered IPT and an Army-led Joint Advanced Development Program. In addition to USSOCOM funding, the program has received important support from both the Air Force and the Army. The first-generation product has been FDA approved for battlefield use and has undergone limited fielding. The ongoing development program is aimed at gaining broader FDA approval and information on clinical use.

Status of the Process

Our process has met with a number of challenges and has been refined over time. Some aspects of developing the process and building support have been more difficult than anticipated. At times, some misunderstandings have caused controversy and resistance. During the first year or two when we were developing and implementing this process, there were concerns that we were trying to bypass established acquisition and milestone processes and to move programs forward without proper programmatic and contracting oversight. We addressed these concerns by increasing communication, by documenting our oversight processes, and by seeking additional guidance where needed.

Bringing the Services together to cooperate on programs has been easier than initially expected. The initial incentive for participation was the potential to leverage DHP funding. However, as the process evolved and achieved some early successes, a belief in the importance of the process seemed to dominate. In fact, after a recent budget cut, two projects were almost completely defunded in future years. Nonetheless, the JTWGs continued to meet to try to move the programs forward. As it turned out, we were able to get partial funding restored, and the teams' interim work was not in vain.

In general, the process has greatly facilitated transitions to Joint Medical Advanced Development Programs, even while higher-level processes were being refined among DHA and the Services. The programs leverage DHP and Service resources and complement existing Service development programs.

The experience of our JTWGs reinforces the importance of developing transition plans and joint multidisciplinary teams for each program. Transition planning should be initiated as early as possible at the portfolio level, as an S&T management function to ensure that the leading technologies are positioned properly for transition. In our experience, the portfolio-level perspective has enabled identification of top-level prioritizations and available funds from DHP and across Services. This portfolio approach facilitates leveraging and allows the targeting of resources toward the highest-priority programs that need to transition. These processes may be useful for other medical or nonmedical development programs. 

The authors can be contacted through anthony.e.pusateri.civ@mail.mil.

The **Myth** of Data Rights

Peter A. Czech

The mystery surrounding data rights stems from the fact that intellectual property (IP) and data rights are among the more complex issues in acquisition management.

How does one reduce the complexity and make the subject more understandable? First, we must understand and answer the following: What are data rights? How can we remove some of the myths surrounding them? What can we do if we don't own the data rights?

Before we answer these questions, a review of history is in order. Back in the 1950s and 1960s, the U.S. Government was leading in research and development (R&D) spending. The government spent between 60 percent and 70 percent of the national R&D expenditures. Most of these expenditures focused on landing a man on the moon. President Kennedy stated that "this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to Earth." In those days, the U.S. Government held all of the IP cards. The government owned a majority of the IP on space exploration and was able to use it as was required. After the nation landed a man on the moon, the national R&D spending gradually was reduced.

As we fast forward to the year 2000 and through to the present, the R&D roles have reversed. Industry is leading in R&D expenditures. And industry's view of IP is diametrically opposed to that of government. (See Figure 1.)

Industry View

IP is the lifeblood of a contractors' business. For most businesses, IP is the business. Their IP allows them to design, build, test and field items that are unique from their competitors' and allows customers to assign high value to their goods and services. Since IP is the lifeblood of the contractors' business, they will protect it at all costs.

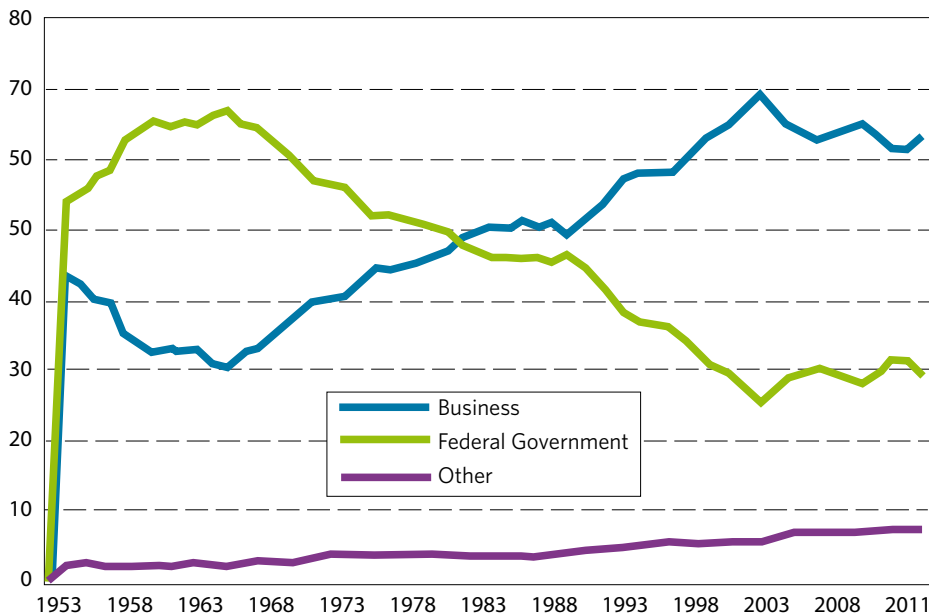
The business IP allows it to build wealth around the design, manufacture, test, sustainment and disposal of an item. Each of these phases of the product development cycle is a renewed income stream for the business. Any business would be loath to give up even one of these income streams for any reason. Additionally, having the IP blocks a competitor from entering the marketplace.

Czech is a Professor of Program Management in the School of Program Management of the Defense Systems Management College at the Defense Acquisition University, Fort Belvoir, Virginia. He previously worked for Chrysler Corp.



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Figure 1. National R&D Expenditures, by Funding Sources



Note: “Other” includes universities and colleges, state and local governments, and other nonprofit organizations.

Source: National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources (annual series).

One must remember, however, that all IP is not codified. This knowledge—or IP—manifests itself in tribal knowledge or on processes that a company fine-tunes over time. This information is not written down; it’s just how we do things here. The company may not know why the process works—but it does work. Therefore, a third party (i.e., the U.S. Government) may have the IP from a company but not the “secret sauce” needed to recompute a project.

Government View

The government looks at IP from two different lenses. First, as a purchaser of goods, government wants competition—for this lowers prices for the goods and services it buys. Competition also drives better solutions into the marketplace, and this also brings lower costs.

The government wants to receive the best return on its investment. The government does not want to pay more than once for the same thing. It also doesn’t want to be locked into a sole-source situation, which would enable the source company to charge higher prices than would be possible in a competitive situation. The government wants an assured service, repair and a modification source that will provide best value at an affordable cost.

The second lens the government looks through on IP begins with our nation’s Founding Documents. Article I, Section 8 of the *United States Constitution*, provides that, “The Congress shall have power ... To promote the Progress of Science and

useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.” Thus, the government wants private-sector industries to maintain their IP. This view can conflict with having competition. On one hand, we want the best value for the dollar, and on the other hand we want the best outcome or product for the public sector. Where does the myth of data rights originate?

Myths

The Merriam-Webster Dictionary defines myth as “an idea or story that is believed by many people but that is not true.” The first myth that most folks have is that data rights and IP are interchangeable. They are not! “Intellectual Property is an expression of a new and useful concept that can be legally protected such that the originator

is granted certain exclusive rights.” However, data rights are a shorthand way of referring to the license rights that the Department of Defense (DoD) acquires to use and publish information. This concept is the hardest to fathom. If we paid for the IP, then we should get the IP. Not so fast: We may have thought (or implied) that we paid for the IP, under *Federal Acquisition Regulation (FAR)* 27.403, but what was stated in the contract? The FAR provides that:

“Data rights clauses do not specify the type, quantity of data that is to be delivered, but only the respective rights of the government and the contractor regarding the use, disclosure or reproduction of the data. Accordingly, the contract shall specify the data to be delivered.”

In other words you only possess the data that are explicitly required in the contract. Use caution on what you ask for and why you require the information. That “why” must be included in your IP strategy. Your IP strategy must include the reasons you require the information and when you need it. Remember, timing is important in your IP strategy.

A delay in needing the information may reduce the cost of that information. For example, if you need the information 15 years from now, this information will be less valuable to the contractor than it is today and thus less costly to you. Knowing that the information in the future will be less valuable to the contractor may allow you to use an option strategy to acquire the IP when you really need it. You could use an option strategy when you are acquiring data rights. Some questions to explore:

- Do I need the information to recompile the source? When will I recompile?
- Do I need the information for diminishing manufacturing sources of supply? When will those sources be available?

Listed below are the fundamental questions that must be answered by the program team regarding its IP strategy.

- What IP do I need for my program?
- What rights do I have?
- When do I need this data?
- How am I at risk?
- At what price?

These questions need to be answered for both product definition data and product operational data. Product definition

“By law, any enforceable right to see, access, or have a copy of data requires an OMB [Office of Management and Budget] approved DID [Data Item Description] or FAR/DFARS [Defense Federal Acquisition Regulation Supplement] Clause. ... Therefore, DoD cannot assume it has any usable rights in data that is informally provided unless such rights are explicitly granted by the contractor and reviewed by legal counsel. All data access provisions must be reviewed by counsel and the data rights in accessed information must be addressed in the contract.”

These takeaways are as important as the data the contractor shared with me informally—they don’t give me the right to share the information with others (data rights). I only have the data rights if the contract explicitly grants that ownership. This can get program offices into some sticky situations, and has done so.



What if the previous program managers were focused on items other than IP and data rights? Is all lost, and are you therefore stuck with the contractor you have? No! Techniques are available to foster competition without possessing exclusive data rights.

data encompass the drawings and specifications of the hardware and software while product operations data address the maintenance and operational information. Taking each of the above questions in turn will allow us to map out our IP strategy.

The second myth regarding data rights: Most people interpret data rights as IP ownership. That is not correct. Data rights only apply to the last part of the definition provided by the FAR:

“The respective rights of the government and the contractor regarding the use, disclosure or reproduction of the data ... to be delivered.”

You can’t publish what you don’t have. What you have may be misleading or incorrect. In other words, you may have the right to publish the information—but is it the right information? If you expect to manufacture the component but have only design data, you may not be able to do so.

That brings us to our third myth, which is that the requirements for data delivered must be addressed in contract terms. The government should not require data that are not necessary to meet its needs. In the Army Materiel Command’s *Army Guide for the Preparation of a Program’s Product Data Management Strategy* (DMS), we find:

What if the previous program managers were focused on items other than IP and data rights? Is all lost, and are you therefore stuck with the contractor you have? No! Techniques are available to foster competition without possessing exclusive data rights. Listed below are a few key strategies that can be applied to assist the program office with their competitions.

- Competitive Copying
- Form-Fit-Function
- Direct Licensing
- Leader-Follower
- Specific Acquisition
- Reverse Engineering

Competitive Techniques

In a 2010 Government Accountability Office report, the following reasons were provided for the program being stuck in a sole-source situation: “Most of the contracting and program officials at DoD that we spoke with pointed to the lack of access to technical data as one of the main barriers to competition. Some of the contracting officers described this condition as essentially being ‘stuck’ with a certain contractor. ... Some contracting and program officials have inquired about the cost of obtaining the technical data, only to discover that the package is not for sale or that the purchase of it would be cost-prohibitive, especially the systems and equipment that

have been contracted out for decades.” (GAO Report 10-833). This information could dishearten the government program manager. However, if you open the aperture, there are options for fostering competition without using data rights. The government program manager has many options to explore, some of them listed below. Examples of competitive techniques or common methods of obtaining competition are drawn from *The Government Contracts Reference Book—A Comprehensive Guide to the Language of Procurement* by R.C. Nash, et al.:

Competitive Copying

One of the most common methods of obtaining competition of relatively simple items is to solicit bids without furnishing technical data package. This strategy is very commonly used in the automotive industry. Go into any auto parts store and request a part for your car. It is a good bet that the manufacturer of the part did not have a data package from the original equipment manufacturer. Some manufacturer decided that it could produce at a lower cost a similar part that would fit and perform like the original part. The second manufacturer found what worked for the part and made improvements to produce the component at a lower cost, or with higher quality, or both.

Form-Fit-Function

Base the procurement of performance or functional specifications rather than provide detailed information to meet government requirements. Again, without proprietary information, I can specify the form, fit and function of a part or system and have that system built. To implement this strategy, the program office will need to supply the form, fit and function parameters. This is an exceptional strategy when the program has an Open Architecture strategy.

Direct Licensing

This is an agreement between the government and a development contractor that permits the government to select a second source after completion of development and requires the contractor to provide technical data and technical assistance to that contractor to make sure that the product is manufactured completely. In exchange, the development contractor is paid some combination of the costs incurred in transferring the technology and some sort of royalty.

This technique is applicable when the original manufacturer is updating its business strategy. It may see this business strategy as unprofitable or the state of the art as evolving, and therefore it is willing to extend the profitability of its IP longer by having another manufacturer bear the load while reaping royalties.

Leader Follower

This technique also establishes a direct relationship between the original developer of the item and competitors, but it does not call for a royalty payment. This operates as procurement techniques under which the sole-source producer furnishes manufacturing assistance and know-how to enable a follower company to become a source for the item.

The Navy’s shipbuilding activities follow this strategy. There is limited competition for building ships. Therefore, the two shipbuilders share information so each shipyard can stay in business. The government benefits because there is competition, and the national shipbuilding assets continue. The companies benefit by staying in business.

Specific Acquisition

Another technique in establishing competition is to purchase the proprietary rights from the developer and then use the data as the basis for a competitive procurement. This is the mindset traditionally used by most program offices. They will buy the weapon-system IP and use it to have another manufacturer build the system at lower cost. While it sounds good, nowhere in the IP can we find the “secret sauce” that will allow duplication of the needed parts or programs.

For a specific acquisition, you must target specifically the areas you need to duplicate. Understand the targets early, and understand that you will need to have internal processes to ensure that the data are up to date. The remaining action is to determine at what price the contractor will sell the rights to its information. The difficulty arises in setting the price for those rights.

Reverse Engineering

A final method of obtaining competition without violating proprietary rights is for the government to “reverse engineer” the product and use the drawings created in a competitive environment. Reverse engineering can do two things. It can enable you to obtain additional competitors instead of being locked into one vendor. Also, through reverse engineering, the system or component can be improved over the original design.

Conclusion

Data rights and IP are complex subjects. This complexity is driven by three sources: the government, industry and the myths that surround them. The contractor looks at the subject through one lens. The government looks at the subject through a different lens, and the myths further exacerbate a complicated situation.

We have found that data rights and IP are not interchangeable. The mere possession of data rights doesn’t mean you have information that would prove useful to create additional competition. Some other debunked mysteries include the question of whether I can make separate use of the data that I have. Legally, you can use the information only if the information is identified in the contract.

Even if we don’t own the IP or the data rights, all is not lost. There are competitive techniques that a program office can explore to help foster competition and lower the costs of weapon systems acquisition. 

The author can be contacted at peter.czech@dau.mil.

Early Birds in Korea

"Exporting" Defense AT&L
Has Far-Reaching Impact

DT Tripp ■ Hwa Yu



"The early bird catches the worm." Who doesn't know this proverb? A study club in the Republic of Korea (ROK) defense acquisition agency was born and has grown with this phrase as the key tenet of its effort to improve defense acquisition professionalism by studying the *Defense AT&L* magazine published for the U.S. Department of Defense (DoD) by the Defense Acquisition University (DAU). The study club's name originated from that tenet as the "Early Birds Study"—or the EBS, for short. This year, the EBS will celebrate the 10th anniversary of its foundation and is almost as old as the South Korean Government organization of which it is part.

Background and Context

The South Korean Government—from the National Assembly to the Ministry of National Defense (MND), and the Defense Acquisition Program Administration (DAPA), which is the equivalent of the DoD's Office of Acquisition, Technology, and Logistics (AT&L)—has been working toward a more responsive, efficient and transparent acquisition system that meets evolving defense needs while developing a more professional acquisition workforce. Well, that sure sounds easy, we all might say, but it is a daunting challenge to assess and find effective ways to make the fundamental changes needed while staying true to a strong bureaucratic culture that has a long track record and some amazing successes. In an increasingly global acquisition environment, Korean officials recognize that

Tripp is director of international programs at the Defense Acquisition University's Defense Systems Management College at Fort Belvoir, Virginia. **Hwa Yu** is chief of the liaison office for the Joint U.S. Military Affairs Group-Korea as part of the U.S. Embassy in Seoul, South Korea, liaising with the Korean Defense Acquisition Program Administration.



Publications of the Early Birds Study group draw information and inspiration from Defense AT&L magazine.
Collage of Early Birds Study Group photos.

change is necessary to survive and prosper. The lessons are certainly clear to the young intellectual professionals who will form the government of the future. This article shines a brief spotlight on just such a group.

DAPA

To talk about the EBS, it is first necessary to understand the Korean Defense Acquisition Program Administration (DAPA). The DAPA was launched on Jan. 1, 2006, and consolidated all acquisition functions scattered across the MND, military Services and defense agencies. Its primary missions are acquiring weapon systems for Korea's military forces and strengthening the Korean defense industry. Many military officers previously in charge of acquisition programs were transferred to the DAPA with the newly designated specialty of "acquisition," and yet many were new to the concept of defense acquisition.

Joint Military Affairs Group

Another key organization that should be introduced is the Joint U.S. Military Affairs Group-Korea (JUSMAG-K). JUSMAG-K is a security cooperation organization working in Korea to support the alliance by advancing U.S.-ROK

mutual security interests. JUSMAG-K closely works with the MND, military Services and the DAPA, particularly on foreign military sales (FMS) and defense cooperation in armaments programs. JUSMAG-K has maintained liaison offices since the MND's establishment.

The Beginning of the EBS

With establishment of the DAPA, the chief of JUSMAG-K reassigned Hwa Yu, who had worked at the MND Liaison Office for the several years, to the DAPA Liaison Office as the DAPA Liaison. She had just completed a master's course in Defense Project Management at the Korean National Defense University. Yu was new to the job and felt the need to gain acquisition knowledge on both ROK and DoD defense acquisition and to develop professional relationships with DAPA personnel.

Yu met then-Maj. Taijun Park, whom she had known during cooperation on the U.S.-Korea Multiple Launch Rocket System (MLRS) project and who was now assigned to the DAPA. They talked about regularly practicing English and studying defense acquisition and agreed to form a club to study DoD acquisition in English. In the first week of April

2006, Yu, Park, Maj. Hansoo Park and Lt. Col. Hyeok Seo gathered at the conference room of the JUSMAG-K liaison office for the first time at 7 a.m. The DAPA compound was still quiet before the official government workday began at 9 a.m. Because they recognized they had developed strong

perspectives. Invited guests include acquisition leaders, such as a former Minister of Defense for Acquisition who offered strategic thinking and a vision of the way forward in defense acquisition. The group also has hosted a legal advisor from a well-known law firm with extensive career knowledge and

As the club members studied trends in defense acquisition, they noted the importance and impact of technology protection.

momentum, the group registered in the DAPA as a “Community of Practice (CoP)” on May 3, 2006. Park first came up with “Early Birds” for the study club name and Yu proposed EBS, an abbreviated version of the Early Birds Study, which became the official study club name.

The club established two main objectives: (1) study the *Defense AT&L* magazine published in English to learn advanced defense acquisition systems, compare these with the ROK systems and find ways to improve; (2) and share what the club members study with the rest of the DAPA personnel. Those two objectives were reflected in the EBS charter and have remained intact since.

Activities

Regular Meeting: Based on the two objectives, the EBS members meet twice weekly to study defense acquisition. The members take turns leading the weekly study sessions in an agreed sequence. The lead member must choose a topic, primarily from the *Defense AT&L* magazine, translate it into Korean and develop a study plan. Government Accountability Office (GAO) reports, *Defense Acquisition Research Journal* papers, and other important reports such as Defense Acquisition Performance Assessment reports also have been selected for discussion.

Friday Social Meetings: These primarily are lunch gatherings to strengthen the personal relationships within the group. While regular meetings are required, the Friday lunch is optional.

Seminars: To achieve the knowledge-sharing goal of the EBS, the club holds quarterly seminars within DAPA and outside DAPA with interested acquisition personnel.

Sessions With Experts: The EBS Club often invites defense acquisition experts to regular sessions, seminars or social meetings so that the members can gain in-depth knowledge and share insights from subject-matter experts and broader

experience in defense contracting as well as a cost analyst and a 3-D printing company chief executive officer.

Annual Publication of Study Materials: Each year, the EBS assembles the Korean translations of articles they had studied for the past year. Currently, the members are reviewing the translated articles for the 10th volume of their study results. But the study results book provides more than translations. Some topics of interest for DAPA, like Acquisition Strategy, that were studied more in depth resulted in the group proposing certain changes. Additionally, the DoD decision-making and contracting systems and other useful information have been added to the books as appendices, in order to help DAPA readers better understand the DoD systems. The EBS books are used as sources of information on DoD acquisition policies and systems and trends and to provide ideas for improvement to DAPA officials. The selected topics usually are of DAPA interest, and the EBS books provide easy access in the Korean language to current and timely information that otherwise would be difficult to acquire.

Membership

The EBS members include both military and civilian officials assigned to the DAPA. English language ability is a requirement of those who join the EBS. Every member is expected to actively participate in the study session. There is a 2-week probationary period in order to provide an opportunity to see if a prospective member can meet EBS’ expectations.

The 17 current members have a variety of working backgrounds and include active-duty military (five Army, four Navy, and two Air Force members), five government civilian employees (including a senior executive official) and a U.S. Embassy employee.

Achievements

Exposing DAPA personnel to the latest DoD acquisition policies and practices through books, Internet postings, seminars, etc., has been well received by many DAPA officials



An Early Birds Study session in April 2014.

Early Birds Study Group Photo.

for providing “food for professional thought.” A few tangible contributions follow:

Since December 2014, the EBS has held three seminars in the DAPA with the themes that are of great interest to DAPA employees—such as professionalism, acquisition ethics and leadership. EBS introduced DoD policies and practices from sources such as the Better Buying Power initiatives (based on a BBP 3.0 White Paper by Under Secretary of Defense for AT&L Frank Kendall); “Ethics and Acquisition Professionalism: It’s All about Trust,” an article by Kendall in the September–October 2014 *Defense AT&L*; and “The 21st-Century Acquisition Leader,” an article by Paul E. Turner in the January–February 2015 *Defense AT&L*.

Comparisons with DAPA systems were followed by extensive discussions at each seminar. The club also has held several joint seminars with the ROK Army HQs and the Defense Agency for Quality and Technology to introduce DoD and ROK acquisition systems to the requirement and technology planning communities and to hear their opinions. These seminars have helped the participants to better understand both their own and U.S. acquisition systems. A large portion of the ROK’s offshore procurement comes from the United States. The EBS club members aspire to expand their reach to the other military Services and the Joint Chiefs of Staff to invigorate communications within the requirements community.

Prior to the 2013 and 2014 U.S.-ROK Defense Technological and Industrial Cooperation Committee (DTICC) meetings co-chaired by the U.S. Under Secretary of Defense (AT&L) and the Korean Minister of Defense Acquisition, the club members prepared the Korean delegation on topics and presented ideas

for discussion points. One of the topics related to the DoD’s Better Buying Power initiatives. The club also held a seminar on the BBP initiatives, sharing the latest DoD trends that the ROK is trying to emulate, and discussed the direction in which the DAPA should evolve.

The EBS has made significant contributions to formulating defense technology security and export control policies. As the club members studied trends in defense acquisition, they noted the importance and impact of technology protection and subsequently studied U.S. technology security and export control systems and shared the knowledge through seminars and lectures at the DAPA training center. After Yu took the DAU’s PMT 203 course on International Security and Technology Transfer/Control in November 2011, the club put together detailed information on defense technology security and export control supporting the establishment of a defense technology security office. That effort is about to bear more fruit in the form of a proposed defense technology security law, which is currently under review in the ROK National Assembly.

The best achievement, perhaps, is the professional growth of the members of the EBS. The members evolve from acquisition professionals to acquisition leaders themselves. EBS President Col. Hyeok Seo of the ROK Army led the nascent EBS club as a freshly promoted lieutenant colonel and now is in charge of Korea’s important tank projects. Acting as a servant leader to the group members (see above-mentioned “21st Century Acquisition Leader” Turner article in *Defense AT&L*), he has endeavored to extend the EBS members’ potential to become global acquisition leaders. Recently, he participated in the International Defense Educational and Acquisition Arrangement (IDEAA) seminar in the United Kingdom, where he briefed the international audience of acquisition and educational experts

The EBS is quite well known in the DAPA since the group has won the first place in the DAPA's annual CoP competitions almost every year, ranking second just a few times.

on Korean approaches to acquisition challenges and the need for training and education. It was the realization of one of the dreams of the EBS. The U.S. delegation was led by Katharina McFarland, Assistant Secretary of Defense for Acquisition, and James Woolsey, President of DAU.

Seo currently is working on the HR development of the DAPA by actively proposing training and career development models and improvement measures for the Korean acquisition professionals. Lt. Col. Hansoo Park is back in the EBS after his return from a 3-year overseas assignment for which he was personally selected as the Army Program Officer at the Korean Embassy in Washington D.C. He says the knowledge and understanding of the DoD acquisition system he had gained through the EBS was, without question, extremely helpful to the performance of his duty in the United States. Now as the “early bird continues to fly,” he is sharing his experience and insight from the United States with junior members of the EBS.

Awards

The EBS is quite well known in the DAPA since the group has won the first place in the DAPA's annual CoP competitions

almost every year, ranking second just a few times. Lately, the EBS also was recognized in the Top 10 at the national government level CoP competition, in which about 100 CoPs competed. It was the first time any DAPA CoP received national government recognition.

Conclusion

The Early Birds Study group is a powerful example of successful international outreach and collaboration. It is unique in being completely driven from within—by a group of young Korean professionals who are making waves. The U.S. co-author of this article has worked for years in seeking improved and/or strengthened international collaboration and rarely has encountered such an energetic, highly effective group of acquisition professionals. The growing professionalism in the DAPA workforce will pay acquisition outcome benefits between our two nations in current and future programs. Just remember—it's the early bird that catches the worm!!

The authors can be contacted at duane.tripp@dau.mil and hwa.yu2.in@mail.mil.



Members of the current Early Birds Study group hold copies of *Defense AT&L* magazine—a resource for their work. Front Row, from left to right: Hwa Yu; Lt. Col. Hansoo Park; Col. Hyeok Seo (president); Cmdr. Yisub Ahn; and Hyoungcheol Kim. Back Row, left to right: Lt. Jeongha Kim; Maj. Sangho Aum; Maj. Joseph Kim; Sangeun Lee; Yunhee Do; Lt. Cmdr. Sehoon Cha; Seok Kim.

Photo by Korean Defense Acquisition Program Administration Photographer Jaehoon Kim.

Airborne, All The Way, 3D From the Sky

Approach for an Air Drop Capable, Medium Tactical Vehicle

CPT Peter F. Syverson, USA





In warfighting today, the U.S. military rolls into combat with heavily armored vehicles capable of protecting their occupants from large and highly lethal improvised explosive device (IED) blasts. Given that threat, it would seem surprising that our forces still require unarmored vehicles for combat missions.

Product Manager Medium Tactical Vehicle (PM MTV) fields three models of unarmored vehicles: the Airborne's MTV Low Velocity Air Drop (LVAD) M1081, M1093, and M1094 (2.5T Cargo, 5T Cargo, and 5T Dump respectively). These models were designed in the early 1990s to provide low-tech solutions to an Airborne requirement. Sustainment and production problems have arisen for the LVAD fleet in recent years. The largest problem to overcome is the obsolescence of the LVAD cabs. Replacement parts are nonexistent in many cases, and contractors are unwilling to produce the small quantities required by the Army to sustain the fleet.

Given the lack of replacement cabs or parts, PM MTV has discovered that old LVADs are potentially coded out due to the unavailability of a door panel that costs a few hundred dollars, even though the rest of the truck is operational. When the cab shell was last built in 2008, it was proprietary to the contractor that manufactured it. At the time, the government did not purchase the Technical Data Package (TDP) or the dies used to stamp out the cab. The dies have since been sold off, highly modified and consequently destroyed. A TDP is necessary in order for PM MTV to build cabs or replacement panels. A reverse engineering project began in 2012 to build a TDP in conjunction with current prime contractor. The cost was well more than \$6 million to validate this TDP, build the 29 tooling stamps required for all the body panels, and produce five prototype cabs. It would take more than 450 days after award to produce the five prototype cabs (remember these numbers). For a niche population of airborne trucks with no new production on the horizon, the price killed the project.

But within three years, units in the field wonder why they cannot acquire a cab part from the Defense Logistics Agency (DLA). The PM and DLA now face the same dilemma they faced a few years earlier. Trying to think outside the box for a low-cost solution to TDP validation and prototyping, on a small budget and with a short timeline, I remembered reading about the Navy's research in constructing 3D buildings.

Syverson is the Assistant Product Manager for Medium Tactical Vehicle at Tank-automotive and Armaments Command (TACOM). He graduated and was commissioned from Northern Illinois University and has an Industrial Technology Degree. His previous assignments included 4th Brigade Combat Team, 82nd Airborne Division as Commander of both A Troop, 4-73 Cavalry (Airborne) and Headquarter and Headquarters Company, 1-508th Parachute Infantry Regiment. He earlier was a Reconnaissance, Surveillance and Target Acquisition Platoon Leader with 5-1 Cavalry Regiment, 1/25 Infantry Division.



Low Velocity Air Drop rigged at Fort Bragg Heavy Drop Rig Site in North Carolina.

Photo by the Army Product Management Office for Medium Tactical Vehicles.

cabs and replacement parts to keep the legacy trucks in the field. Since our visit, the research staff at ORNL has agreed to prototype our cab, starting with the most complex part—a complete door assembly. If the door proves to be feasible and functions properly on an existing LVAD cab, PM MTV will move forward with the prototype of the whole cab. With the assistance of the DoD Manufacturing Technology Program, all this will happen for less than \$100,000 and within a few weeks of the project's start. Compared to the \$6 million and more than

I thought if the Department of Defense (DoD) can print in that size in concrete, why not a 6x4-foot truck cab? With the Detroit Auto Show in town, I read about a company called Local Motors that printed a 3D car and would exhibit both its car and Local Motors' additive manufacturing technology at the show. I decided to make the Detroit Auto Show my place of duty in order to research the feasibility of using additive manufacturing to build a 3D composite cab.

At the show, I was impressed with Local Motors' Strati 3D car and impressed again with the technology partner's exhibit. Oak Ridge National Laboratory (ORNL) was showcasing its 3D printed Shelby Cobra next to Local Motors, and all the minds behind the project were present to answer questions. Located conveniently across from the ORNL exhibit was the Tank-automotive and Armaments Command (TACOM) exhibit featuring an autonomous legacy MTV with an unarmored cab. As I spoke with the ORNL people who had developed the 3D Cobra, I pointed to our MTV and asked if it was feasible to print the shell of the cab. To my delight, the short answer was "Yes."

Oak Ridge National Laboratory is at the leading edge of large-scale additive manufacturing and produces at speeds and sizes that make printing a high-strength LVAD cab very feasible. The lead PM MTV LVAD engineer, Jason Zebrowski, and I decided to take a trip to visit ORNL in Knoxville, Tennessee. Our idea was to produce a 3D composite prototype cab that looks and functions the same as the old. Ideally, PM MTV will achieve a validated TDP and manufacturing method that requires no tooling and no production line and that has the ability to build affordable, low volumes of new

450 days for the conventional manufacturing method, 3D may end up being the better buy.

Although this information is not new to some, I wanted to discuss the many potential benefits of additive manufacturing to both the Army and the PM when looking at the LVAD. As we look at cost as our largest consideration in a physically constrained environment, we look first and foremost at the departure from the traditional manufacturing process. As mentioned, 29 stamps are required to make the current panels that comprise the LVAD. These stamps, in 2012 dollars, cost more than \$4 million and required 6 months just to manufacture. Stamps also require large machines or fixtures to function, in addition to an assembly line that requires time to set up and calibrate. By shifting to an additive manufacturing process, we fundamentally shift away from tooling and set-up time. Theoretically, a company like Local Motors can build their Strati today, and, by tomorrow, with a TDP and 3D models, produce LVAD cabs on the same manufacturing floor. That concept is revolutionary, given how the automotive industry traditionally builds vehicles.

The PM would never reach thousands of units of production for LVAD, and we do not want to do so. Low volume is our goal, and our dilemma. Industry and the Army do not want to produce a few hundred anything, especially something as complex as a vehicle cab. Due to the time and effort required, low production runs leave little profit for industry and huge costs to the customer (although, for deep enough pockets, this dilemma does not apply). With additive manufacturing, we sidestep the issue. Given a total fleet of 2,200 vehicles, PM MTV would produce only about 900 vehicles

(maximum) to replace the obsolete 20-year-old initial (A0) models and a limited run of replacement parts for the ATR models remaining in the fleet over the next 5 years.

Continuing to take cost into consideration, PM MTV has looked at the materials used in additive manufacturing. At \$2.40 to \$5.00 per pound, the composites and thermoplastics utilized today become very attractive when analyzing our current, 800-pound metal LVAD cab. As we explored these composites, MTV discovered that they also are largely—up to 80 percent—recyclable. Recyclable material can have huge implications, if the Army ever invests in 3D printers in its depot-level maintenance facilities. Imagine a scenario in which an LVAD comes into maintenance with a damaged door and requires a new one. The chief maintenance officer takes off

mission, but the LVAD may reach a level of ballistic protection not seen in the legacy cabs—depending on the composite we choose and internal design structure of the panels.

Additionally, a persistent problem in the legacy LVAD fleet is corrosion of the earlier A0 models. Once a cab is damaged and the bare metal exposed, corrosion rapidly sets in if not checked by corrective painting or part replacement. A plastic composite cab will help reduce the DoD's expenditures on corrosion prevention programs and use of the ever time-consuming and difficult Chemical Agent Resistant Coating paint. Depending on the plastic composite chosen for the LVAD, we may even avoid painting altogether. Some plastics are translucent, which allows the adding of color pellets to achieve olive drab or tan paint schemes.

As I spoke with the ORNL people who had developed the 3D Cobra, I pointed to our MTV and asked if it was feasible to print the shell of the cab. To my delight, the short answer was "Yes."

the door, strips it, throws the door through the shredder, then in short order prints a new one for the paratrooper, using the same material as the old. All the maintenance officer needs is a 3D printer and the 3D-model computer-aided design (CAD) data from DLA.

I also have been asked why PM MTV is pursuing the same LVAD cab design. The answer is that PM MTV wants to maintain all the current National Stock Numbers and part numbers that make up the rest of the cab (seats, steering columns, hinges, etc.) and avoid spending the time and money on engineering new when parts already exist. By doing so, we can create a new stock of replacement panels for the LVADs still in service, reduce logistic footprints and save money by not reinventing a truck that has a limited production quantity.

Performance is the biggest question PM MTV has for our prototype. While we believe ORNL will produce a composite cab that looks and functions like our legacy sheet-metal cab, we will need to conduct static and live drop testing from an aircraft to determine if it will pass test requirements. With that said, there are promising prospects that we will succeed, given our options of composites with varying strengths and mechanical properties. These properties will have added benefits that are not possible for the current metal cabs. For instance, LVADs are exempt from current MTV armor requirements, due to weight and the nature of the Airborne's

The schedule of this ambitious project has raised some eyebrows, and we understand why. To counter the skepticism, I would have to say you need to see ORNL's additive printing process in action. As you discover where 3D printing is today and begin to understand the process, you gain an appreciation for how quickly a prototype can develop and move to production. While at ORNL, Zebrowski and I witnessed an exchange between two engineers deliberating why a design of theirs had printed poorly. In a 20-second exchange, they decided to modify the design on the CAD model and print another one. That is two prototypes and one design change created in a single day—and, for the complexity of the part, it was quite impressive. Knowing how fast the staff there move, ORNL thinks they can create the whole LVAD cab in a 2- to 3-week timeline. This includes consideration of design errors and reprints for incorporation in a final validated TDP.

That is why PM MTV hopes to have the cab prototype in hand by summer and a completed truck assembled by the end of 2015 to take to test in 2016. Is it ambitious? Absolutely. But with additive manufacturing, such a timeline becomes feasible, and working with limited resources under short time constraints is what (former) paratroopers do. PM MTV and I are up for the challenge and look forward to providing an update in the near future. 

The author can be contacted at peter.f.syverson.mil@mail.mil.

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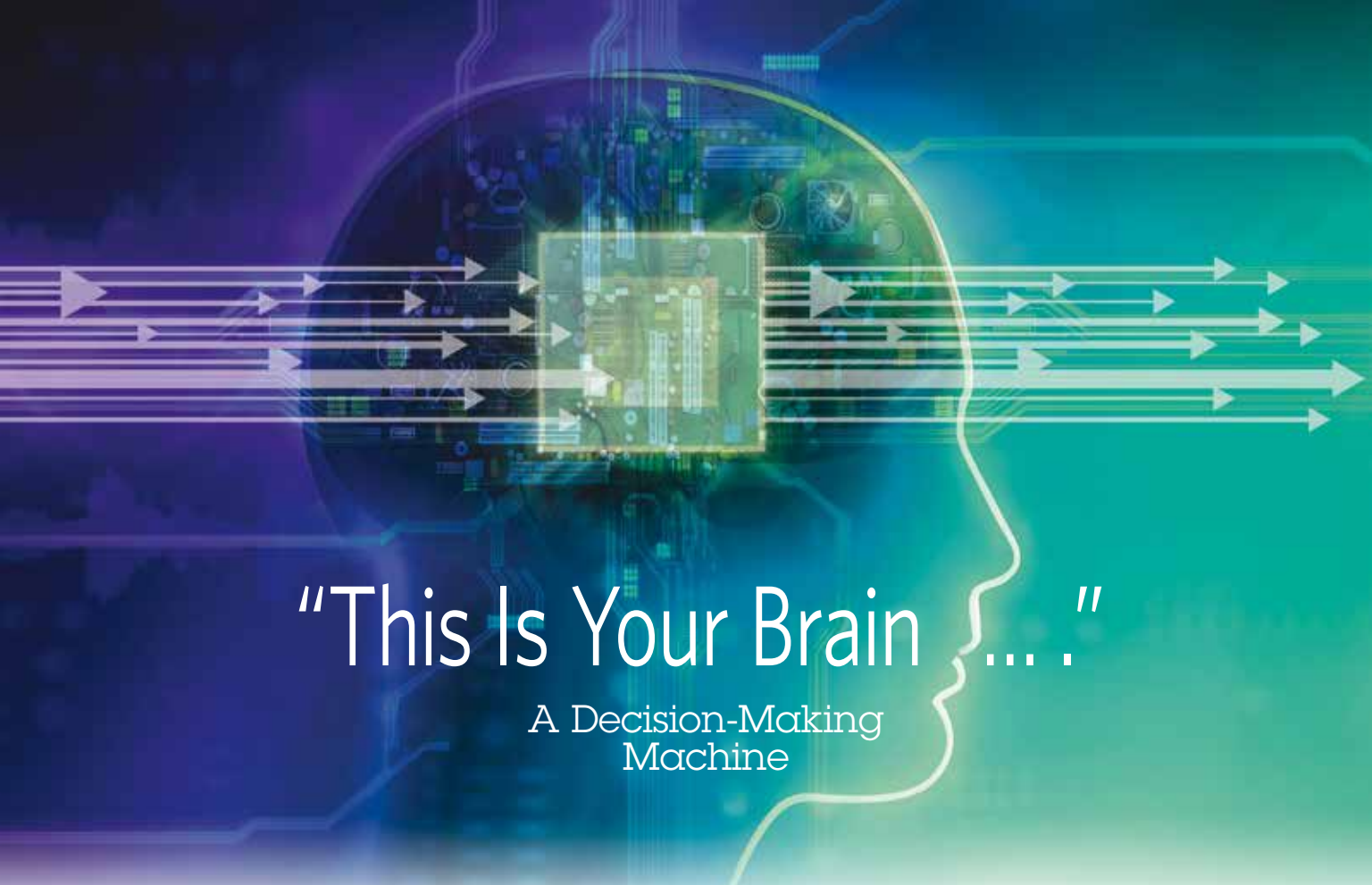
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S U R V E Y



"This Is Your Brain ..."

A Decision-Making
Machine

Roy Wood ■ Patrick Barker

**"The brain is a
wonderful organ.
It starts working
when you get up
in the morning,
and doesn't stop
until you get to
the office."**

—Robert Frost

The lump of gray matter you call your brain has vast computing power that performs a plethora of vital tasks. It regulates your bodily functions, movements and emotions. It processes and makes sense of incoming sights, sounds, smells and touch sensations. The brain can store years of memories and allow you to perform complex tasks such as analysis, reasoning, goal setting and planning.

Yet, even with all these capabilities, the brain, paradoxically, has some rather stark limitations. It makes sense then that the more we understand about the capabilities and limitations of our brains, the better we are able to coax the maximum productivity from our internal computers. The goal is not necessarily to increase our brain's capacity, but gain more efficiency and effectiveness from the capacity we already have.

The Neocortex and the Limbic System

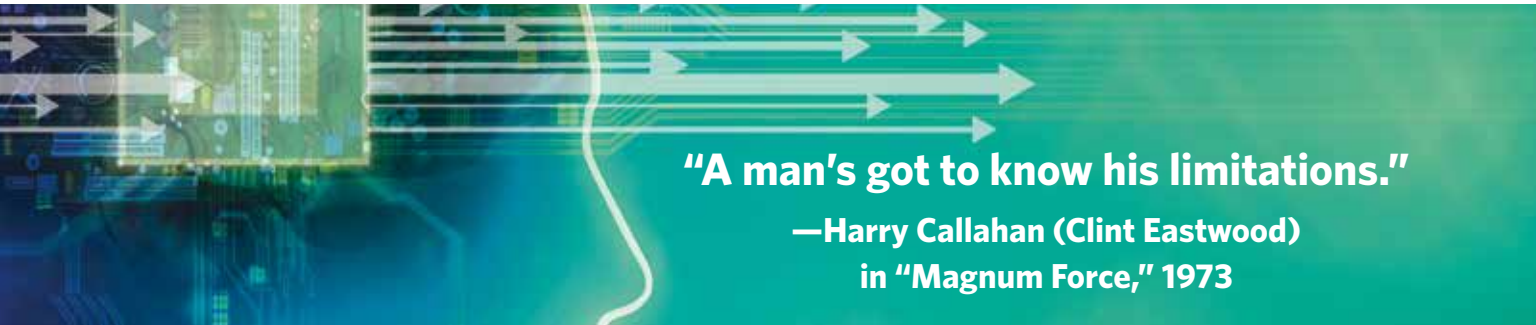
Without going too deeply into the science of the brain, we would point out two components: the neocortex, located atop the cerebrum's frontal lobes and which is the computational portion of the brain, and the limbic system beneath the cerebrum and associated with long-term memory and emotions. In our

Wood is Acting Vice President of the Defense Acquisition University. **Barker** is a Professor at the Defense Systems Management College.

everyday work, these tightly connected, complementary systems help us manage, think and make decisions. The neocortex is where much of our conscious thought occurs. There short-term memories are stored and processed. The limbic system takes on our more primal challenges of deciding whether to fight or flee in the presence of perceived danger. Long-term memories and experiences also are stored here, often along with their emotional connections to pain or pleasure, past success or failure. The two portions of the brain also are quite different in their contributions to our conscious behaviors. The neocortex engages when we attempt

favorite decaf mocha soy cappuccino at the corner coffee shop without comparing prices, or evaluating the health benefits of soy over whole milk, emerge from the limbic system almost automatically. This may be especially true if your coffee's flavor is linked to a pleasant taste or memory of that time you and your significant other visited in Rome.

Likewise, some of your decisions at work may emerge surprisingly quickly. Your brain may recall memories and connections from a similar situation in the past. If that past decision got you into trouble, your emotional brain may deliver



"A man's got to know his limitations."

**—Harry Callahan (Clint Eastwood)
in "Magnum Force," 1973**

to do something new and challenging. The thinking portion of our brain tends to be slow, methodical and logical.

Consider, for example, when you were first learning to drive a car. You probably were overwhelmed with all the things you had to think about—operating the steering, accelerator, brake; keeping vigilant watch forward and in the rearview mirrors; planning your route, etc.

Our limbic system, on the other hand, prompts quicker and more automatic actions and sometimes more visceral "gut" reactions. One might expect this from the portion of our brain that evolved from caveman times to make fast life-or-death decisions. In modern human beings who are less likely to be lunch for some saber-toothed tiger, the limbic system has evolved into a storehouse for rules of thumb, or heuristics, that we rely on to make most of our routine decisions without really thinking about them.

Returning to the driving example, it is likely that after years of practice, you have had the experience of arriving at the office with few conscious memories of having done any of the mechanical process steps during your drive. You have moved thinking about driving the car from the conscious neocortex to the subconscious limbic system, making driving virtually a "no brainer."

Maximize Your Brain Power

Given this amazing organ and its two decision-making systems, how can we best leverage the way the brain works to optimize the things we have it work on?

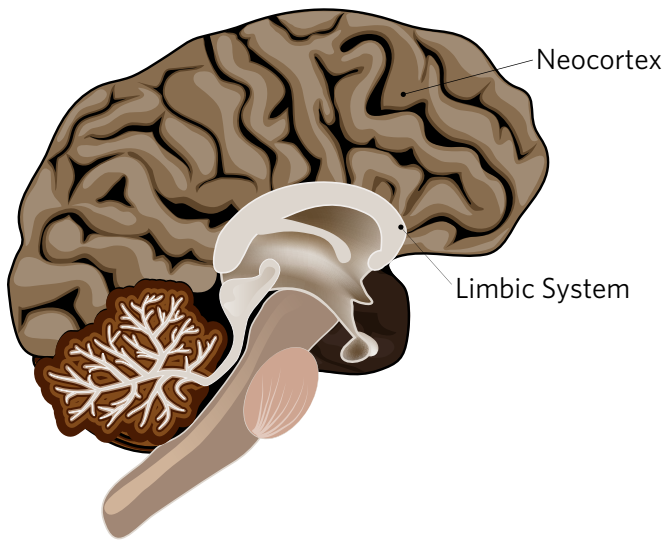
Know which system in your brain is making the decision. Most of our routine decisions, including habits like ordering your

a strong, fast recommendation that we recognize as a "gut reaction." If the situations truly are similar, then going with your gut is probably fine. However, if something is subtly different this time, it may be better to slow down your decision making and engage your neocortex to look at the facts and analyze the situation a bit more. It will require a conscious effort on your part to have your thinking brain overrule the limbic system, especially if a strong emotion is associated with the situation.

If we have to guard against our emotional brain taking over, why then do we not engage our neocortexes for every decision? The answer, as you might imagine, is that this strategy would slow your life to a crawl, require a lot of time and effort to make even simple decisions, and likely paralyze your decision making. Instead, you should save your computational brainpower for really hard problems, new tasks and important decisions. It generally isn't hard to know which problems require real concentration and thought, but recognize that those decisions will require more time and focus.

Manage Your Energy: The neocortex is not only slow but also an energy hog. It consumes a lot of glucose and oxygen to accomplish higher-order tasks like planning, assessing and decision making, so do what you can to address complex tasks only during your peak brain times. Are you a morning person or a night owl? Use these times and block your calendar for brain-draining tasks. Don't try to multitask. Turn off your email and avoid other distractions. Be aware that each task or decision reduces your energy reserve, so that subsequent efforts become even more challenging. For this reason, schedule 15- to 30-minute breaks between thinking sessions or decision meetings to allow your neocortex to rest and recover. Don't skip meals. Stay hydrated. It matters.

Figure 1. The Brain



Get Stuff Out of Your Head: Short-term memory is very limited, so find a way to capture things like to-do items, ideas, and other thoughts on paper, in your computer or smart phone. As simple as it sounds, writing down a comprehensive to-do list may be the most important step in clearing your brain of clutter so you can focus on more important matters. The book *Getting Things Done (GTD)* by David Allen can help you set up systems to do this and clear your brain for more useful tasks. As Allen says, "Your brain is for having ideas, not for holding them."

Practice Makes Perfect: Transitioning important information and process knowledge from short-term memory in the neocortex to long-term memory in the limbic system through practice and reinforcement helps the brain form time-saving heuristics (or rules of thumb) and builds subject-matter expertise. Malcolm Gladwell, noted author and researcher, claims that it takes 10,000 hours of deliberate practice to build expertise. Experts often can make insightful judgments and decisions without appearing to think too hard, since these insights come from a different part of the brain trained to sort out complex problems by recognizing patterns and relationships developed through years of experience. Consider how quickly an experienced program manager or contracting officer can spot anomalies and problems in a Statement of Work that would be beyond an intern's capability. Author Gary Klein calls this "seeing the invisible," and it is a skill reserved for those who invest the time and effort to become experts in their fields.

A Picture Is Worth a Thousand Words: Since long-term memories are stored in the emotional brain, linking information to emotions can aid in this transformation. Many memory experts suggest creating vivid (and sometimes outrageous) mental images linked to ordinary information in order to help remember them. This portion of our brain is particularly attuned to interpreting and remembering pictures and metaphors. Charts and graphs are quicker and easier to grasp

than spreadsheets. Diagrams and flowcharts can demystify complex processes. Mind maps are more brain-friendly than outlines. Similarly, word pictures and metaphors are powerful and memorable. Abraham Lincoln was a gifted speaker who frequently used metaphors. He once described the continuous flow of reinforcements requested by one of his Civil War generals as "shoveling flies across a barnyard." An entertaining introduction to memorizing information by using vivid images and other aids can be found in Joshua Foer's book, *Moonwalking With Einstein*.

Problem Solving Made Easy: The limbic system has hundreds of millions of nonlinear associations that are created and re-formed constantly. Sometimes, solutions to sticky problems seem to appear from nowhere in flashes of intuition. These "Aha!" moments can occur when the limbic system makes unexpected and subconscious neural associations. This very often happens during idle times when the neocortex is not focused on the problem at hand, allowing the limbic system room to work. Some experts suggest that we might be able to prompt these amazing insights by writing down a specific question about a problem or dilemma and then posing that question to the brain before going to sleep or when rising in the morning. The brain subconsciously looks for associations to answer the question without necessarily engaging the conscious brain. When least expected, and almost always when you're in the shower, exercising, or on a break, the brain delivers a brilliant flash of insight. If you're stuck on a problem, take a short walk and you may be rewarded with a productive thought. Oh, and keep a notebook handy to write it down.

Summary and Recommendations

You may not have 10,000 hours of experience with neuroscience, but you do have some experience and expertise operating your own brain. With these tips and some practice, you can have a reasonable shot at becoming an expert thinker and sound decision maker. Remember to maximize your brain power and decision-making capabilities by managing your energy levels and focusing your efforts. Avoid multitasking. Segregate the more difficult thinking and deciding tasks to times when you are at your peak, and fill the rest with less brain-stressing work. Clear your mind by writing down all your to-do items and miscellaneous notes rather than trying to remember them. Recognize that real experts make decisions from a different part of their brains that have been honed over time to make deep and varied connections through intentional practice, and get started building your own expertise.

Finally, give yourself some time and space and expect those "Aha!" moments when you take a break from thinking about your difficult challenges. Know your limitations and organize your work and life to maximize your brain's potential. You will be better thinkers and decision makers when you follow these steps. &

The authors can be contacted at roy.wood@dau.mil and patrick.barker@dau.mil.

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Defense AT&L

Writers' Guidelines in Brief

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Defense AT&L is a bimonthly magazine published by DAU Press, Defense Acquisition University, for senior military personnel, civilians, defense contractors, and defense industry professionals in program management and the acquisition, technology, and logistics workforce.

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Submit articles by email to datl@dau.mil. Submissions must include each author's name, mailing address, office phone number, email address, and brief biographical statement. Each must also be accompanied by a copyright release.

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Issue	Author Deadline
January-February	1 October
March-April	1 December
May-June	1 February
July-August	1 April
September-October	1 June
November-December	1 August

Audience

Defense AT&L readers are mainly acquisition professionals serving in career positions covered by the Defense Acquisition Workforce Improvement Act (DAWIA) or industry equivalent.

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Defense AT&L prints feature stories focusing on real people and events. The magazine seeks articles that reflect author experiences in and thoughts about acquisition rather than pages of researched information. Articles should discuss the individual's experience with problems and solutions in acquisition, contracting, logistics, or program management, or with emerging trends.

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