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# Defense AT&L

Acquisition, Technology and Logistics

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## The Climate/Team Effectiveness Survey

**Use of Fixed-Price Incentive Firm (FPIF) Contracts in Development and Production**
*by the Under Secretary of Defense (AT&L)*

**Competitive Prototyping**

**Defense Acquisition Workforce Awards for 2012**

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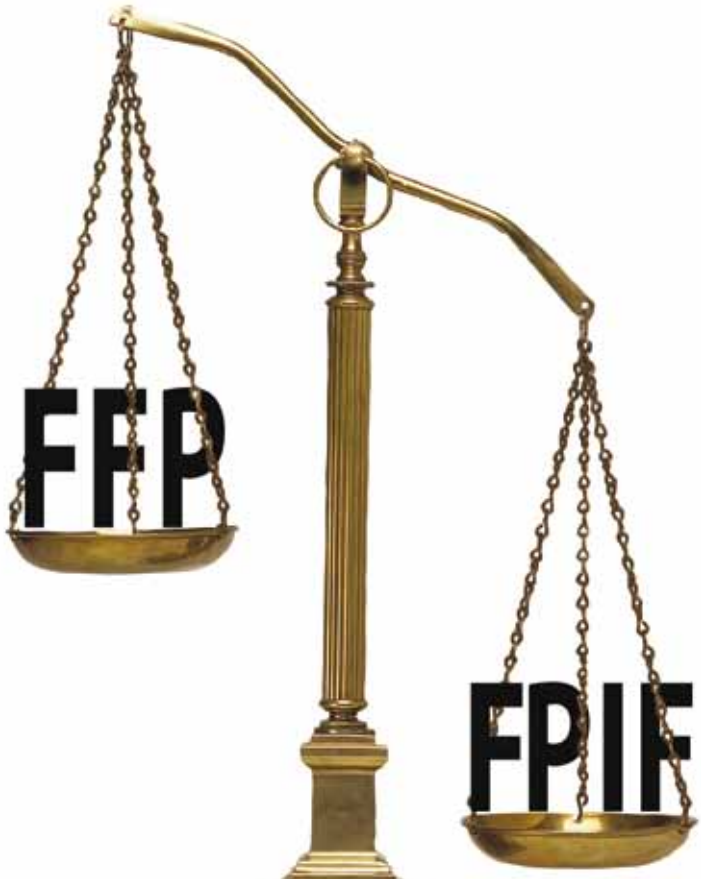
# Use of Fixed-Price Incentive Firm (FPIF) Contracts in Development and Production

*Frank Kendall*




The choice of appropriate contract types is very situationally dependent, and a number of factors must be taken into account to determine the best contract type to use. From the perspective of both industry and the government, it makes a good deal of difference whether the Defense Department asks for Cost type, Fixed-Price Incentive (FPI), or Firm Fixed Price (FFP) proposals. In the original Better Buying Power (BBP) initiatives, although Dr. Carter and I encouraged greater use of FPI, we also included the caveat "where appropriate." BBP 2.0 modifies this guidance to stress using appropriate contract types while continuing to encourage use of FPI for early production.

I would like to be more explicit about what "appropriate" means and how I believe we should analyze a given situation. In particular, I will address both Engineering and Manufacturing Development (EMD) and production situations.

During the early 1990s, I had a lot of painful experience with fixed-price development. The A-12 was a notorious case that ended badly. On another fixed-price major program in development during the same timeframe, the program manager was relieved for finding creative but illegal ways to provide cash to the prime contractor who lacked the resources to complete development. FFP development tends to create situations where neither the government nor the contractor has the flexibility needed to make adjustments as they learn more about what is feasible and affordable as well as what needs to be done to achieve a design that meets requirements during a product's design and testing phases. Any fixed-price contract is basically a government "hands off" contract. In simplistic terms, the government sets the requirements and the price and waits for delivery of a specification-compliant product. While we can get reports and track progress, we have very

little flexibility to respond to cases where the contract requirements may be particularly difficult to achieve.

Most sophisticated weapons systems development programs deal with maturing designs and challenging integration problems. As a result, the government often will and should provide technical guidance and make tradeoff decisions during development. In EMD, we often do want to work closely with the prime contractor to achieve the best outcome for the government. While it certainly is possible to negotiate changes in a fixed-price contract environment, the nature of development is such that informed decisions need to be made quickly and in close cooperation with our industry partners. The focus in a fixed-price environment is squarely on the financial aspects of the contract structure and not on flexibly balancing financial and technical outcomes.

Risk is inherent in development, particularly for systems that push the state of the art. Even with strong risk reduction measures in Technology Demonstration phases and with competitive risk reduction prototypes, there still is often a good deal of risk in EMD. By going to EMD contract award after Preliminary Design Review, as we routinely do now, we have partially reduced the risks—but again, only partially. Our average EMD program for a Major Defense Acquisition Program (MDAP) over the last 20 years has overrun by a little under 30 percent. Industry can only bear so much of that risk, and in a government fixed-price contract, industry cannot just stop work and walk away. A commercial firm doing development of a product on its own nickel has complete freedom to stop work whenever the business case changes. Firms on government contracts do not, at least not without some liabilty.

For good reasons, I am conservative about the use of fixed-price development, but it is appropriate in some cases. Here are the considerations I look for before I will approve a fixed-price or FPI EMD program:

- **Firm requirements:** Cost vs. performance trades are essentially complete. In essence, we have a very clear understanding of what we want the contractor to build, and we are confident that the conditions exist to permit the design of an affordable product that the user will be able to afford and is committed to acquiring.

- **Low technical risk:** Design content is established and the components are mature technologies. There are no significant unresolved design issues, no major integration risk, the external interfaces are well defined, and no serious risk exists of unknowns surfacing in developmental testing and causing major redesign.

- **Qualified suppliers:** Bidders will be firms that have experience with this kind of product and can be expected to bid rationally and perform to plan.

- **Financial capacity to absorb overruns:** Sometimes overruns will happen despite everyone's best efforts. We still want responsible contractors who have the capacity to continue and deliver the product despite potential overruns that may not have been foreseeable.

- **Motivation to continue:** A business case must be provided via a prospective reasonable return from production that will motivate suppliers to continue performance in the event of an unanticipated overrun. It is unrealistic to believe contractors will simply accept large losses. They will not.

As an example, the Air Force Tanker program met all of these criteria.

Early or low-rate production have similar considerations, but here is where greater use of FPI contract vehicles makes the most sense as an alternative to cost-plus vehicles. Over the last 20 years, the average overrun for MDAPs in early production has been a little less than 10 percent. This is a reasonable risk level to share with industry in an FPI contract arrangement. I expect our program managers and contracting officers to have

## 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 changes of leadership, for both civilian and military program managers.

***U.S. Navy***

**Capt. Scott D. Porter** assumed the position of program manager of the Advanced Tactical Aircraft Protection Systems Program, (PMA-272), PEO(T) on Dec. 1, 2012.

**Capt. (select) Thomas J. Anderson** became program manager of the Littoral Combat Ship Program (PMS-501), PEO(LCS) on Nov. 16, 2012.

**Ms. Valerie Carpenter** became program manager of Navy Enterprise Resource Planning (ERP), (PMW-220), PEO(EIS) on Nov. 15, 2012.

**The focus in a fixed-price environment is squarely on the financial aspects of the contract structure and not on flexibly balancing financial and technical outcomes.**

meaningful, detailed discussions about the risks in contract performance over target cost. Determining a ceiling price is all about the fair recognition of risk in contract performance. Unlike an FFP contract, there needs to be a fair sharing of the risk—and the rewards—of performance.

To be comfortable with a fixed-price vehicle for early production, I would look for the following:

- Firm requirements (as explained)
- Design proven through developmental testing
- Established manufacturing processes
- Qualified suppliers
- Suppliers with the resources to absorb some degree of overrun
- Adequate business case for suppliers to continue work if they get in trouble

It should be noted that some of the items on this list reflect the "responsibility determination" that should be part of every contract we sign. However, the decision I am talking about here is not the decision to award a contract or accept a proposal for consideration but rather the decision about what type of contract to employ.

The above apply to FPIF procurements for which proposals are solicited at or near the end of EMD after we have been through Critical Design Review, built production representative prototypes, and completed some significant fraction of developmental test (DT). This is very different from a case in which we are only at Milestone (MS) B when we ask for low-rate initial production (LRIP) options. In that case, designs are not usually firmly established, production representative prototypes have not been built, and DT has not yet been done. So when we ask for FPIF proposals as options at MS B, we have already failed criterion 2 at least. In those cases, we ought to have a low risk of completing EMD without major design changes that would affect cost. Again, the Air Force Tanker program serves as an example. Another example where this can be done is a Navy auxiliary, where the shipyards have a great deal of experience with similar designs and with the design process for that class of ships.

FPIF LRIP can have a number of advantages, including better insight into contractor costs and an opportunity to share in contractor cost reductions. While it is attractive to secure FPIF prices at the time we award EMD contracts, as we usually still have competition at that point, we need to balance the benefit with the risk. Optimism tends to prevail early in programs, both for government and industry, and we need to be realistic about the risks that remain before EMD has even begun. It also is an illusion to believe we can routinely transfer all the risk in our programs to industry. Industry has a finite capacity to absorb that risk and knows how to hire lawyers to help it avoid large losses.

We can and should increase the use of FPIF contracting, but we need to approach with some caution FPIF contracting for EMD and for options on LRIP lots that are still years away from execution. During the transition to production, after successful DT has established that the design is stable and that production processes are under control, FPIF becomes a very attractive bridge to an FFP contracting regime.

Finally, there also may be times during the mature production phase of a program when the use of FPI contracts would be preferred. Typically, mature production programs are well established in terms of requirements, design content, and production processes at both the prime contractor and subcontract level. This environment should provide for accurate pricing, and FFP contracts would seemingly be appropriate. However, if we have reasons to conclude there may be a poor correlation between negotiated and actual outcomes, the use of an FPI contract would be more appropriate. In that case, we would share the degree of uncertainty with the contractor.

There could be several reasons why the correlation between negotiated and actual outcomes may be poor—e.g., ineffective estimating techniques, unreliable actual cost predictions at either the prime and/or subcontract level, incomplete audit findings, or diminishing manufacturing sources for some components. In addition, there may be times (e.g., multiyear contracts) where the period of performance is long enough that it places too much uncertainty and risk on either party. The key is understanding the pricing environment. If we have well-prepared contractor/subcontractor proposals, an environment where we have a solid actual cost history, and we have done the necessary analysis to ensure we have the price right, the use of FFP contracts is fine. If the environment is uncertain, the use of an FPI contract may make sense.

Again, BBP 2.0 stresses use of the appropriate contract types. Unfortunately, sorting this out is not always easy. It is hoped that this discussion will be helpful as we all wrestle with the problem of getting the best answer to the question of what type of contract to use in a given situation, whether it is an MDAP or an Acquisition Category III product, and at any phase of the product life cycle.

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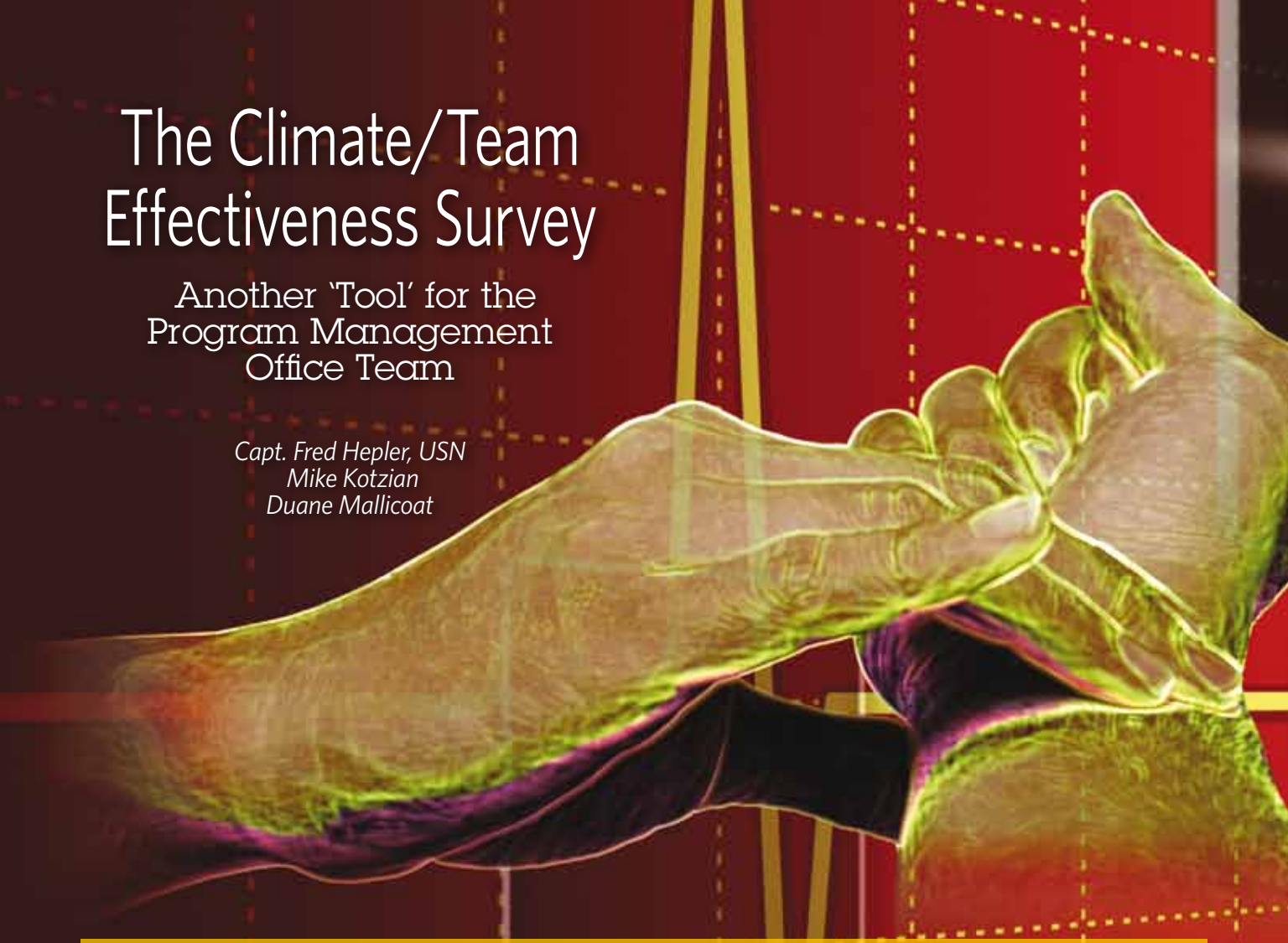
# The Climate/Team Effectiveness Survey

## Another 'Tool' for the Program Management Office Team

*Capt. Fred Hepler, USN*
*Mike Kotzian*
*Duane Mallicoat*



The challenges facing an acquisition Program Management Office (PMO) team are endless. With the charge to navigate an acquisition process that typically has innumerable moving parts at any one time—and all with a very thin margin of error in terms of meeting cost, schedule, performance, and affordability goals—every PMO team must be effective and adaptable across all phases of the acquisition process. Adding to this complexity is the PMO team's need to interface and coordinate with various key stakeholders and, potentially, some geographically dispersed organizational supporting sites.

When a "new" program manager, or PM, takes command of a PMO, he or she is interested in determining just how effectively the PMO team works together while trying to identify specific "focus" areas that might need some level of dedicated leadership attention. So how does a PM and the PMO leadership team obtain fact-based information to act upon in the name of organizational improvement? By what means can the PM determine how well the organization works together and possible focus areas that might warrant attention?

### PMA-260 PMO Overview

The Naval Air Systems Command (NAVAIRSYSCOM) is headquartered in Patuxent River, Md. Within NAVAIRSYSCOM is the Acquisition/Program Management competency and one of many program offices is Program Manager,

**Hepler** *is the PMA-260 program manager,* **Kotzian** *is the DAU Mid-Atlantic Acquisition/Program Management Department chair, and* **Mallicoat** *is the DAU Mid-Atlantic Region associate dean for Outreach and Mission Assistance.*

**There is a school of management thought that advocates the criticality of one's first 90 to 120 days "in charge." It is in this limited window of opportunity that any leader—including a PM—can fully take advantage of the old adage "first impressions are lasting impressions."**

Air (PMA-260), Aviation Support Equipment. PMA-260 manages the procurement, development, and fielding of Common Ground Support Equipment and Automatic Test Systems that support every Type/Model/Series (TMS) aircraft within the Naval Aviation Enterprise.

Common Ground Support Equipment (SE) includes all Platform, Armament, Weapons Control, Airframes, Propulsion, Cryogenics, Pollution Prevention, Avionics Software Loading, Vibration, Crash/Salvage, Hydraulics, Electrical Servicing, and Air Conditioning SE that support multiple systems in multiple TMS aircraft.

Common Automatic Test Systems (ATS) includes Consolidated Automated Support System (CASS), Reconfigurable Transportable CASS, electronic CASS, and associated Legacy Automatic Test Equipment (ATE) Offload to CASS Test Program Sets.

The majority of PMA-260 Integrated Product Team (IPT) members are attached to Naval Air Warfare Center Aircraft Division (NAWCAD) and Fleet Readiness Center (FRC) activities. IPT leaders will draw upon NAWCAD and FRC activities for engineering, integrated logistics support, contracting, and program management support.

Comprising 1 Acquisition Category (ACAT) II, 1 ACAT IVM and 48 Abbreviated Acquisition Programs supporting more than 3,700 aircraft with $6.5 billion of aviation support equipment inventory, PMA-260 is the resource of choice for common support equipment solutions for the U.S. Navy and Marine Corps team.

## Getting Started as the New PMO

For those of us who have been around the block, experience has shown that to succeed, one must plan—and to plan effectively, one must have accurate data that can be viewed with a high level of confidence. With that in mind, there also is a school of management thought that advocates the criticality of one's first 90 to 120 days "in charge." It is in this limited window of opportunity that any leader—including a PM—can fully take advantage of the old adage "first impressions are lasting impressions." Actions—or inactions—during this period in large part set the stage for a leader's relationship with his or her organizational team. As a result, the first 90 to 120 days are key to assessing the PMO's state and identifying any potential areas that may require leadership focus.

Inspired by the May-June 2010 *Defense AT&L* magazine article, "Determining Your Organization's Health," on how climate surveys can be used to determine if an organization is operating at its full potential, Capt. Fred Hepler, the new program manager for PMA-260, decided to conduct an initial PMO assessment. Upon assuming command, Hepler asked the DAU Mid-Atlantic Team to help him conduct an organizational climate survey.

## Creating the Survey

The process was relatively straightforward, but required some dedicated time and attention. The first step was a little more challenging than expected: determining the desired outcomes. Hepler felt sure that a climate/team effectiveness survey would provide insights into his new command organization, but what were the specific outcomes he hoped to achieve? This part of the process required several face-to-face meetings between PMA-260 and DAU Mid-Atlantic to discuss fully and to understand what a climate/team effectiveness survey might provide, and then what Hepler wanted to achieve through the survey.

In the end, as Hepler stated, "I wanted to gain the pulse of the PMA-260 organization from 'all hands' at 'all locations' as well as their views of where the organization stood. I specifically wanted to hear the 'good' as well as the 'not so good.' I felt a properly constructed survey would help provide me with this type of information, so my leadership team could then make fact-based decisions on how to improve the organization."

Once agreement was reached regarding the desired outcomes, a draft survey was developed with suggested demographics and survey questions. With an organization comprising five major locations spread across the United States, one of the key areas for Hepler was a focus on the demographics. The goal was to create a demographic list that would allow the data to be "sorted" in order to have the capability to look at the data from various viewpoints—hence, improving the data analysis portion of the effort. However, the demographics also had to be general enough so all survey respondents had a great confidence that the survey was, in fact, "anonymous." Nothing can deter respondent honesty and openness faster than a perceived lack of anonymity.

Once the demographics were addressed, the question flow took center stage. While this step might sound fairly

straightforward, the trick was to organize the survey questions so "actionable" items resulted to provide Hepler with some hope of influencing his organization's direction. In addition, it was considered important to add qualitative "text boxes" that would allow respondents to enter text comments to supplement the quantitative methodology used for most questions. For Hepler, this was an important feature, since "raw" qualitative comments linked to the quantitative responses from previous surveys have provided very insightful after data analysis.

Finally, Hepler relied on several qualitative questions to seek workforce feedback that could best be captured through a text-based approach: What are we doing that we should keep doing? What are we doing that we should stop doing? What are we not doing that we should start doing?

The result was a survey of 52 questions divided into five categories of interest: Demographics (eight questions), Organization (nine questions), Team Effectiveness (19 questions), Individual Satisfaction (12 questions), and Final Comments (four questions). Thirty-eight of the questions asked for a quantitative response on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree). All quantitative questions had a text box in which respondents could add qualitative remarks.

When the final survey was ready, Hepler believed he had the right mix of questions and categories that would provide a clearer picture of his organization's health and, based on the subsequent data analyses, survey results that would best steer him to potential areas of interest requiring leadership attention.

Once the survey was finalized, it went live for 30 calendar days. (A recommended "best practice" is to have the survey link go out to the PMO team via an e-mail from the PM. With a geographically dispersed organization such as PMA-260, it is important that the team know senior leadership fully supports the survey. In fact, the survey introduction emphasized how PMA-260 leadership viewed the survey as a means to "directly affect the strategic future of the organization, so please give us your most honest responses.")

Jim Deffler, PMA-260's NAWCAD site lead at Joint Base McGuire-Dix-Lakehurst, N.J., summed up his survey experience as follows: "With almost 40 percent of the PMA-260 workforce based at Lakehurst, N.J., I encouraged all to take the necessary time to complete the online survey and help PMA-260 to better understand the health of our organization. I wanted to follow my own advice and thoughtfully considered each question. Even as a member of PMA-260's Executive Leadership Team [ELT], I found the anonymity to provide my candid and unedited opinions and recommendations liberating."

## After the Survey

Hepler was not sure what to expect. Ideally, he hoped to receive sufficient data to allow the leadership team to gain insights into the "health" of the PMO in a variety of key areas: communication, processes, leadership, and effectiveness—to name a few. Hepler wanted the view from the geographically dispersed supporting activities away from the PMO Headquarters at NAS Patuxent River, Md. He also wanted to identify the specific areas/issues that required attention at all the sites. Hepler expected more "positives" than "negatives" as PMA-260 has a very solid reputation within the NAVAIRSYSCOM community.

The results were out-briefed by the DAU Mid-Atlantic team to the entire PMA-260 ELT, allowing key managers to ask/clarify results and, as a group, discuss points that went across functional areas. The ELT out-brief soon was followed up with a full out-brief of the survey results to the entire PMO team, which was held as a video teleconference to all supporting sites. This was accomplished as a joint PMA-260 PM and DAU Mid-Atlantic brief. This approach allowed for immediate clarification of any questions, comments, clarifications regarding the process, data collected, and/or specific survey results.

## Outcomes

Once PMA-260's ELT had the survey results, what was next?

One area immediately adopted was the scheduling of a command ELT offsite to strategize how the results could be used to improve the PMA-260 organization. (This process has been institutionalized as an ongoing PMO "best practice.") The ELT's basic approach was to explore "what could we do better" based on the survey results—quantitative and qualitative. After reviewing the data, and with discussions across the ELT functional areas, several initiatives were formalized as immediate outcomes.

- A minor reorganization to improve efficiency and distribution of work effort
- Changes to current organizational processes
- A revised/improved process to standardize the creation, review, and approval of related acquisition documentation to support the entire cadre of PMA-260 programs and products
- The need to grow in-house capability and competency levels in several key functional areas, initially Earned Value Management to serve as a PMO program forward-looking tool enabler

Beyond the actions of the ELT itself, a valuable outcome of the survey results showed Hepler that some within the PMA-260 workforce believed he was going to blindly "force" ACAT I program policies and procedures across the numerous programs within the PMA-260 portfolio. Hepler said he had no intention of doing so.

Once he realized the organizational concerns, Hepler proactively took steps to alleviate them. For example, he was able to inform the PMA-260 workforce that there were certain NAVAIRSYSCOM policies in place that the organization needed to

**Some within the PMA-260 workforce believed he was going to blindly "force" ACAT I program policies and procedures across the numerous programs within the PMA-260 portfolio. . . . Once he realized the organizational concerns, Hepler proactively took steps to alleviate them.**

follow. Without the survey results, it might have taken Hepler a lot longer to pick up on this workforce concern. By the time he did so, it might have been even harder to overcome this perception, to the detriment of his organization's efficiencies.

Another valuable outcome is that the survey results revealed that many within the PMA-260 workforce were concerned about having to "blindly" adhere to the established NAVAIRSYSCOM Systems Engineering Technical Review (SETR) process. This insight provided an opportunity for Hepler to quickly communicate his expectation that programs were expected to tailor their SETR approach to ensure the process's intentions were met while attempting to maintain schedule—i.e., do not simply "follow the process" and accept schedule delays.

A final outcome is that the survey results helped verify Hepler's initial thoughts about PMA-260's "health" with fact-based information. As a whole, the organization had undergone some major changes during the 12 months preceding Hepler's arrival. The survey results confirmed that the organization had some underlying issues that he, as the new commander, needed to address quickly.

The survey also transformed one PMA-260 senior leader from skeptic to believer.

Dennis Albrecht, PMA-260's principal deputy program manager, summarized leadership's thoughts regarding the survey experience: "I was initially somewhat skeptical about the benefits of a climate survey for our program team when approached with the idea of conducting one, but I was glad we did it when we were presented with the results. Although most of the feedback received was very positive, I was somewhat surprised at some of the issues and concerns that were identified in an anonymous environment, and I was motivated to take action to try and respond to some of our teammates' concerns."

## Conclusion

PMA-260 has not declared "victory" as a result of its workforce taking a climate/team effectiveness survey. Time will tell if the changes implemented as a result of the survey will realize the hoped-for return on investment and efficiency savings. However, the leaders can say the data results gave them actionable fact-based and concise information; the results gave them unhindered feedback from their program team with a specific focus on each of the supporting sites. Hepler considered team effectiveness a vital backbone for a PMO's success, and he believed the PMA-260 climate/team effectiveness survey process was a way to better understand this vital characteristic.

Nonetheless, while the climate/team effectiveness survey process worked for PMA-260 and allowed its ELT to grow to new levels of effectiveness and efficiency, it may not be the best option for all.

Any PMO will have dynamics if the decision is to make this journey. PMO leadership and the individual PMO team members are human. Be prepared. Everyone may not share the organization's vision or see the climate/team effectiveness survey as beneficial and/or worth the investment. This might be a major obstacle if this is the first time the PMO has used such a tool. As you probably have guessed, Hepler received this feedback from some of the PMO team.

The individuals in a typical PMO team are proud professionals who are not necessarily excited about the prospect of reading that someone does not view areas of the PMO in the same light that they do. Therefore, it can be unsettling to have an organization take the survey and subsequently see results that might seem contradictory to leadership's expectations or perceived notions. But this is the power of the survey: a chance to receive unhindered feedback so leadership has fact-based information from which to chart a "new" course leading to increased productivity, higher morale, more effective teamwork, and, most important, improved capabilities delivered to the warfighter.

Keith Sanders, the assistant commander for Acquisition, which has oversight of PMA-260, said climate surveys can be a powerful tool for positive organizational change.

"While conducting a climate survey isn't novel, the leadership of PMA-260 has taken full advantage of this simple tool. They listened, learned, and reacted constructively to their team's feedback," Sanders said. "In this challenging acquisition environment, it's essential that we find ways to increase alignment, productivity, and trust among our teammates—especially across dispersed geographic sites."

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# Defense Acquisition Workforce Awards for 2012

The Honorable Katharina G. McFarland, Assistant Secretary of Defense for Acquisition, presented nine Workforce Achievement Awards and six Workforce Development Awards in a ceremony on Monday, Dec. 17, at the Pentagon's Hall of Heroes.

In remarks prepared for the program, the Honorable Frank Kendall, Under Secretary of Defense for Acquisition, Technology and Logistics, wrote: "Our winners represent the very best of professionalism, ingenuity, and accomplishment among their peers—the 151,000 members of the acquisition workforce. We proudly recognize these winners and the entire acquisition workforce for delivering world-class products and capabilities to our warfighters and for protecting taxpayer dollars."

## Workforce Achievement Awards

From the left, Assistant Secretary McFarland presents Lt. Col. Chase Martin, U.S. Army project manager—Forward Iraq, with the award for acquisition in an expeditionary environment for work done in support of Operation New Dawn.

Mrs. McFarland with Jeffrey Le Claire, U.S. Navy, who was given the business Workforce Achievement Award as lead business and financial manager for weapons in support of the Program Executive Officer for Unmanned Aviation and Strike Weapons.

Mrs. McFarland presents the award for contract auditing to Rhonda Brock, a senior contract price/cost analyst in the pricing directorate of the Army Contracting Command at Redstone Arsenal.

David C. Block, U.S. Air Force, won his award for contracting and procurement, as chief of contracting for Military Satellite Communications. Block executed 172 contract actions valued at $1.74 billion in support of space-based global communication.

Photos by Erica Kobren

Saeed Emadi received the Achievement Award for information technology. He was responsible for acquisition, modification, and sustainment of all Air Force information technology systems supporting the Minuteman III weapon system, achieving a 99 percent ICBM alert rate.

The Life Cycle Logistics Achievement award was presented to Robert Levitt, who, as U.S. Navy program manager for air PMA-261 Director of Logistics, focused his team on weapon system affordability and on developing continuous maintenance planning.

Capt. Shane Gahagan, U.S. Navy, received the program management award. He led a diverse team of more than 1,200 as the E-2/C-2 program manager (PMA-231) for Program Executive Officer, Tactical Aircraft Programs. He was responsible for the $21 billion program's cost, scheduling, and performance.

Clint Justin Govar received the award for systems planning, research, development, and engineering. He leads the advanced expeditionary power system development and fielding for the United States Marine Corps in the areas of battery technology, renewable energy development, fuel cell development, and portable power distribution.

Peter Manternach was the recipient of the test and evaluation Workforce Achievement Award. He is the lead survivability engineer for the United States Marine Corps, selected to fulfill the task of developing the Commandant's No. 1 priority program—a military combat helmet capable of providing select small arms protection to reduce battlefield fatalities.

# Workforce Development Awards

## *Gold Award Large Organization*

Space and Naval Warfare Systems Center Atlantic

Shown receiving the award from Mrs. McFarland is Christopher Miller, Senior Executive Service and executive director at the Space and Naval Warfare Systems Center Atlantic. The organization instituted a creative, thorough, and standardized program for all new hires and created a well-defined curriculum focused on mid-career leadership development. It also provides executive coaching and mentoring to help advance employees.

## *Gold Award Small Organization*

Washington Headquarters Services (WHS) Acquisition Directorate (AD)

Above left to right: Edith Pierce, chief of staff, WHS/AD; Richard Selby, deputy director, WHS/AD; Mrs. McFarland; Linda Allen, director, WHS/AD; and William Brazis, director, WHS and deputy director of administration and management.
The organization created a Knowledge Management system that is used by all of its employees. It also created in-house training that focuses on dissecting the entire process of new contracts, and exposes novice employees to differing contracting types and varied customer bases through assignment rotations.

## *Silver Award Large Organization*

Missile Defense Agency (MDA)

Left to right: Sandra Rawdon, MDA deputy director for human resources; Mrs. McFarland; John H. James, Jr., MDA executive director; and Donna Davis, MDA director of human resources.
The organization concentrated on recruitment initiatives by creating the Missile Defense Career Development Program for entry-level talent and by focusing on virtual career fairs to increase exposure. It expanded opportunities for mid-career employees by increasing awareness of lateral career broadening opportunities and created 18 agency-specific, mission-critical career guides.



Photos by Erica Kobren

## *Silver Award Small Organization*

U.S. Special Operations Command (USSOCOM) Special Operations Research, Development, and Acquisition Center (SORDAC). Left to right: Theodore W. Koufas, director of resources and analysis, SORDAC; Mrs. McFarland; James W. Cluck, director, SORDAC. The center's SORDAC University is the central repository for all knowledge sharing across the organization. SORDAC also focuses on recruiting high-caliber students and provides rotations for interns. In addition, it instituted an awards program to recognize contributions of individuals and teams demonstrating core values.

## *Bronze Award Large Organization*

Naval Air Systems Command (NAVAIR) Test and Evaluation Group (AIR-5.0)

Left to right: Stephen Cricchi, director, Integrated Systems Evaluation, Experimentation and Test Department; Lori Jameson, NATEU program manager; Christina Crowley, AIR 5.0C Test and Evaluation chief of staff (now senior T&E Engineer for Integrated Warfare, Test and Evaluation Division); Mrs. McFarland; Leslie Taylor, director, Flight Test Engineering, NATEU chief of academics; Jennifer McAteer, NATEU deputy program manager; Gary Kessler, deputy assistant commander, Test and Evaluation/executive director, Naval Air Warfare Center, Aircraft Division. The group exhibits best practices in training and development through its Naval Aviation Test and Evaluation University, career broadening opportunities, and for sharing training strategies across the Test and Evaluation communities.

## *Bronze Award Small Organization*

Medium Altitude Unmanned Aircraft Systems (MAUAS) Division, Air Force Life Cycle Management Center (AFLCMC/WII)

Left to right: Dr. Yvette Weber, deputy chief, MAUAS Division; Mrs. McFarland; Col. Christopher Coombs, chief of MAUAS Division; Maj. Russell Burks, chief, Director's Action Group. The division supports the Air Force Academy Summer programs, alternate workplace arrangements, and risk management partnerships to ensure that research, development, and emerging technologies are brought to the warfighters.

# Competitive Prototyping

## A PMO Perspective

*Capt. Paul Overstreet, USN ■ Bradley Bates ■ Duane Mallicoat*

A common theme within today's Department of Defense (DoD) acquisition community is the importance of competition in reducing technical and cost risks, and in ensuring that a program's technology solution is mature enough based on where the program is located within the acquisition framework. To emphasize how foundational the concept of competition is in today's acquisition environment, a program's

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Government Workload
Technical Risk Reduction
Reduced Government Influence
Competitive Future Pricing
Timing Issues
Responsive Contractors

ability to "promote real competition" is one of the five major areas comprising DoD's Better Buying Power initiative identified to improve organizational and program efficiencies.

While most acquisition professionals feel, fundamentally, that "competition" is important, what are the positives and challenges of adding competition as part of a competitive prototyping process in support of an acquisition strategy? To answer this question, we will look at the competition process from a sitting program manager's (PM's) perspective and discuss the aspects and impacts of a competitive prototyping process during a program's Technology Development (TD) phase.

Our specific example is the Joint and Allied Threat Awareness System (JATAS–AN/AAR-59) program within Program Management Aviation-272 (PMA-272) (Advanced Tactical Aircraft Protection Systems), part of the Naval Air Systems Command (NAVAIR) Program Executive Office for Tactical Aircraft (PEO-T) at Naval Air Station Patuxent River, Md. The AN/AAR-59 is an Acquisition Category (ACAT) IC program that recently completed a competitive prototyping TD phase between two contractors. The competitive prototyping process resulted in a Milestone B decision and subsequent Engineering and Manufacturing Development (EMD) acquisition phase contract being awarded in early third-quarter Fiscal Year 2011. The AN/AAR-59's Initial Operating Capability (IOC) date is 2015 onboard the MV-22 Osprey aircraft platform.

## In the Beginning

The Counter/Counter Air Defense Initial Capabilities Document (ICD) dated June 15, 2006, established the need to increase the survivability of assault aircraft operating in hostile environments. In Fiscal Year 2007, the Chief of Naval Operations Air Warfare Division (OPNAV) N98 (Air Warfare Division) executed an independent Analysis of Alternatives (AoA) to evaluate alternatives to meet the capability gap identified in the Counter/Counter Air Defense ICD. The AoA results determined that threat-warning technology was mature enough to proceed with an advanced Missile Warning System (MWS). Subsequently, OPNAV/N98 drafted a Capabilities Development Document that designated the system as the AN/AAR-59. The Department of the Navy approved the draft document to enter the Joint Requirements Oversight Council review process.

The JATAS team spent the summer of 2007 preparing program documentation for an intended program initiation at Milestone B. In September and November 2007, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]) and the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN[RDA]) released memos on prototyping and competition. Throughout the spring of 2008, the program worked with PEO-T, ASN(RDA), and Deputy Under Secretary of Defense for Portfolio Systems Acquisition to design the architecture of a competitive prototyping Technology Development Strategy (TDS). By the time the updated DoDI 5000.02 was released in late 2008, including a requirement for competitive prototyping, the program was already well under way with documentation and contracting plans for a competitive TD phase. The JATAS TDS was signed in December 2008, and in January 2009 the final Request for Proposal (RFP) for a competitive TD phase was released. In April 2009, then USD(AT&L) John J. Young Jr., concerned about the possibility of uncoordinated missile warning and countermeasure approaches on similar systems by each of the Services, issued an Aircraft Survivability Equipment (ASE) Acquisition Decision Memorandum (ADM). This memorandum directed a more coordinated solution for missile warning and countermeasures. The PMA-272 JATAS program was designated an Acquisition Category 1 (ACAT IC) special interest program, and the ASN(RDA) was designated as the Milestone Decision Authority. The ADM effectively endorsed the Navy Program Management Office use of competitive prototyping as part of its acquisition strategy.

## TD Phase: the Heart of Competitive Prototyping

The JATAS program's acquisition strategy determined that a 16-month competitive prototyping TD phase would be used that included two prime contractors: Alliant Techsystems and Lockheed Martin. The effort would be managed via a cost-plus, incentive-fee contract. Each prime contractor completed a System Requirements Review, a System Functional Review, and a Preliminary Design Review that resulted in an approved allocated baseline for its respective AN/AAR-59 design. In addition, both contractors completed prototype ground and flight tests, and modeling and simulation were used to predict system performance.

JATAS's implementation of a competitive prototyping phase resulted in some intended and unintended consequences. To capture the positives and challenges that PMA-272 experienced as an outcome of implementing a competitive prototyping phase, various program stakeholders were interviewed and program documentation analyzed to gain insight into the PMA-272 competitive prototyping phase. This resulted in a white paper in November 2010 that identified, from the government's perspective, positives and challenges with respect to TD competitive prototyping during the AN/AAR-59 program. A synopsis of these findings follows starting with the positives.

### *Positives*

- **Responsive Contractors:** Though the program was not technically in a source selection environment for a TD contract execution, the arrangement resulted in a "competitive environment" additionally fostered by the government team. Both TD contractors were extremely responsive to the government during TD contract execution, allowing the program to maintain its aggressive schedule. Both contractors were reluctant to exceed planned costs, even on cost-plus, incentive-fee contracts, because of the perception of competition. The performance of each contractor in

cost, schedule, and performance was to be an important discriminator in the next phase of the competition.

- **Competitive Future Pricing:** As a result of a competitive prototyping effort, the program was able to award a Fixed-Price Incentive Firm (FPIF) contract for the EMD phase, an FPIF option for Low-Rate Initial Production, and Firm-Fixed Price (FFP) options for the first seven full-rate production lots, as well as FFP options to purchase hardware and software data rights to enable future competition. Prices were formulated by contractors in a competitive environment, resulting in the lowest possible cost to the government. Competing for production contract awards and purchasing the data rights are not typically affordable during a TD program.

- **Technical Risk Reduction:** Prototyping during the TD phase reduced technical risk for the AN/AAR-59 program. Both contractors, as a result of competition, made significant efforts toward early integration of their designs. Early looks at hardware before Preliminary Design Reviews (and analysis based on data collected during government prototype testing) increased government confidence in contractor assertions of predicted performance of the EMD designs. Prototype data from two separate approaches also allowed the AN/AAR-59 program to more accurately evaluate Technology Readiness Level. With all system performance being equal, the EMD and production contracts were able to be awarded based on total cost.

- **Program Execution Risk Reduction:** Dual contract execution in a competitive environment allowed the government team to observe in real time the effectiveness of the corporate management systems, earned value performance, program management, and contract execution of the TD contractors. The government team was able to leverage this experience and insight to assess program execution risk for each contractor during the EMD source selection. Personal relationships were developed between the contractor and government teams, reducing the time required during EMD for the joint team to become effective. As a result, the teams developed a clearer understanding of areas that led to effective communication paths, roles, and responsibilities.

Additionally, both the AN/AAR-59 system and the government's technical team matured during the TD phase. The technical team had a chance to observe two technical approaches, exposing team members to greater technical insight compared with monitoring a single development phase. As a result, the government team members felt they would be more effective during EMD because of this experience.

Also, a set of documentation core to the program was developed during the TD phase. These core program documents then could be leveraged into the development of other products such as the Acquisition Strategy, Systems Engineering Plan and the Test and Evaluation Master Plan supporting the EMD phase. Finally, there was the opportunity to collect sensor data to support development of new algorithms. These data would have been required for completion of EMD, but waiting to collect them during EMD would have introduced additional technical and schedule risk much later into the program's acquisition life cycle.

**Competing for production contract awards and purchasing the data rights are not typically affordable during a technology development program.**

### *Challenges*

While there were positives associated with PMA-272's JATAS competitive prototyping efforts during the TD phase, there also were some program challenges.

- **Government Workload:** Administering two TD contracts increased the government workload without a comparable increase in team size, doubling the meetings, Contract Data Requirements Lists to review, and contract administration. The AN/AAR-59 government team executed eight major reviews (two each of Integrated Baseline Reviews, System Requirement Reviews, System Functional Reviews, and Preliminary Design Reviews—instead of one each) in 13 months, while simultaneously preparing for EMD source selection and a Milestone B review. In addition, the Systems Engineering Technical Review events doubled the attendance requirements for senior engineering and logistics competency members to sit as board members and provide subject matter expertise.

A case could be made for the necessity of three teams successfully executing a competitive prototyping effort. To prevent the government from inadvertently leveling the technical solution by having the same government team deal with both contractors, the AN/AAR-59 Logistics and Engineering disciplines built two teams to interface directly with each of the two vendors. The need for a third team immediately was evident to provide the link between the two, prepare for the

**Staying abreast, and, in some cases, ahead of emerging policy guidance can help a program team make progress in a changing environment.**

milestone decision, and build the RFP for the follow-on for the EMD acquisition phase. The net effect of competitive prototyping was a large increase in workload for the JATAS Program Management Office team.

- **Reduced Government Influence on JATAS Design:** As a by-product of the competitive environment in the TD phase, the government played a limited role in influencing the JATAS engineering design. To avoid "technical leveling" between the two TD contractors, the government team restricted itself to (1) ensuring the contractors fully understood the government's requirements and intent, (2) ensuring the government fully understood each contractor's approach to meeting the requirements, and (3) providing guidance about perceived risk if a particular approach might fall short of government requirements. Beyond that, the government explicitly did not provide specific technical direction or design solutions to the TD contractors. As a result, the government's ability to influence the JATAS design early in its development was limited. Similarly, the government was limited in its ability to adopt good concepts from either TD contractor into its requirements because the JATAS specification could not be changed for the benefit of one contractor over the other.

- **Timing Issues With Gate Review Process/ Contract Gap.** The Secretary of the Navy (SecNav) Gate Review Process (see Figure 1 on p. 21) did not optimally align with the TD competitive prototyping strategy as it did not allow execution of the EMD source selection in parallel with execution of the TD contracts. The result was a gap between the end of the TD period of performance and award of the EMD contract because the RFP for the EMD source selection could not be released until Preliminary Design Reviews were complete and the Capabilities Development Document was signed, essentially at the end of the TD phase. The impact of this "gap" was an additional expenditure of funds to extend the TD contracts and, as a result, the program realized a schedule delay in starting the EMD phase.

- **Workload Issues with DoDI 5000.02 and SECNAVINST 4105.1B and Certification Requirements.** The SecNav Independent Logistics Assessment process required a review of supportability plans prior to a single vendor down-select at Milestone B. This created a situation in which documentation from vendors could not be provided to assessors without nondisclosure agreements, and, in some cases, special training due to the nature of source selection sensitive materials. This resulted in an overarching Life Cycle Sustainment Plan being evaluated and not the initial product support strategies from the vendors, in effect tripling the workload of the logistics team in this area.

In addition, the timing of the Independent Logistics Assessment was too late in the process to be truly effective. To restore a proactive stance to the assessment, it should be conducted prior to releasing the RFP instead of a prescribed length of time prior to the milestone. Focusing only on the milestone resulted in passing the window of opportunity to influence the Statement of Work, Contract Data Requirements Lists, and all other associated deliverables (and their timing).

## Lessons Learned

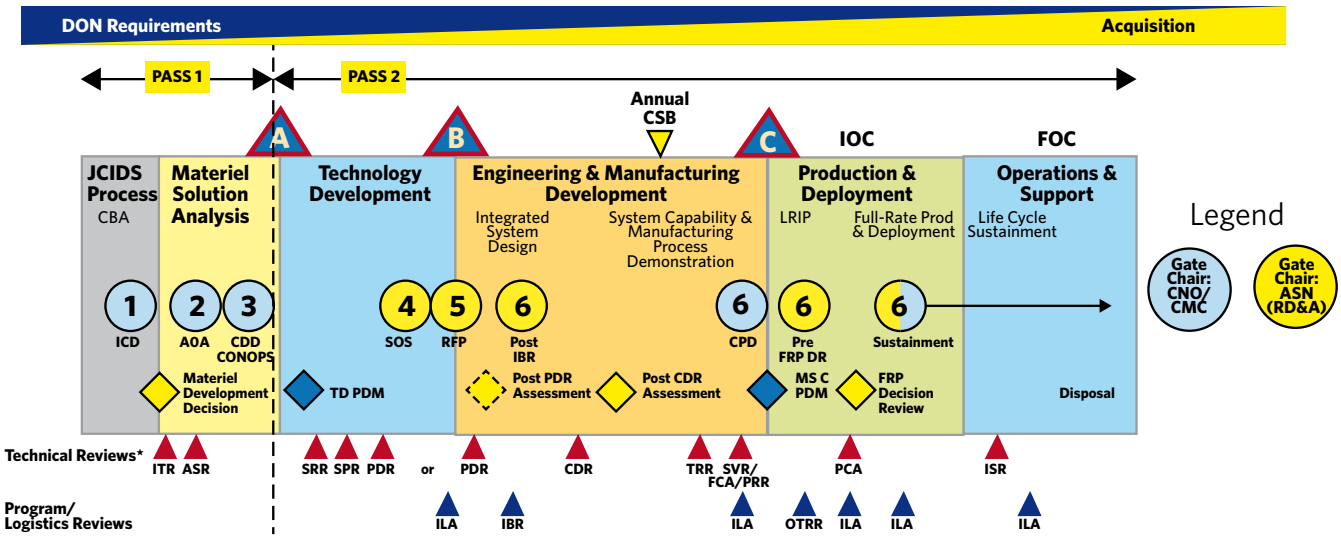
After looking at the positives and challenges associated with PMA-272's competitive prototyping during the TD phase, several lessons were learned from this experience.

- The program did not have an established Acquisition Program Baseline when the competitive prototyping policy guidance was released. Upfront and early communication with Navy and Office of the Secretary of Defense staff identified that this emerging policy would be applicable to this program. Close collaboration with the resource sponsor and policy authorities allowed the program to define a TD strategy intended to meet the needs of all stakeholders. Staying abreast, and, in some cases, ahead of emerging policy guidance can help a program team make progress in a changing environment.

- The standard process requirements of maturing a system through Preliminary Design Review will limit the number of contractor teams that can be effectively managed during competitive prototyping.

- The complexity and number of the system interfaces (internal and external) required to successfully field a system will limit the number of contractor teams that can be effectively managed during competitive prototyping.

## *Figure 1. Navy Gate Review Alignment with DoDI 5000.02 Phases and Milestones*




- Competitive prototyping requires the government team to practice thoughtful engagement when dealing with the contractor team. The government team member must stop and think of the competitive environment before directing or responding to the contractor. This requires the government team member to look at all decisions from multiple viewpoints. Hopefully, this will result in a more thoughtful response.

- The JATAS team felt that a single government team working to ensure its direction would not result in technical leveling, but would provide better and more balanced leadership than two government teams with strict firewalls.

- It is important to make sure the team agrees on how the competition will be conducted. The contracts and technical teams may have different views regarding how best to maintain a "level playing field." To the program manager, procuring contracting officer, and technical team, playing "fair" may consist of providing both teams the same information.

- When the program is to down-select from competitors, plan for the gap that will fall between the final demonstration/presentation and award of the follow-on contract. JATAS chose to have both teams continue on risk-reduction efforts.

- There is a price for competitive programming, and the program will need sufficient funding.

- The maturity of the system specification going into a competitive prototyping environment is extremely important as there potentially will be at least twice the number of requests for clarification. This increased workload will only further stretch already limited program resources.

- The user community must be involved early and invested in helping create the system the warfighters need. The platform office provides the detailed information regarding the environment in which the system will be operated and maintained once it has been installed successfully.

- Logistics and Test and Evaluation are part of the technical team and should be invited to the engineering meetings whenever possible.

- When a program uses competitive prototyping during the TD phase and the EMD contract is to be Fixed-Price Incentive-Firm, it can be difficult for the government team to have a meaningful dialogue with the contractor and provide technical direction and insight without causing "technical leveling" during TD or out-of-scope requirements during EMD.

## Summary

Though the final chapter is yet to be written, the AN/AAR-59 competitive prototyping effort appears to have been a technical success. But the savings and/or costs associated with resources and schedule are still unknown. High-risk TD programs should consider this prototyping strategy as a risk mitigation strategy. In addition, the competitive nature of the contracts forces the contractors to be responsive to cost, schedule, and performance during the system's development.

It is hoped that the sharing of PMA-272's competitive prototyping positives and challenges may help future program management teams as they make a determination to include competitive prototyping in their acquisition strategy, and that the lessons learned can add to the proficiency of the process.

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# Big 'A' Systems Architecture

## From Strategy to Design: Systems Architecting in DoD

*Chris Robinson*

As a Systems Engineering instructor at DAU, I have engaged in a number of discussions and debates, both in and out of the classroom, on architecture in systems acquisition. Over time, I began to see there was a real lack of consensus about the importance of architecture, how it fits in to the Defense Acquisition System (DAS), and how it relates to system engineering.

I, admittedly, had a somewhat narrow view of the subject when I first got into the acquisition business. I viewed architecture as simply an output of the design process. I understood architecture to be, simply, the block diagram

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that depicted all the major components of a system and illustrated how those components are logically or physically connected together. Certainly that block diagram was part of it, but as I worked in various engineering and management roles at different stages of the development life cycle, I started to see a bigger picture. I began to understand the importance of architecture as a discipline that goes well beyond that block diagram.

DAU has afforded me the opportunity to learn more about the various perspectives on architecture and system architecting from colleagues, students, and the broader acquisition community. I also have had the opportunity to study the subject in more depth.

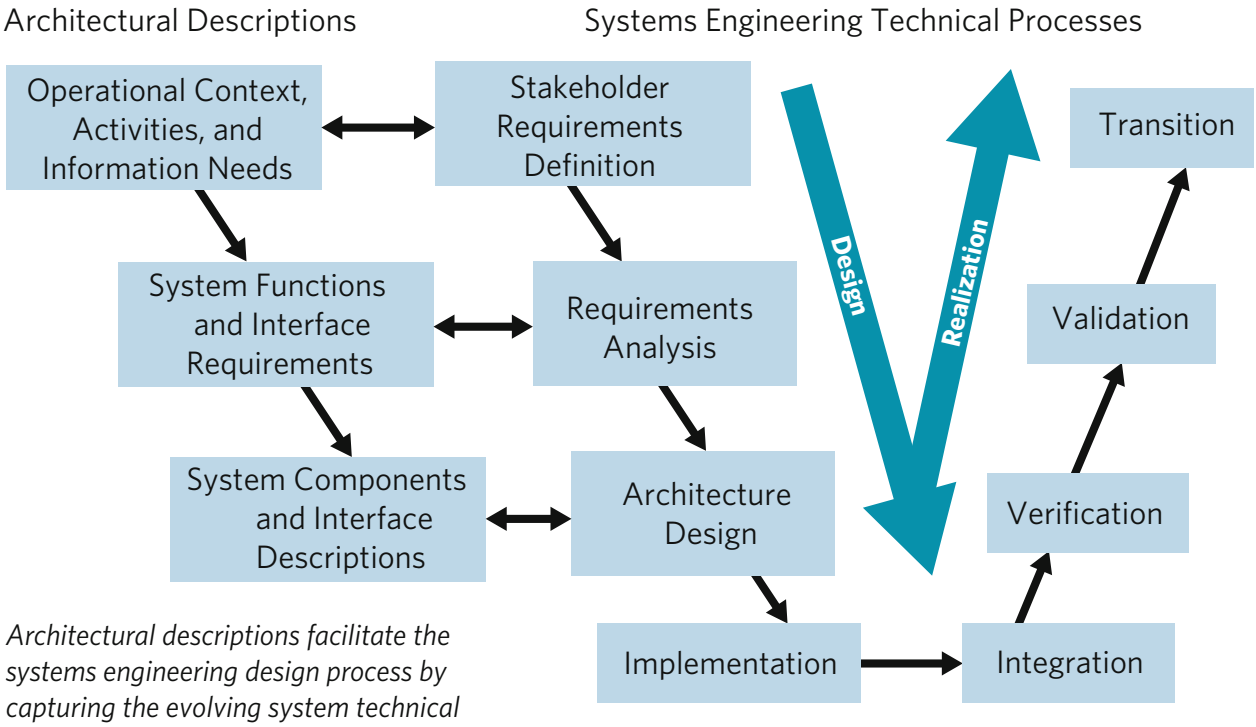
My observation is that systems architecting in DoD is best understood from the perspective of the broader Big "A" acquisition enterprise that includes not only system developers, but strategy and policy makers, resource sponsors, and combat developers. I refer to this framework as Big "A" systems architecting.

## Systems Architecting As Design

Fundamentally, system architecting is part of the system engineering design process where decisions are made that significantly affect stakeholder needs and life-cycle costs. A system's architecture defines the components of the system, the interfaces among those components, and the processes or rules that govern how the components and interfaces change over time. This definition, however, does not tell the whole story, nor does it capture the vital role that effective system architecting has in achieving successful acquisition outcomes. During system development, the emerging structure of a system sets the baseline for the work to follow. Early life-cycle decisions that affect this emerging structure will have a large impact on the evolution of the system's design, verification, production, sustainment, and disposal, and, therefore, a significant impact on the system's life-cycle costs. Consequently, architectural decisions provide the basis for the detailed technical planning needed to effectively manage these life-cycle activities. The evolution of the technical plan will parallel the evolution of the behavior and structure of the system.

Architecting is the part of the system engineering design process that involves decisions related to the behavior and structure of a system that are significant in achieving an optimal balance among stakeholder objectives and total system cost. Systems architecting develops a deep understanding of the required system behavior that is traceable to an overall goal and achievable within established constraints. This understanding informs the thoughtful partitioning of the whole into constituent components, the definition of the relationships among these components, and the processes that govern how the structure and relationships among system components change over time. Architects set the boundaries of the system, define the system's relationship with the larger context (i.e., system of systems or business enterprise), and provide focus

***Figure 1. Systems Architecting and the Systems Engineering Technical Processes***




*Architectural descriptions facilitate the systems engineering design process by capturing the evolving system technical baseline in models that describe the system from various perspectives at successive levels of development*

for detailed component-level engineering. This partitioning facilitates collaboration by helping stakeholders visualize emerging solutions from their unique perspectives, helps systems developers get a handle on complexity, and supports analytical activities used to evaluate and assess system performance.

Figure 1 illustrates the relationship of the systems engineering design process to architectural descriptions that are both artifacts of and inputs to the process. Architectural descriptions capture the results of each step in the process, but also set the stage for subsequent steps. Composing architectural descriptions is a discovery and learning process that helps drive the iterative refinement of a system's high-level design as steps in the systems engineering process are repeated to converge to a solution.

## Systems Architecting As Art With Engineering

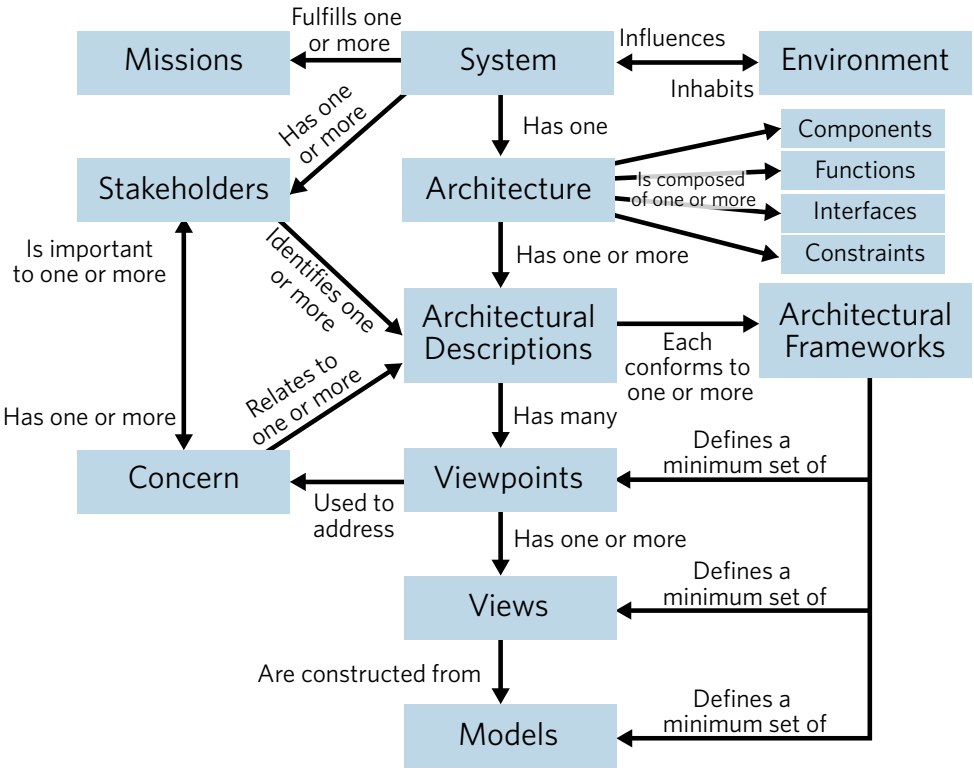
The transformation from strategic objectives to the structure of a system solution often is characterized by great complexity. This complexity is driven by myriad competing stakeholder concerns as well as technological and environmental challenges. Thus, the architecting process depends as much on the "artistic talents" of the architects involved as it does on their engineering acumen. The architecting process makes extensive use of heuristics ("rules of thumb" based on lessons learned from experimentation and experience) and judgment in order to deal with complexity, and places less emphasis on engineering analysis to decide on the best approach (see *The Art of Systems Architecting* by Mark W. Maier and Eberhardt Rechtin for a more in-depth discussion on the use of heuristics in architecting systems). Understanding and defining the problem to be solved, applying experience and lessons learned, balancing the needs of all stakeholders, evaluating alternative approaches, and choosing the best way forward constitute a highly creative, artistic process. The creative aspects of systems architecting require architects to be effective communicators and to possess a sound understanding of the technical landscape (i.e., knowledge of technical standards and certification requirements, knowledge of the relevant engineering domains, and knowledge of enterprise-level rules and processes). This thoughtful aspect of systems architecting, with its application of heuristics and "soft" engineering, is necessarily complemented by the rigorous "hard" engineering analysis required to evaluate architectural decisions and assess the performance of alternatives.

## Systems Architecting As Modeling

In addition to its artistic nature, the architecting process is characterized by its use of modeling. Models serve as the canvas on which the systems architecting process is realized. Modeling helps architects think about, understand, and present the system of interest. Each step in the systems architecting process is captured in a set of models that organize underlying architectural data so as to clearly describe a solution from various perspectives. Architects, engineers, and managers use these architectural descriptions to plan for and manage subsequent development efforts and to communicate technical information to stakeholders. Models can be documents, spreadsheets, dashboards, block diagrams, or other graphical representations that serve as a template for organizing and displaying complex information in a more comprehensible format.

When data are collected and presented as a "filled-in" model, the result is called a view. The Department of Defense Architecture Framework (DoDAF) provides a standard set of building blocks and conventions for capturing architectural data and presenting those data in various formats that target specific perspectives or concerns. The DoDAF defines a set of templates (DoDAF-defined models) that, when filled in with solution-specific architectural data, provide a completed architectural view. Logically organized collections of views are

***Figure 2. Systems, Architectures, and Architectural Descriptions** (adapted with permission from lecture notes of Matthew Henry, Johns Hopkins University)*



referred to as viewpoints. A set of viewpoints related to a specific system solution is collectively called the architectural description of that system.

Figure 2 describes the relationship among a system, its architecture, and the description of the architecture. A system can support one or more missions, but each system is understood to have just one architecture. This architecture can have multiple architectural descriptions, and those architectural descriptions typically conform to an architectural framework. An architectural framework defines a set of models (standard templates), views (filled-in models), and viewpoints (logical groupings of views) that can be used to capture and present architectural data in standardized or custom formats. Architectural frameworks like DoDAF typically define a set of fundamental building blocks—an architecting "vocabulary"—that provides the basis for composing architectural views. The building blocks are the primitive elements and rules used to create architectural views in much the same way the Periodic Table of Elements is used to describe the structure of chemical compounds and chemical processes. The DoDAF Meta-Model (DM2) is the "vocabulary"' of DoDAF. A meticulously defined, comprehensive set of basic modeling elements like the DM2 is necessary to ensure that architectural descriptions are standardized down to the data element level, and, as a result, portable between modeling tools and easily communicated and understood across organizational boundaries. This aspect of architecting is especially important with regard to interoperability requirements and interoperability design for systems that exchange information with other systems within an enterprise like DoD. This is why, as a matter of policy, the mandatory Net Ready Key Performance Parameter (NR-KPP)—a mandatory KPP that helps DoD ensure systems are interoperable—is elaborated for each system through the development of DoDAF-compliant architectural descriptions.

In my experience, too often the acquisition community fails to integrate architecting activities into its plans efffectively. Architecture is viewed as a retrospective chore used only to document what has already been decided. The production of architectural descriptions frequently is treated as a "check in the block" required to get past the next major program decision review.

Instead, program offices and the broader acquisition community must look at architecture (or systems architecting) as a proactive endeavor. This proactive endeavor leverages modeling as a learning and discovery process vital to systems acquisition, enabling the sound decision making required to successfully transform strategic objectives into system solutions. I believe the right approach for the acquisition community is to focus on architecture and architecting as a discipline essential to the system engineering and management processes, and also to recognize that, in DoD, the application of this discipline actually goes beyond the boundaries of the acquisition program management office (PMO) and DAS, and is a process that includes the broader acquisition enterprise.

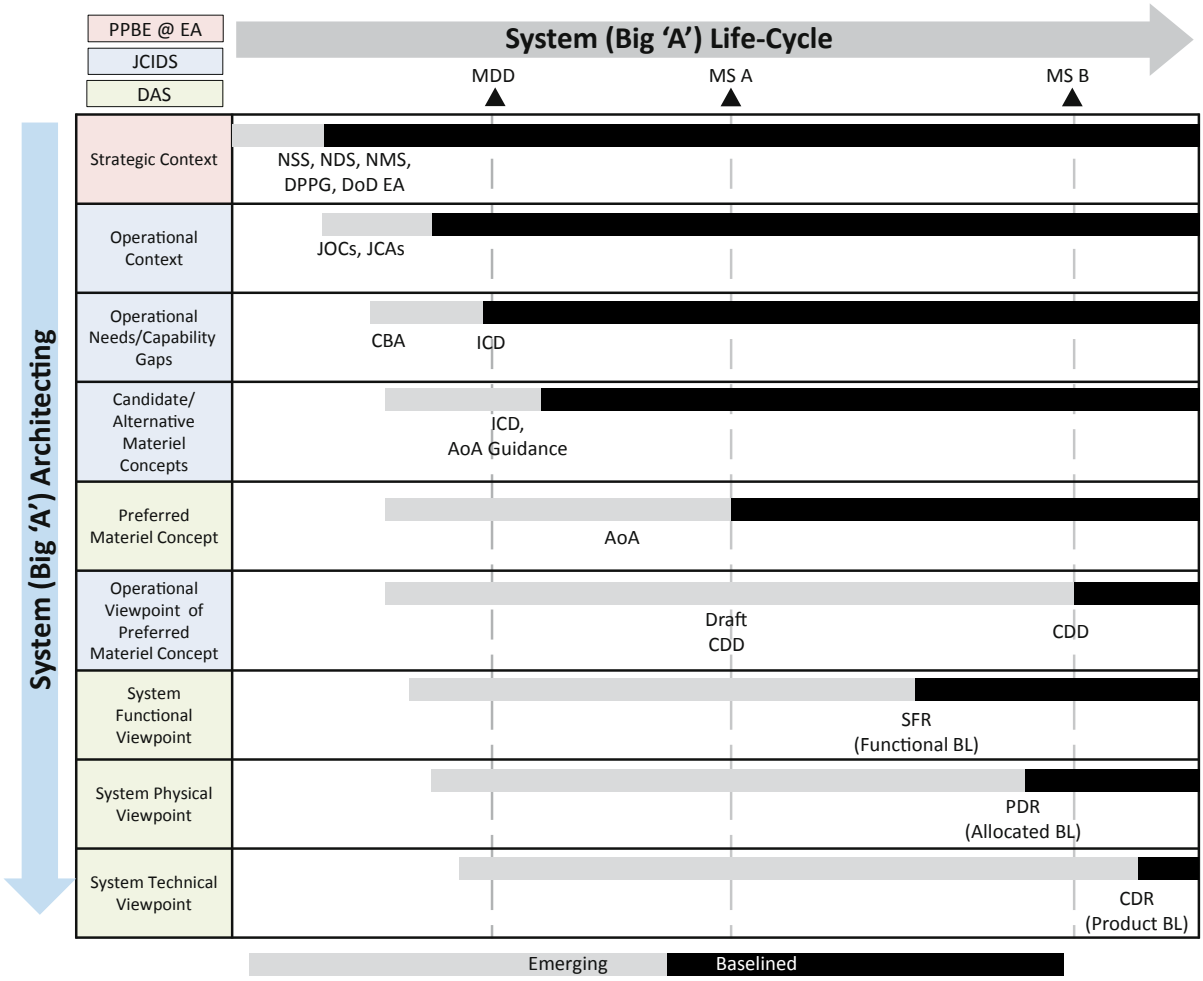
**Early life-cycle decisions that affect this emerging structure will have a large impact on the evolution of the system's design, verification, production, sustainment, and disposal, and, therefore, a significant impact on the system's life-cycle costs.**

## Big "A" System Architecting in DoD

The DAS is responsible for managing development, production, and sustainment of systems and for doing the technical planning that supports these activities. Accordingly, it might make sense that the DAS (or acquisition program manager) also controls the systems architecting process, and that this process proceeds in a linear fashion, starting with a set of stakeholder requirements and ending with an architectural description of a solution that provides the basis for the detailed design work to follow. However, I believe this is too narrow a perspective.

Certainly, the DAS plays a leading role in the architecting of defense systems, but I believe a broader perspective is needed. My observation is that the systems architecting process in DoD transcends the DAS and involves the other major DoD decision supports systems—the Joint Capabilities Integration Development System (JCIDS); the Planning, Programming, Budgeting, and Execution System (PPBES); as well other strategic operational-level planning and decision activities. This holistic enterprise view of the architecting process for complex weapon and information systems sees a process that

## *Figure 3. Big "A" Systems Architecting in DoD*

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|---|---|---|---|
| AoA | Analysis of Alternatives | JCA | Joint Capability Areas |
| BL | Baseline | JCIDS | Joint Capabilities Integration Development System |
| CBA | Capabilities Based Analysis | JOC | Joint Operations Concept |
| CDD | Capabilities Development Document | NDS | National Defense Strategy |
| CDR | Critical Design Review | NMS | National Military Strategy |
| DAS | Defense Acquisition System | NSS | National Security Strategy |
| DoD EA | DoD Enterprise Architecture | PDR | Preliminary Design Review |
| DPPG | Defense Planning & Programming Guidance | PPBE | Planning, Programing, Budgeting, & Execution |
| ICD | Initial Capabilities Document | SFR | System Functional Review |

cuts across organizational boundaries and is characterized by a high degree of concurrency among its constituent stages (see Figure 3).

Accordingly, systems architecting, in light of this broader perspective, involves Resource Sponsors and Strategic Planners (responsible for setting the strategic context and allocating resources), Combat Developers (responsible for operational or mission viewpoint), as well as System Developers (responsible for developing the materiel or technically focused system viewpoint). As shown in Figure 3, I refer to this process as Big "A" systems architecting to reflect the cross-organizational involvement and its enterprise-wide characteristic. By this convention, the piece of the process that falls under the purview of the DAS and focuses on the technical/technological aspects of systems architecting, rather than the strategic and operational, can be thought of as *Little* "a" systems architecting.

Figure 3 is in relation to the early acquisition life-cycle phases and depicts the concurrency that exists among the stages. What this concurrency suggests is that lower-level architectural definition—the more technically focused stages managed by the DAS—in reality begins to emerge even before the outcome of higher-level architectural artifacts are fully established and base lined. The nature and degree of concurrency will vary from program to program, but I strongly believe the effectiveness of cross-organizational collaboration during this highly concurrent Big "A" architecting process substantially influences acquisition outcomes.

In short, the idea of Big "A" Systems Architecting in DoD suggests that the decisions on how to partition a system, connect those parts, and define the processes and rules that govern its evolution are the results of a highly concurrent process that includes the range of activities from modeling and documenting

department-level strategic goals to the development of models that describe system solutions from an operational, functional, physical, and technical perspective. These models, as they are developed, provide the foundation for communication among stakeholders, drive analyses that support key decision making, and provide the basis for the detailed technical planning required to efficiently and affordably execute an acquisition program.

The significance of the Big "A" systems architecting perspective is that it reveals opportunities to improve the overall acquisition process. I believe the biggest opportunities rest with the institutionalization of emerging modeling methodologies such as Model Based Systems Engineering (MBSE) and modeling standards such as Systems Modeling Language (SysML). These tools have great potential to facilitate collaboration and improve the productivity and efficiency across the Big "A" systems architecting stages in the early acquisition life-cycle phases. Ideas on the application of MBSE and SysML to Big "A" systems architecting and the potential benefits to acquisition outcomes are planned to be the subject of a future article.

## Summary and Conclusion

Systems architecting is part of the systems engineering design process that results in the partitioning of a system into components, the defining of interfaces among those components, and the processes that govern their change over time. This is a critical step in the acquisition of a system since it sets a framework and provides a roadmap for all the work that follows. More important is that systems architecting supports the holistic perspective of systems engineering and combines the art of balancing stakeholder concerns with the rigorous use of engineering analysis to handle complex problems that require a system solution. The systems architecting process is captured in models—architectural descriptions—that describe the system from various perspectives related to stakeholder concerns. Systems architecting is a learning process that leverages models and modeling to understand and define problems, communicate alternative solutions, support analysis, and ultimately capture the high-level design of a system. In DoD, this process extends beyond the DAS and involves the other major DoD decision-support systems (JCIDS, and PPBE) as well as decision making at the strategy and policy level. This cross-organizational, Big "A" systems architecting process is characterized by a high degree of concurrency where, early in the system life cycle, lower-level system and technical views of candidate solutions begin to emerge in parallel with the higher-level strategic and operational perspectives.

Emerging modeling methodologies present an opportunity for DoD to improve collaboration and productivity during the concurrent evolving stages of the Big "A" systems architecting process, and this can contribute to better acquisition decisions with concomitant improvement in acquisition outcomes.

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# Delivering Military Software Affordably

*Christian Hagen ■ Jeff Sorenson*

Much of the weaponry now used by the U.S. military—advanced warplanes, drones, smart bombs, autonomous vehicles—is driven by software. In the future, the capacity of the Department of Defense (DoD) and the military commands to defend our country will depend more on their ability to develop the best software rather than on the physical design chosen for the weapons. Like it or not, the DoD now is in the software business.

As one Air Force general makes clear, the military forces and DoD have reached their limit on improving the capabilities of our warplanes and other weapons systems by simply changing their physical design. "The B-52," the general explains, "lived and died on the quality of its sheet metal. Today our aircraft will live or die on the quality of our software."

This increased software demand reflects the DoD's need for advanced operational capabilities and requirements. In the future, fighter jets will have to be even faster, more maneuverable, with split-second response. Drones and other remotely piloted aircraft will require greater accuracy and controllability. GPS-guided smart weapons will need more advanced software, continually updated, to remain smart.

As software has become more important, the DoD has begun to see it as a strategic weapon on which its success relies. But to shift emphasis from hardware to software, the DoD must change its perspective, processes, and capabilities if it is to avoid the increasing costs of developing, modernizing, and sustaining

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software. So far, this effort, while seeing some success, has been plagued by failures, cost overruns, program delays, and cancellations. Look at the following two programs, for example:

**F-35 Joint Strike Fighter.** The F-35 already has cost the DoD billions of dollars and has surpassed its delivery date by several years. No definite timeline is yet set for when the Navy, the Air Force, or the Marines will receive a fully operational version of the plane. In the meantime, costs continue to rise. The Pentagon recently confirmed the F-35 program's estimated development and sustainment costs are likely to be $1 trillion over the aircraft's 50-year projected life.

These skyrocketing costs and delays are caused, in part, by the overall size and complexity of the F-35's software. When the JSF first was tested in late 2006, the estimated number of operational source lines of code was about 6.8 million. Recent estimates put the operational plus support lines of code at approximately 24 million (see Figure 1, on p. 32).

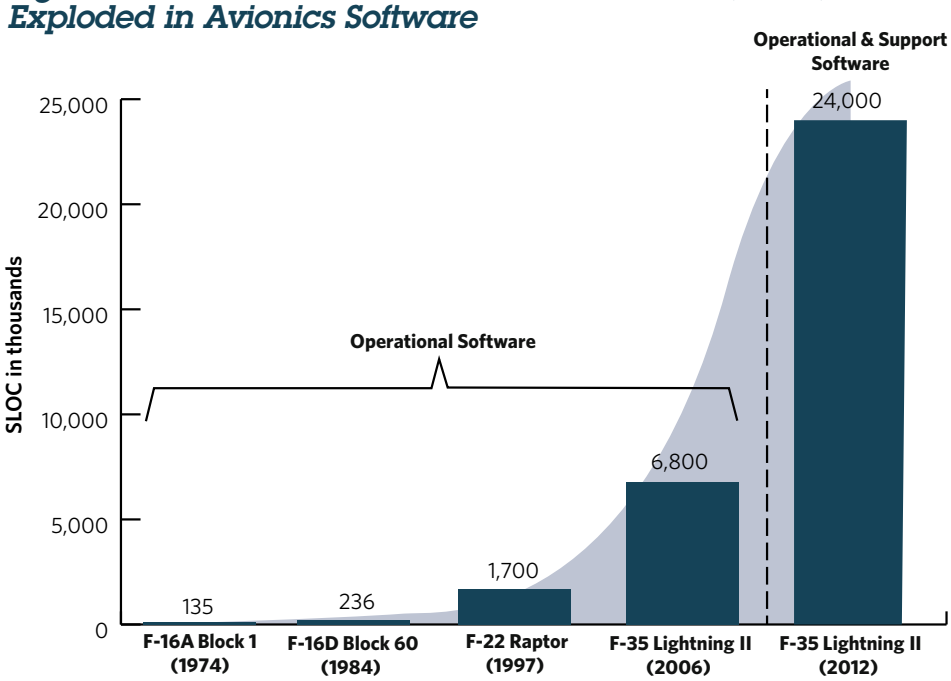
**Expeditionary Combat Support System.** In December 2012, the Air Force canceled this system after 8 years of development and costs of more than $1 billion. The software program, designed to manage Air Force logistics, required comprehensive change to the "processes, tools, and languages of all 250,000 people in our business at once," according to Air Force director of transportation Grover Dunn. The program was canceled when this change became unmanageable, leaving the Air Force to rely, in part, on its outdated 1970s-era logistics systems.

In June 2012, the Air Force Scientific Advisory Board released a report that highlighted the growing role of software in sustaining aircraft for the long term and noted that software's utility and complexity have grown faster than the Air Force's ability to address it across a system's life cycle. So while hardware sustainment costs will decrease as the USAF reduces the number of aircraft, software sustainment costs will not decrease because a weapon system generally needs the same software sustainment, whether it is a fleet of 10 aircraft or 1,000 aircraft.

As the DoD, the military, and their contractors attempt to build needed software capabilities into our weaponry, they must contend with increasingly complex system requirements and a shrinking budget. This challenge makes the transition to software extremely difficult for modernizing systems and managing sustainment.

The challenge appears even more daunting when one considers the technological, programmatic, and enterprise barriers that, over the next few years, will impact the already dynamic defense and software landscape. A few of these many barriers are the following:

## *Figure 1. The Number of Source Lines of Code (SLOC) Has Exploded in Avionics Software*




*Note: SLOC for F-16 and F-22 are at first operational flight. F-35 SLOC figures are from first test flight and current estimates/sources.*
*Source: P. Judas and L.E. Prokop, "A historical compilation of software metrics with applicability to NASA's Orion spacecraft flight software sizing." Innovations in Systems and Software Engineering, vol. 7 issue 3, September 2011, p. 161-170*
*Andrea Shalal-Esa, "Pentagon focused on resolving F-35 software issues," Reuters, www.reuters.com/article/2012/03/30/lockheed-fighter-idUSL2E8EU8C420120330, March 2012*
*Robert N. Charette, "F-35 Program Continues to Struggle with Software," IEEE Spectrum, http://spectrum.ieee.org/riskfactor/aerospace/military/f35-program-continues-to-struggle-with-software/, September 2012*

- Application of open architecture paradigms
- Management of self-healing software
- Development of a cyber warfare strategy
- Exploration of mission adaptable programs
- Introduction of fully autonomous vehicles

Regardless of the magnitude of this challenge and its barriers, the overriding considerations must be around software affordability. Few would doubt that together the DoD, the military, and their contractors have the capabilities to develop the software-driven weaponry needed for future combat. But can they develop and maintain this software in an affordable manner?

As the role of software continues to grow, the DoD must drive savings and efficiencies in the way its software is designed and maintained, ensuring that needed savings are realized and performance is preserved. Bringing about these objectives requires the mastery of four critical areas: architecture, commercial software, software should-cost analysis, and organic software sustainment.

## Architecture

To achieve the best advantage from its software architecture, the DoD must address two key issues at the start of the design and planning process and then reassess them throughout the maintenance phase. The first issue is how to design the architecture to deliver the performance and capability needed. The second is how to develop that architecture to be sustainable and drive effective maintenance programs and costs going forward.

Designing software architecture against specific capabilities has tight restrictions since many DoD applications cannot tolerate compromise on the ability of a weapons system to perform its objectives. However, several architecture choices are available for reducing the costs of achieving that capability, while also providing cost-effective maintenance and enhancements. For example, the ease or difficulty of enhancing or modifying a weapons system's software is strongly linked to how integrated and tightly coupled the architectures are designed. By starting with a modular and loosely independent design, the DoD can perform maintenance and enhancement efforts more cost efficiently.

Rather than select a tightly coupled and integrated architecture, which requires more effort to develop and maintain across the software development life cycle, the DoD could select a federated, open, or open-federated architecture. A federated architecture's overall effort and associated costs of software design are half or less than those of an integrated architecture. With open architecture's ease in adding, upgrading, and swapping components that conform to agreed-upon standards, developers across multiple contractors can work at the platform level to achieve reduced efforts and costs. Combining the first two approaches into an open-federated architecture leads to an even greater level of efficiency and cost savings, while encouraging development teams to modularize their code and compartmentalize their efforts.

## Commercial Software

The custom software traditionally used by the DoD is both expensive and time consuming to develop, especially when compared to software developed by the private sector for commercial uses. For this reason and others, the DoD is turning to commercial software for noncritical, and some critical, applications. As a result, it is instilling both battlefield and support systems with the latest capabilities at a cost significantly below that delivered by custom software.

Besides lower cost and shorter time to develop, commercial software offers the DoD several advantages for modifying or retrofitting existing platforms into weapons systems for the future. For example, with it, the DoD can do the following:

- Adopt proven best practices that are already free of potential problems.
- Achieve cost-effective, faster development by relying on a large pool of experienced developers who may be between 50 percent and 100 percent more productive than those proficient with DoD custom development standards.
- Obtain new technology that offers more advanced capability and increased performance—technology made possible by the wider range of tools for coding applications now available for commercial software developers.
- Capitalize on the continual maintenance of commercial software to gain new capabilities with each software release as well as a faster, more coordinated refresh strategy.
- Coordinate upgrades across weapons platforms by using the common architectures, code, and maintenance efforts offered by commercial software.

While the DoD can significantly benefit from using commercial software, its ability to both recognize the shift away from custom hardware and to manage the vendors and solutions making it possible will be critical over the next decade. In addition, it will need to determine the right balance between relying on contractors to drive innovation and using the government's own organic resources to perform standard maintenance.

## Software Should-Cost Analysis

Given the complexity of most software development efforts, it's not surprising that even those who are experts at estimating hardware-related efforts often struggle to correctly gauge and manage software development costs. Their inaccurate estimates often prove to be costly in time, money, and lost capabilities.

Estimating total software costs for weapons systems is far more complex than for typical commercial projects, which seldom are completed within budget or provide promised functionality. Military cost and schedule overruns often result from a poor estimate of the software development effort and complexity. Nevertheless, senior DoD and military leaders stress that they can accurately estimate the required work and cost by using standard techniques of software effort and cost modeling and, thus, can avoid the overruns often associated with software development.

Within the DoD, as in private enterprises, a software should-cost review can provide a better estimate than that achieved without such an analysis. A should-cost review—which enables everyone involved to question the traditional ways of doing business and to improve value-chain efficiency— offers important advantages. It can save the DoD millions of dollars on key projects by estimating costs more accurately for the software capabilities being produced, integrated, and tested. Additionally, it can break the cycle of history-based cost estimation and improve transparency and affordability—making clear what the costs of a program should be in an efficient, highly competitive environment.

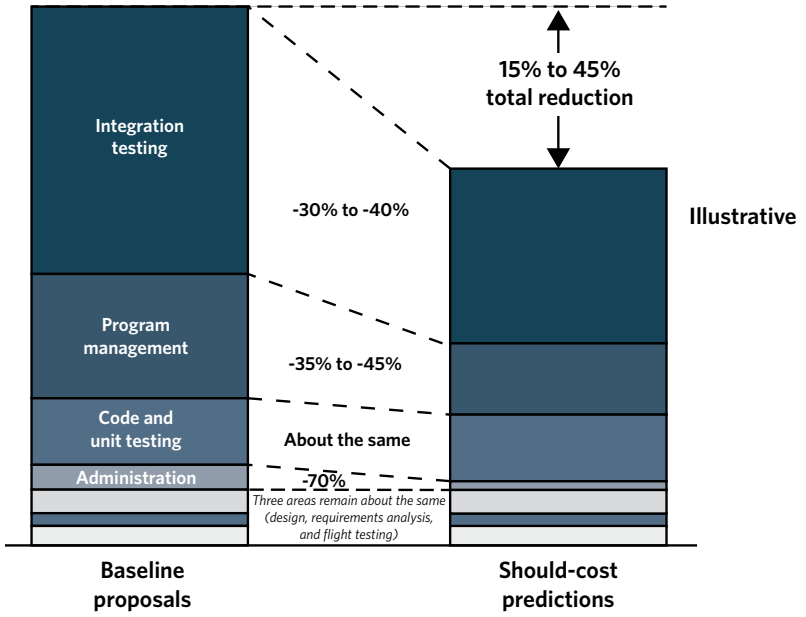
Furthermore, this win-win proposition for both the DoD and its suppliers is a valuable tool for reducing costs without eroding supplier profits or cutting capabilities.

Of course, the DoD cannot save money merely by conducting a should-cost analysis. Instead, it must incorporate the review's results and implement its key initiatives to bring about expected savings. That's why, to make sure the review is not just a theoretical study, a successful should-cost analysis includes a detailed action plan with specific milestones for re-evaluation and an aggressive implementation mindset. It also contains the following five actions for delivering accelerated, maximum benefits.

**Bring best practices to bear.** The should-cost analysis must be approached with an aggressive attitude for making changes and moving beyond the status quo. Ask "What if?" and "Why not?" Then ask these questions over and over again. Find the best practices that can be adopted for a competitive environment. Focus on comparable and relevant benchmarks as well as determining the most efficient cost-to-deliver program requirements.

**Perform a rigorous analysis.** Acquire an in-depth understanding of the root-cost drivers and efficiency potential for supply chain, manufacturing, program management, overhead, and other major areas. Detail the savings potential to support the conclusions and drive tangible actions.

*Figure 2. Software Should-Cost Modeling Identifies Significant Potential Savings*




*Source:: A.T. Kearney analysis*

**Establish the right incentives.** The proper incentives—those that benefit both the government and its suppliers—will inspire workers to challenge the status quo and act with appropriate urgency. Therefore, set up incentives to encourage performance that improves suppliers' profits while lowering government costs. Seek a collaborative effort to better achieve the best results.

**Translate opportunities into tangible action.** Convert cost-management opportunities into realistic action plans with clear timelines and responsibilities. Use multiple cost-cutting approaches, such as negotiation, investment, joint-process improvement, and contract restructuring.

**Track performance against the cost-reduction plans.** Implement a target assurance program to identify cost-reduction targets and milestones. Review progress regularly to understand performance slips and ensure that mitigation steps are in place. Make sure progress is transparent, credible, and well managed.

Since a should-cost analysis provides insight into cost drivers and forces accountability (especially across contractors and suppliers), it offers a tangible value proposition for avionics software development. With it, the DoD can shed light on the development process, isolate opportunities at the subcomponent level, increase the fact base for negotiation—and reduce the long-term cost of software development by 15 percent to 45 percent (see Figure 2). On the F-22 increment 3.2A program, according to a recent DoD Better Buying Power fact sheet, the Air Force successfully identified and implemented cost-saving initiatives of 15 percent (equaling $32 million) to address areas in the software development process that were above industry benchmarks.

## Organic Software Sustainment

With software's growing importance in weapons development and design, software maintenance has taken on a greater role in the post-development work needed to enhance and sustain weapons platforms. This work can be done far less expensively by a stable organic sustainment organization than by primary contractors—in part because wages and overhead are lower, and payback periods are fewer than 5 years. Such cost-cutting opportunities can be found in a number of programs, as the following projected savings illustrate:

- Operational programs, 25 percent
- C4I (command, control, communications, computers, and intelligence), 25 percent
- Ground systems, 20 percent
- Training systems, 20 percent
- Diagnostics and repair, 25 percent

For the DoD to achieve these savings, much of the contractor sustainment efforts must be supplemented with more cost-effective and efficient government-led sustainment. This approach—which follows a recent mandate that much of the sustainment be done in-house to ensure captive capacity during war—will enable the government's organic resources to focus on updating the many legacy platforms now undergoing service-life extension programs. Equally important, it will give contractors the freedom to concentrate on modernizing to keep pace with rapid advances in sensor and weapons technology.

**Data rights.** If the DoD is to increase its in-house software maintenance, the government must have the appropriate rights to the data and all appropriate personnel must be capable of using them. Achieving these objectives requires that (1) the government earmarks as a critical expenditure the funding needed for data rights acquisition, (2) the DoD increases software data-rights training for all appropriate personnel so they understand the use and relevance of these rights, and (3) the DoD confirms that all acquired data and data formats are usable throughout the system's life.

**Skills.** Furthermore, the DoD must give its organic resources the capacity and skill to conduct tomorrow's sophisticated sustainment activities. Are these resources ready for the challenge? They probably are more ready than is typically assumed. But to find out, the DoD should evaluate their potential and their organizational readiness to accept future workloads.

Also, DoD should create a capability roadmap that includes plans for building out the specific skills required over the next 5 to 10 years and details the organic actions needed to maintain the weapons systems. Such a roadmap would govern schedules and priorities and ease the transformation required to meet crucial software maintenance goals.

Organic software sustainment organizations are likely to need several key in-house skills over the next 10 or so years if they are to succeed in developing and supporting the critical work of the future. Besides continuing their work (in some instances) in test stand and control, and verification and validation, they will need the ability to handle advanced work in operational flight programs, advanced ground control stations, and command and control systems. The DoD will need software architecture, design, and engineering skills, and will have to use them earlier in the software develop life cycle. And it will need new skills in requirements analysis, functional design, and software architecture.

As software becomes the driving force behind most weapons systems, and the DoD shifts its emphasis away from hardware design, the department is challenged to find the best, yet least expensive, way to develop and sustain its software. By mastering the four key areas of architecture, commercial software, should-cost analysis, and organic sustainment, the DoD can achieve this transformation more efficiently and can deliver modern software-powered weapons systems to our armed forces more affordably.

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# 'Technical Debt' in the Code

## The Cost to Software Planning

*Don O'Neill*

It is time that "Technical Debt" assessment and measurement be recognized in defense acquisition and procurement and that its anticipation, avoidance, and elimination be incentivized. Accomplishing this is essential to the sustainability of the defense software industry. Technical Debt enthusiasts are themselves in technical debt regarding its definition. It is time to put a finer edge on this definition and update it. The early, archaic, and somewhat awkward definition, introduced by Ward Cunningham in 1992, is, "Not quite right code which we postpone making right."

Instead, I suggest the following definition: Technical Debt is the organizational, project, or engineering neglect of known good practice that can result in persistent public, user, customer, staff, reputation, or financial cost.

### Scope of Technical Debt

The current scope of Technical Debt as a metaphor for the consequences of neglect in software engineering and management is somewhat old-style and certainly programmer-centric. This scope of Technical Debt from the viewpoint of the programmer is one of software components, code and test activities, and static analysis. However, the neglect for which the project and enterprise will pay in terms of interest on the debt includes systems and software

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engineering and management, systems and systems of systems, iterative life cycle model dynamics, dynamic analysis, and finite word effects. So, clearly, the scope of Technical Debt must be elevated.

Technical Debt is an interesting metaphor. Its utility lies in its simplicity and ease with which complex software planning and technical issues can be framed for executives and managers who may lack the technical background to engage these issues firsthand. This shorthand method of framing complex problems leads to loss of underlying detail that can restrict or misdirect the identification, analysis, and resolution of software planning and technical issues among those who do possess the technical background to engage these issues firsthand.

For starters, Technical Debt involves more than the technical and engineering dimension; it also involves software engineering process and management.

The success of large-scale software intensive systems largely depends on the engineering, management, and process capabilities, people, practices, methods, and tools of the enterprise charged with the requirements determination, design, development, testing, fielding, and sustainment of systems and systems of systems. Within any organization, these elements of success are in various stages of maturity, and their evolution and alignment may become the source of strategic software management and continuous process improvement. At any time, these gaps can be referred to as Technical Debt when they result in persistent costs and risks to reputation, economics, mission, or competitiveness.

When these gaps are neglected, whether undiscovered or consciously ignored, Technical Debt may be incurred.

Technical Debt, then, is the organizational, project, or engineering neglect of known good practice that can result in persistent public, user, customer, staff, reputation, or financial cost. Shortcuts, expedient activities, and poor practice contributing to the initial product launch or initial operational capability often are cited as justifiable excuses in taking on Technical Debt. But, in truth, most Technical Debt is taken on without this strategic intent, without even knowing it, and without the wherewithal in capability or capacity to do the job right.

In any event, as the twig is bent so grows the tree, and the weight of accumulated Technical Debt immediately and continuously extracts its cost on the organization.

## Sources of Technical Debt

Technical Debt is considered written off only when it is eliminated. Draining the swamp depends on understanding and aligning the sources of Technical Debt in management, engineering, and process.

Sources of Technical Debt in engineering involve neglect in application domain understanding, requirements determination, system and software architecture, iterative multilevel design, staged incremental development, software development life cycle, programming language, middleware, operating system, network interface, and software development environment.

Sources of Technical Debt in management involve neglect in requirements management, estimating, planning, measurement, monitoring and controlling, risk management, process management, team innovation management, supply chain management, team building, personnel management, and customer relationship management.

Sources of Technical Debt in process involve insufficient evidence of explicit goals and readiness to perform, insufficient accountability based on work responsibility matrix, insufficient planning of design levels and staged increments, and insufficient planning, management, and control of software product releases.

Some argue that Technical Debt should be limited to intentionally deferred work as though incurring Technical Debt is a calculated risk. However, in the heat of battle on a project looking for shortcuts to meet cost and schedule, there is no calculation. There is only expediency.

Suppose there was a calculation. What would it look like?

Would it accord a cost benefit for rework of deferred effort? No, doing it right the first time is more cost-effective. Doing it later, perhaps with less skilled personnel, may mean doing it yet again and again.

Would it accord a cost benefit if the rework of deferred effort was never needed at all? Yes, uncertainties that a calculated risk might consider include banking on the possibility that the initial effort will become a throwaway prototype or that the demand for modernization will overtake the project before the rework of deferred effort is performed.

Would it accord a schedule benefit if function were postponed or some functionally equivalent shortcut were adopted for the moment? Yes, doing less work should take less time.

Would it accord a schedule benefit if "going fast" entails abandoning the organization's standard of excellence in disciplined software engineering and drifting into a stream of consciousness, ad hoc hacking style of programming? No, the ad hoc programming style will result in a higher defect rate that will impact testing and fielding. Ad hoc programming does not deliver superior results with respect to cost, schedule, quality, and performance. Delivering on these attributes takes engineering. So when thinking about "going fast," it may actually pay to go slow.

For those who reserve Technical Debt for intentional deferment of effort, there may be a sort of pride in going against the grain of good, disciplined software engineering practice—as if

their superior skills will permit them to dodge a bullet of some kind during development, only to patch up the situation later when the coast is clear. In my experience, the coast rarely is clear, the rework is ignored or gets done later by less skillful people, and the interest paid and higher cost to fix later defeat competitiveness.

Another category of Technical Debt is not intentional and centers around the "neglect of known good practice." Perhaps some feel neglect is too harsh a term; perhaps others reserve Technical Debt for intentional deferment of effort. In either case, the result is deferred work with consequences that extract an ongoing cost and the postponed elimination of which will cost more than doing it right the first time.

Technical Debt from all sources needs to be on the table when the full cost of rework is weighed against the cost of additional functionality or the cost of a modernization program.

## Technical Debt, Triggers, and Analytics

Technical Debt is the organizational, project, or engineering neglect of known good practice that can result in persistent public, user, customer, staff, reputation, or financial cost. When adopted, Technical Debt becomes the hole in your canoe. Each gallon of water bailed incurs additional cost. Each gallon of water not bailed adds to the sluggishness of the operation.

Technical Debt refers to postponed or deferred work, whether by intent or by neglect. Incomplete or shoddy work extracts a persistent cost on ongoing software operations. In addition, corrective rework costs more than doing it right the first time.

Technical Debt typically is viewed as a problem to recover from once it has occurred. However, a better strategy is systematically to anticipate and avoid the conditions that contribute to Technical Debt in the first place.

The methods to anticipate systematically and avoid Technical Debt need to be built into the software development life cycle. The intended outcomes include on-budget, on-schedule deliveries of defect-free components and systems traceable to requirements with managed and controlled frequency of releases that sustain user operations. Project assessment focuses on the cost, schedule, quality, and performance triggers that serve as the preconditions for Technical Debt.

Technical Debt is considered written off only when it is eliminated at the source, including management, engineering, and process. What are the conditioning triggers for each source?

Sources of Technical Debt in management involve neglect in requirements management, estimating, planning, measuring, monitoring and controlling, risk management, process management, team innovation management, supply chain management, team building, personnel management, and customer relationship management.

The Technical Debt conditioning triggers for management are shown in Table 1.

Sources of Technical Debt in engineering involve neglect in application domain understanding, requirements determination, system and software architecture, iterative multilevel design,

*Table 1. Technical Debt: Management, Trigger, Condition, Action*

| Source | Trigger | Condition | Action |
|---|---|---|---|
| **Management** | M1. Prioritized goals | Where schedule or cost is accorded priority over defect free delivery | A Technical Debt conditioning trigger is set. |
| | M2. Organization levels | Where the software function is separated from program management by two or more levels | A Technical Debt conditioning trigger is set. |
| | M3. Schedule | Where the number of months planned is less than the estimated month at completion | A Technical Debt conditioning trigger is set. |
| | M4. Cost | Where the budget at completion is less than the estimate at completion | A Technical Debt conditioning trigger is set. |
| | M5. Milestone completion | Where the completion schedule for any milestone completion planned date is replaced with a replanned date | A Technical Debt conditioning trigger is set. |
| | M6. Headcount and effort | Where overtime, off-the-clock time, and personnel turnover rate is trending upward | A Technical Debt conditioning trigger is set. |
| | M7. Frequency of release | Where the frequency of release is daily or weekly | A Technical Debt conditioning trigger is set. |
| Total | | | Multiple Technical Debt conditioning triggers are set. |

staged incremental development, software development life cycle, programming language, middleware, operating system, network interface, and software development environment.

The Technical Debt conditioning triggers for engineering are shown in Table 2.

Sources of Technical Debt in process involve insufficient evidence of explicit goals and readiness to perform, insufficient accountability based on work responsibility matrix, insufficient planning of design levels and staged increments, and insufficient planning, management, and control of software product releases.

The Technical Debt conditioning triggers for process are shown in Table 3.

*The author can be contacted at* **oneilldon@aol.com**.

### *Table 2. Technical Debt: Engineering, Trigger, Condition, Action*

| Source | Trigger | Condition | Action |
|---|---|---|---|
| **Engineering** | E1.<br>Deep domain expertise | Where deep domain expertise is not widespread on the project | A Technical Debt conditioning trigger is set. |
| | E2.<br>Software architecture | Where software architecture is not tightly coupled with middleware, operating system, and network services | A Technical Debt conditioning trigger is set. |
| | E3.<br>Requirements known | Where requirements are not fully known | A Technical Debt conditioning trigger is set. |
| | E4.<br>Technical risk | Where the source of technical uncertainty in function, form, or fit is high | A Technical Debt conditioning trigger is set. |
| | E5.<br>Product size | Where product size estimates at completion exceed product size estimates planned | A Technical Debt conditioning trigger is set. |
| | E6.<br>Complexity | Where cyclomatic or essential complexity trend upward from one product release to another | A Technical Debt conditioning trigger is set. |
| Total | | | Multiple Technical Debt conditioning triggers are set. |

### *Table 3. Technical Debt: Process, Trigger, Condition, Action*

| Source | Trigger | Condition | Action |
|---|---|---|---|
| **Process** | P1.<br>Software Project Management | Where the software project management mode is low | A Technical Debt conditioning trigger is set. |
| | P2.<br>Software Product Engineering | Where the software product engineering mode is ad hoc | A Technical Debt conditioning trigger is set. |
| | P3.<br>Iterative development | Where incremental or iterative development of design levels and delivery stages is not used | A Technical Debt conditioning trigger is set. |
| | P4.<br>Best practices | Where the use of best practices is rated low | A Technical Debt conditioning trigger is set. |
| | P5.<br>Metrics | Where metrics are not used | A Technical Debt conditioning trigger is set. |
| | P6.<br>Quality Assurance | Where quality assurance is not in place and functioning | A Technical Debt conditioning trigger is set. |
| | P7.<br>Defect rate | Where the actual defect rate including both defect detection and defect correction exceed the expected | A Technical Debt conditioning trigger is set. |
| Total | | | Multiple Technical Debt conditioning triggers are set. |

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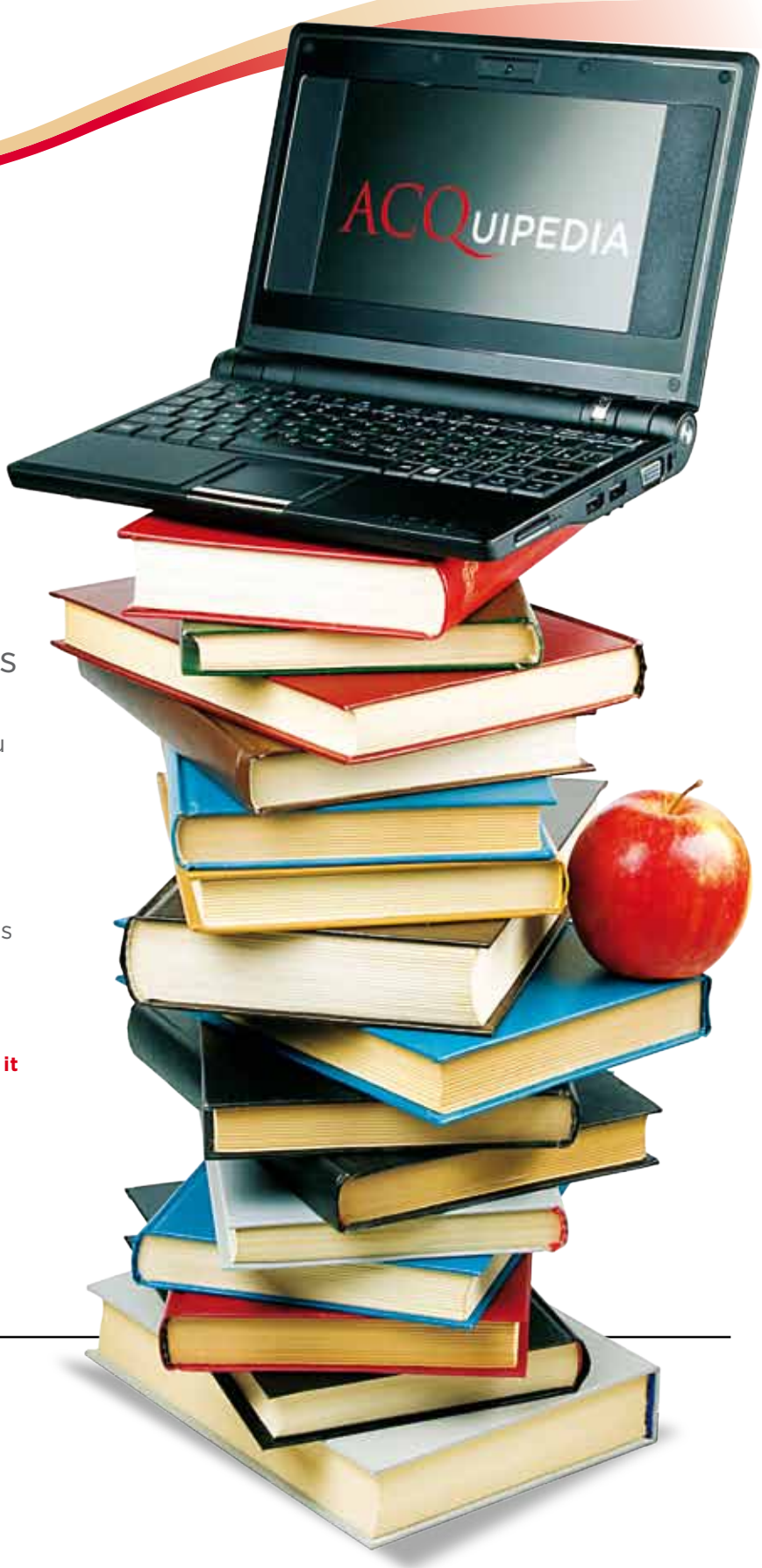


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STANDARD
PROGRAM
STRUCTURE

# Striving for the Optimal Program Structure

*Patrick M. McGinn*

The July-August 2012 issue of *Defense AT&L* published an article by Under Secretary of Defense for Acquisition, Technology and Logistics Frank Kendall titled "The Optimal Program Structure." The genesis of Kendall's article was a question concerning the same topic he had fielded from a student during a question-and-answer session with one of the classes at the Defense Acquisition University. His thesis was grounded in his discussions with the acquisition workforce about Better Buying Power initiatives throughout the preceding year.

Kendall's article noted that "[t]here is no one best way to structure a program," emphasizing that "[t]he first responsibility of key leaders in the acquisition workforce is to think" and that, when determining how best to structure a program, "[y]ou begin with a deep understanding of the nature of the product you tend to acquire," noting that "[t]he nature of the product should be the most significant determiner of program structure" and that there is a need to understand technology maturity, design complexity, integration difficulties, manufacturing technology, and the inherent risks associated with each of these areas. He accurately observed that "[t]he behavior I'm afraid I've seen too much of is the tendency to default to a 'school solution' standard program structure," noting that he has "seen programs twisted into knots just to include all the milestones in the standard program template." He postulated two causes for this: first, our leaders don't know any better and, second, they think it's the only way to get a program through the system.

To extend these observations, one may ask 1) why don't these leaders know any better, 2) why do they think the school solution is the only way to get their programs approved, and 3) is the nature of the product truly the most significant determiner of program structure? In my opinion, the answers to these questions boil down to two things: training and the institutional characteristic of the workforce. My hope here is to explore more deeply and expound on these topics and provide additional "food for thought" as we consider the possible answers to these questions.

New entrants to the acquisition workforce are taught the acquisition process on their first day, and, as they advance in their careers, the process is continually ingrained into their psyches, progressively making them less able to respond to variables and unknowns. Much as a computer can execute only installed code, a person trained only in process cannot respond to

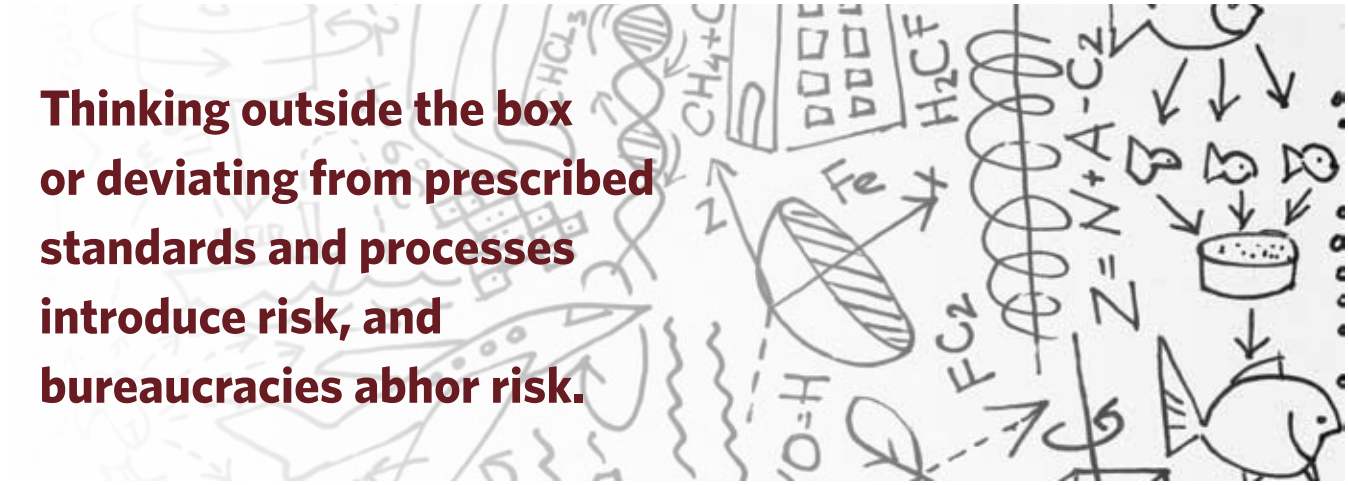
**McGinn** *is a retired Marine Corps officer, F/A-18 pilot, and former Naval Air Systems Command PMA-265 Integrated Product Team Lead who now works as an analyst for a defense contractor.*

situations outside the confines and complexity of the "installed code." A chef uses culinary knowledge and skill to create a fine dish, whereas a cook merely executes a recipe to create the same dish. If an ingredient must be substituted or a cooking technique modified, chefs use their knowledge and skill to adapt and produce an acceptable dish, while cooks executing a recipe will likely end up with a gastronomical failure. In the same light, military leaders are filled with knowledge, taught skills, provided with rules, and then given mission-type orders to reach an objective. The process used to reach the objective is left up to the leaders, thereby giving them the flexibility to respond to variables and unknowns as they proceed along a path toward their objectives. Military leaders who merely execute processes are little more than automatons easily defeated in the fog of war.

The roadblock that prevents us from teaching the acquisition workforce to cook like chefs or lead like soldiers, sailors, airmen, and Marines is the institutional nature of the workforce itself. More and more of the acquisition workforce today is made up of civil servants, many of whom have spent lifelong careers in government. As we well know, government bureaucrats and bureaucracies thrive on standardization and conformity. We've all heard the expression "get along to get ahead," and in a bureaucracy no words were more truly spoken. Thinking outside the box or deviating from prescribed standards and processes introduce risk, and bureaucracies abhor risk. Compliance with and execution of standard processes often are rewarded while the introduction of innovative change is ignored or shunned, particularly if it reduces the size and scope of the bureaucracy itself. Execution of process often becomes the metric for success rather than the efficient and expeditious delivery of effective products or services.

As anyone who has studied animal behavior will tell you, when you reward a behavior, you get more of it. When it is not rewarded, or if it is punished, you get less of it. Our processes are an important means to an end, but they need to be deglamorized and put back where they belong—in our "toolbox." I don't reward a carpenter for how well he drives a nail with a hammer or cuts a 2x4 with a saw. I reward him for how well he builds my house. Like the chef who uses culinary knowledge and skill to create a fine dish, the carpenter uses his knowledge and skill to build my house. The hammer and saw are merely tools he uses to build the house.

Having a deep understanding of the nature of the product is certainly important. However, something even more important and central for key acquisition leaders appears to have been missed. If the acquirer lacks an intimate understanding of the nature of the user, there is a good chance the product or service acquired for the user will fail, regardless of how well it was developed, tested, and produced, and regardless of how well the technology maturity, design complexity, integration difficulties, manufacturing technology, and risks were understood. The acquisition workforce is full of very intelligent individuals, but many of them have never experienced the nature of the user. With each passing year, fewer and fewer of them are being exposed to or work with the user; therefore, they may have little understanding of what the nature of the product they are acquiring should be. Many key leadership billets in the workforce that once were filled by active duty servicemen and women now are filled by career civil servants who have never spent a day in uniform. Active duty end strength was at a post-Vietnam War peak of 2.17 million in 1987. As part of the "peace dividend" after the Cold War ended in 1991, active duty end strength was gutted by 36 percent, plummeting to just 1.38 million by 2000 where it has hovered for the last 12 years. In past conflicts and wars, active duty end strength was increased to meet operational demands.



**Thinking outside the box or deviating from prescribed standards and processes introduce risk, and bureaucracies abhor risk.**

When the Global War on Terror commenced after the attacks of Sept. 11, 2001, end strength was not increased. Operational demands from that war have continually drained active duty personnel from acquisition staffs, leaving key billets unfilled or back filled by civil servants. These individuals, who often lack an understanding of their military customers, find themselves unable, and sometimes unwilling, to communicate effectively and regularly with the most important person in the whole acquisition process—the end user. Therefore, they tend to focus

inwardly on the technology and the execution of process as their metric for success. I don't see active duty end strength increasing any time soon, so I don't foresee these key acquisition billets being filled by individuals who are focused on the nature of the user. We need to identify, hire, train, mentor, and retain individuals who can quickly understand and effectively communicate with a user who frequently is saturated by current operational tasks and who has little time or capacity to discuss the nature of a product that might not be fielded for years.

To be truly successful at building an optimal program structure, a leader in the acquisition workforce needs to understand four equally important elements: process, product, customer, and team. We've touched upon the dangers of merely executing process. However, I would prefer to avoid using the term "process" altogether and focus instead on the importance of imparting knowledge, teaching skills, and understanding the rules that are action boundaries. A leader who is armed with knowledge, skills, and bounding rules, and who is assigned a clear objective, has the flexibility to respond effectively to variables and unknowns and successfully reach the objective.

The acquisition process should merely be a tool in the "toolbox" that is used to reach the objective. Knowing how to use a tool is important, but knowing when to use it is even more germane. We teach leaders how to use a tool, but we often don't teach them when to use it.

Understanding the nature of the product is certainly critical, but as I've expounded here, it is only half of the equation. To avoid the risk of producing what might technically be an excellent product but one that is irrelevant to the end user, a leader must also understand the nature of the user, i.e., the customer. If a leader lacks personal experience with the nature of the user, effective and regular communication with the end user is an absolute must in order to be successful. The last element of success—understanding the team—is equally as important as the other topics. At the end of the day, the structure of any program is made up of people, and it is those people who make up the team. Many acquisition leaders and key billet holders I see today execute management principles ad nauseam, yet few are taught and mentored on how to be leaders.

The military individuals who filled these positions in the past came from a career field that demanded leadership and team building skills, where failure could result in the death of a teammate. The inability to lead a team effectively is one of the quickest paths to failure, regardless of how well you understand process, product, or customer.

I have two items posted on the wall in my office that I look at every day. One is an iconic image of Uncle Sam pointing his finger at me under which is written "Have You Talked to the Fleet Lately?" The other is a quote from an unknown source that says, "In any program built on technology, education in management principles without technical competence is simply a different path to failure." Both of these keep me grounded in the four things that are important to success: process, product, customer, and team. What we need in order to reach the "Optimal Program Structure" are acquisition leaders who are selected, trained, mentored, rewarded, and promoted to think instead of merely to execute process; to communicate effectively and regularly with and understand their customers, resulting in an understanding of the product; and to lead rather than simply manage a team.

*The author can be contacted at* **mcginnpm@gmail.com**.

# Sustainable Acquisition

*Elizabeth Pickering*

The Department of Defense (DoD) has the continuous mandate to provide national security by supporting the warfighter's mission success and providing the forces necessary to prevent war. To accomplish this mission, the DoD requires several essential resources, including energy, land, air, and water. Changes caused by the post-Cold War international power structure and shifting global economies have increased the competition for these resources worldwide. This global competition has increased their value exponentially. To ensure these resources are readily available, the DoD has focused more attention on sustainability.

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## Sustainable Acquisition

Sustainability allows DoD to plan for and maintain resources necessary to operate in the future without decline. The Office of Federal Procurement Policy defines sustainable acquisition as "acquiring goods and services in order to create and maintain conditions under which humans and nature can exist in productive harmony, and that permits fulfilling the social, economic, and other requirements of present and future generations of Americans." The government has initiated ongoing efforts to protect the country's natural resources by promoting environmental stewardship throughout the acquisition process.

**If the targeted percentages are reached, the federal government could save approximately $11 billion in energy costs.**

## DoD Policy

The DoD's Strategic Sustainability Performance Plan (SSPP) was implemented by the Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]). This plan addresses the government's sustainability performance expectations and establishes a path in which DoD can promote sustainability while executing its mission. The SSPP was developed in accordance with Executive Order 13514, "Federal Leadership in Environmental, Energy, and Economic Performance."

Executive Order 13514 was signed by President Barack Obama on Oct. 5, 2009. The goal was to institute a strategy toward sustainability in the federal government and to make reduction of greenhouse gas emissions a priority for federal agencies. In addition to reducing greenhouse gas emissions, the order implemented policy requiring federal agencies to increase energy efficiency, conserve and protect water resources, and eliminate waste and pollution.

## Energy Efficiency and Greenhouse Gas Limits

A major global challenge to sustainability is the availability of energy and the associated increase in production of greenhouse gas emissions. Greenhouse gas emissions are those that absorb and emit infrared radiation into the world's atmosphere. This causes heat to be trapped in the atmosphere and is an escalating worldwide issue contributing to global warming. Scientists believe humans play a major part in the increase of greenhouse gas pollution. A majority of these gases are produced through the human use of energy resources such as petroleum byproducts and electricity. DoD is concerned about global warming because it can adversely affect the weather, sea levels, and land erosion. These changes would then impact our warfighter's ability to conduct successful military or humanitarian relief operations.

Several greenhouse gases that humans release into the atmosphere include carbon dioxide, nitrous oxide, and methane. Carbon dioxide is the primary greenhouse gas released by humans. It is released through the burning of solid waste, wood, and fossil fuels. Nitrous oxide also is released by humans through various fertilizers and industrial processes or when solid waste or fossil fuels are burned. Finally, methane is typically produced in landfills, coal mines, and farms. It is released when organic waste decomposes and during the production of fossil fuels.

Executive Order 13514 asked the chair of the Council on Environmental Quality (CEQ Chair) and the director of the Office of Management and Budget (OMB Director) to establish a federal target for reducing greenhouse gas pollution. In 2010, these targets were established. President Obama declared the federal government would reduce direct greenhouse gas emissions, such as those from building energy use, by 28 percent and indirect greenhouse gas emissions, such as those from business travel and employee commuting, by 23 percent within a decade. This plan will be implemented by requiring federal agencies to execute targets and goals in an annual sustainability plan. Agencies will report on the status toward meeting these goals, and they will be monitored through agency greenhouse gas inventories. If the targeted percentages are reached, the federal government could save approximately $11 billion in energy costs.

## Water Conservation and Protection

A second major global challenge to sustainability is the assurance of an adequate supply of fresh water. Fresh water is an essential resource necessary for military operations, drinking, hygiene, medical care, and food preparation. The availability of fresh water continuously declines with changes in climate and human usage. DoD is concerned with protecting and maintaining drinking water sources and protecting the ecological and biological integrity of the country's wetlands and waterways. Sustaining the country's water resources is vital to preserving human health, the environment, and the economy. To guarantee availability for future generations, the withdrawal of fresh water from an ecosystem should not surpass its natural replacement rate. DoD has addressed this issue by implementing water conservation procedures. Water

conservation includes practices that reduce or enhance the beneficial use of water.

Executive Order 13514 requires federal agencies to reduce their potable water intensity each year by 2 percent through fiscal year 2020. In addition, the order requires agencies to reduce nonpotable water usage for industrial, landscaping, and agricultural purposes 2 percent annually through FY2020.

## Pollution and Hazardous Waste Prevention

A third and final major global challenge to sustainability is pollution and hazardous waste prevention. The DoD relies on many chemicals in its operations. However, relying on these chemicals poses environmental and health risks. The DoD is committed to protecting Americans and U.S. readiness by reducing and properly managing the use of high-risk chemicals and wastes. Properly managing these chemicals protects the vital resources of land, air, and water; reducing these chemicals decreases environmental concerns and DoD costs associated with their use.

DoD is looking for ways to reduce its use of hazardous chemicals. In 2008, the department released the Toxic and Hazardous Chemicals Reduction Plan which addresses the selection, management, use, and disposal of chemicals. This plan requires DoD to evaluate the environmental, safety, and occupational health of chemical usage.

In addition to controlling hazardous waste, DoD is providing measures to manage nontoxic types of pollution that contribute to global warming. One such chemical that is not toxic but has 23,000 times more global warming potential than carbon dioxide is sulfur hexafluoride. Sulfur hexafluoride is used in DoD's Airborne Warning and Control System radar systems. DoD is researching ways to reduce, capture, and recycle sulfur hexafluoride. DoD also is looking for alternatives to this chemical.

Executive Order 13514 requires federal agencies to promote pollution and hazardous waste material prevention. It states that agencies shall deter 50 percent of nonhazardous solid waste by FY2015. It also states that printing paper usage shall be reduced by 30 percent. Further, it requires a reduction in the quantity of toxic and hazardous materials and requires agencies to increase usage of acceptable alternative chemicals.

## DoD Sustainable Acquisition

In addition to requiring federal agencies to implement sustainability plans, DoD has begun addressing sustainable acquisition in government contracts. Federal Acquisition Regulation (FAR) Part 23.1 addresses the policy on sustainable acquisition. It states that, "Federal agencies shall advance sustainable acquisition by ensuring that 95 percent of new contract actions for the supply of products and for the acquisition of services . . . require that the products are energy efficient . . . water-efficient, bio-based, environmentally preferable . . . non-ozone depleting, or made with recovered materials." There are several clauses DoD requires in applicable government contracts, including FAR 52.223-15, Energy-Efficiency in Energy Consuming Products; FAR 52.223-10, Waste Reduction Program; FAR 52.223-11, Ozone-Depleting Substances; and FAR 52.223-5, Pollution Prevention and Right-To-Know Information.

In October 2011, DoD also created policy providing that sustainability attributes shall be reported to the Federal Procurement Data System (FPDS). FPDS is a reporting system that collects data on contract awards. These data are provided to the president, Congress, the Government Accountability Office (GAO), federal executive agencies, and the general public. These data measure and assess the effect of federal contracting on the nation's economy. By requiring sustainability attributes to be reported in this system, the government can see whether progress is made oward sustainment goals.

**By requiring sustainability attributes to be reported in this system, the government can see whether there is progress toward sustainment goals.**

## Conclusion

Sustainability of the essential resources of energy, land, air, and water is critical to the nation's security. The government has begun looking more deeply into energy efficiency and greenhouse gas pollution prevention, water conservation and protection, and pollution and hazardous waste management. DoD has established goals for reducing usage of vital resources through the its SSPP and Executive Order 13514. By implementing new policies and procedures to protect resources, DoD will address current and emerging mission needs in order to meet future challenges.

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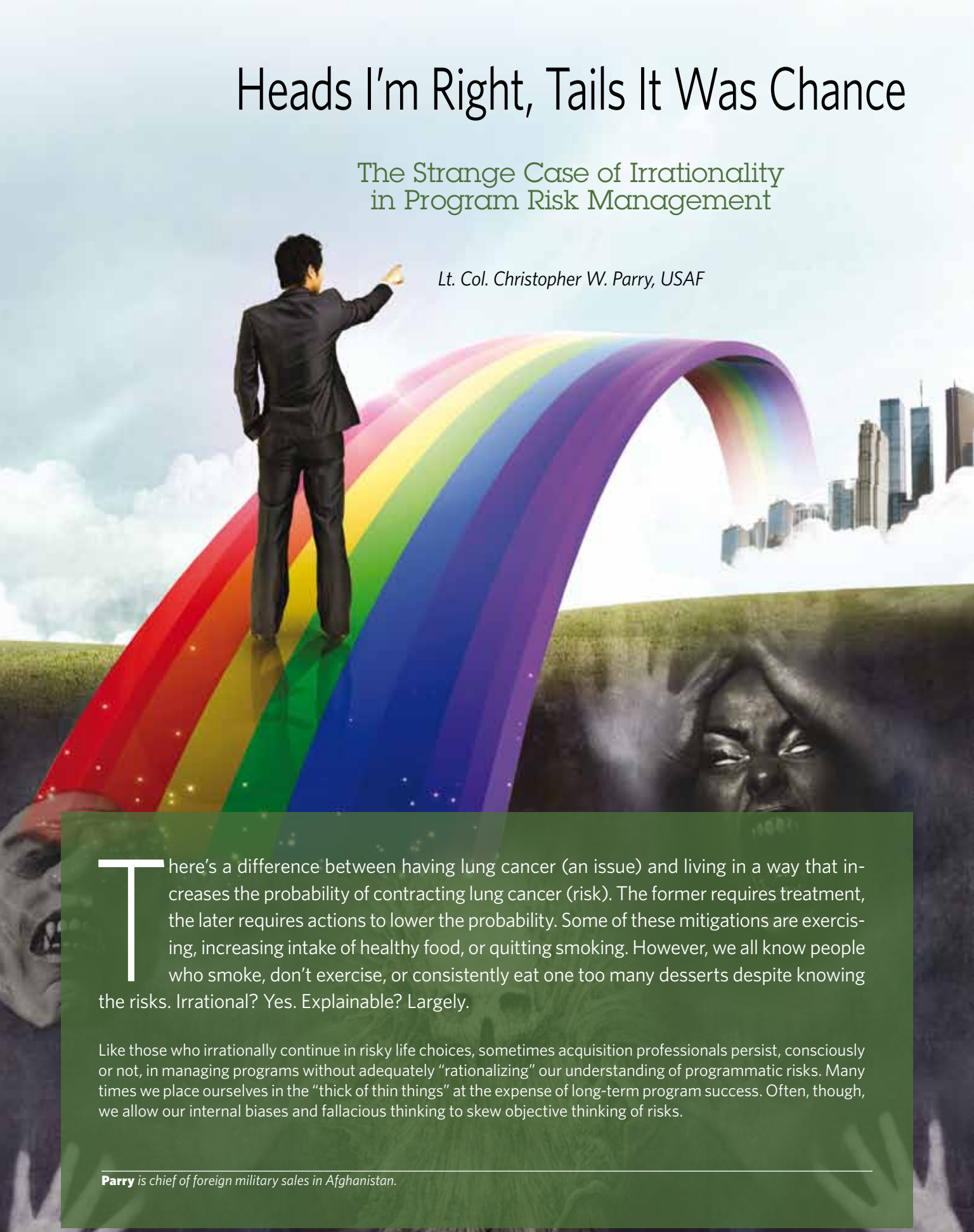
# Heads I'm Right, Tails It Was Chance

## The Strange Case of Irrationality in Program Risk Management

*Lt. Col. Christopher W. Parry, USAF*



There's a difference between having lung cancer (an issue) and living in a way that increases the probability of contracting lung cancer (risk). The former requires treatment, the later requires actions to lower the probability. Some of these mitigations are exercising, increasing intake of healthy food, or quitting smoking. However, we all know people who smoke, don't exercise, or consistently eat one too many desserts despite knowing the risks. Irrational? Yes. Explainable? Largely.

Like those who irrationally continue in risky life choices, sometimes acquisition professionals persist, consciously or not, in managing programs without adequately "rationalizing" our understanding of programmatic risks. Many times we place ourselves in the "thick of thin things" at the expense of long-term program success. Often, though, we allow our internal biases and fallacious thinking to skew objective thinking of risks.

**Parry** *is chief of foreign military sales in Afghanistan.*

Behavioral economists and psychologists have made great strides in understanding some of these biases and thinking errors. Many insightful studies have shown how seemingly irrational decisions can be explained. With this knowledge on how we humans process information, we can take steps to correct our biases and fallacious thinking that, left alone, can severely undermine effective risk management objectivity. As Sun Tzu so simply stated in *The Art of War,* "If you know the enemy [the risks] and know yourself [your own biases and fallacious thinking], you need not fear the results of a hundred battles"... or program management reviews. Below are a sampling of biases and fallacious thinking that may negatively impact our programs' successes. I share these as a first step in understanding and channeling our irrationality.

## Irrational Biases

*"Seventy percent of people think they're above average."*

An often encountered bias in our world is termed the "Planning Optimism Bias." In my domestic "program management" experience, I told my wife and family that I could build a playhouse in the backyard in 2 weekends, no problem. After taking 2.5 weeks of leave and 4 weekends, the playhouse was completed ... just 8 hours before I left for a yearlong deployment. Does this sound familiar to anyone, or am I alone in being below average?

A study in 1995 found only 13 percent of a group of students completed their projects within their most-likely time estimates. Furthermore, only 45 percent of these students completed their work within their previous absolutely worst-case projections. These results have been validated throughout other populations. Have you experienced schedule slips in programs you've managed despite the ardent belief at the program's beginning that delivering on schedule would be a "slam dunk"? Beware of planning optimism bias and mitigate the risks that are surely there.

Have you ever bought a timeshare? Do you look back and think "that was the best decision I've ever made"? Do you remember the positive reasons you bought the timeshare but not the negative aspects you considered? If so, you too have fallen victim to the "Choice Supportive Bias." In studies, researchers have found people tend to embellish the positive aspects of previous decisions while neglecting the negatives. In one study, 99 college freshmen, when asked about their high school grades, erred systemically to higher grades than what they actually obtained.

Experience in program management is invaluable in program success. However, we must base our future programmatic decisions on a nonbiased view on what we've learned in the past. We must remember the negative aspects of the decisions we've made. Arguably from a risk management perspective, we need to remember *more* of the negative aspects of former decisions and then apply that learning to better manage the current program risks.

A close cousin to the Choice Supportive Bias is the "Confirmation Bias," or the tendency to give more weight to evidence that already supports your current belief. With this bias combined with our "Planning Optimism Bias," the acquisition professional could find himself not paying enough attention to warning flags or signals in a timely manner.

Even more interesting within this Confirmation Bias is the finding that we give greater weight to information that we hear or see first. For example, "people form a more positive impression of someone described as 'intelligent, industrious, impulsive, critical, stubborn, envious' than when they are given the same words in reverse order."

First impressions count as do first looks at the program's execution data. And isn't the program nearly always on schedule at the beginning? And when should the acquisition team be most actively engaged in risk identification? Could we as a profession be lulled early in our programs by the "Dark Sith Lord" of Confirmation Bias? One must actively fight this bias by being aware of it and by pessimistically overcompensating to address programmatic risks adequately.

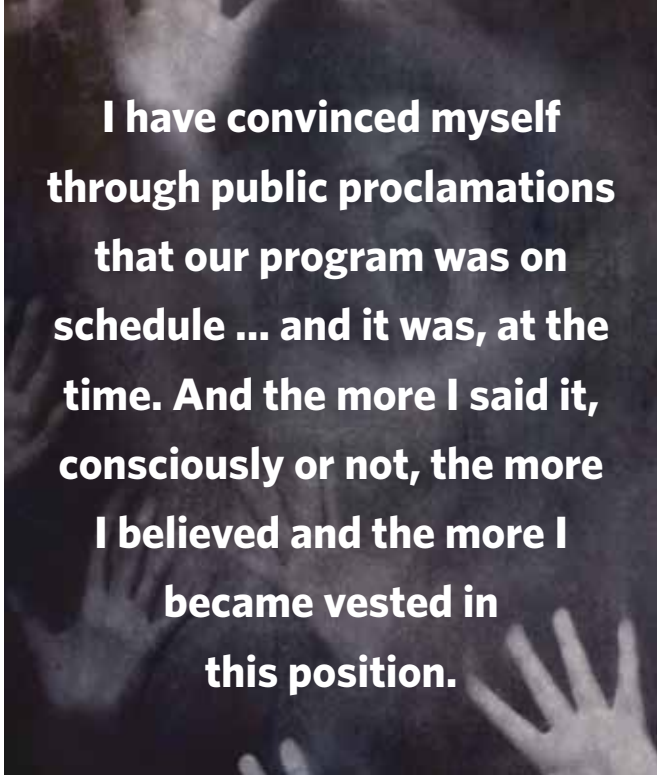
As our program begins to execute, we may fall into another insidious bias trap. In Dan Ariely's book *Predictably Irrational: The Hidden Forces That Shape Our Decisions*, we suffer from the "Endowment Effect Bias." The bias describes the tendency for people to overvalue what they own or on what they've spent time. This overvaluation (normalized for sentimental items that sometimes don't have a price) can at times approach more than twice the amount one could spend to buy the item today. This bias expresses itself at times as the reluctance to dismiss "sunk costs" of either projects or to abandon currently executing courses of action.

Over time, as involved program team members, we gain a feeling of "ownership" of our projects. We care how the project performs. We want the program to succeed. We want to deliver success. However, are we willing to defer our project to a different project (managed by somebody else) when the data show our program no longer is the best value? Or do we insist on an inflated value of the program (on average, twice the value, according to studies) and minimize the risks our program faces?

Even internal to our programs, are we willing to objectively look at the risks of our current courses of action and rationally weigh the benefits of pursuing another course that would reduce the risks overall, despite our investment in the previous path?

Closely linked to this Endowment Bias is what is called the "Availability Snowball Bias" or "Availability Cascade." Briefly stated, the bias is shown when your belief becomes stronger and stronger through publicly sharing it again and again and seeing people adopt or believe what you say—for example, "We are going to deliver on schedule!"

Previously I have convinced myself through public proclamations that our program was on schedule ... and it was, at the time. And the more I said it, consciously or not, the more I believed and the more I became vested in this position. Team members and supervisors also seemed to believe in my explanations, furthering my belief that I was right. I'm not suggesting we all became hypnotized by predicted success but rather we became a little more complacent than we should have been. This bias is insidious as it tends to lull the program manager into a sense of false security. This security can whitewash risks that the team could and should be actively managing.


I have convinced myself through public proclamations that our program was on schedule ... and it was, at the time. And the more I said it, consciously or not, the more I believed and the more I became vested in this position.

## Fallacious Logic

*"I shot an elephant in my pajamas. How he got in my pajamas, I'll never know!"*

*— "Animal Crackers," Marx Brothers film*

Closely related to thinking biases, fallacious logic clouds our ability to adequately come to proper risk assessments. Biases tilt our thinking in one direction or another. Fallacious logic doesn't just tilt one's thinking—it completely undermines it.

A common fallacy witnessed often in program management is the "Wishful Thinking Fallacy." This fallacy occurs when we believe, despite evidence to the contrary, that a program is going well because we want it to. Columnist Christopher Booker in the April 9, 2011, *Telegraph* described wishful thinking in terms of "the fantasy cycle" the following way:

> When we embark on a course of action which is unconsciously driven by wishful thinking, all may seem to go well for a time, in what may be called the "dream stage." But because this make-believe can never be reconciled with reality, it leads to a "frustration stage" as things start to go wrong, prompting a more determined effort to keep the fantasy in being. As reality presses in, it leads to a "nightmare stage'"as everything goes wrong, culminating in an "explosion into reality," when the fantasy finally falls apart.

Risk management is the exercise to "ease into reality" instead of "exploding into it." In many ways, an acquisition professional should be the pessimist when pushing his team to ensure program success. I have often told program teams who have worked for me that I don't want to see an "issue" briefed that I haven't several months earlier seen briefed as a "risk."

Although the acquisition team needs to be optimistic about the chances for success, they cannot do so by focusing only on the positive data or reports that they receive. If they do, they'll fall into the "Texas Sharpshooter Fallacy." This fallacy is named after a Texas sharpshooter (I guess the sharpshooter could be from any other state, but the name just seems to fit) who shoots a bunch of bullets at the side of a barn, walks up to the barn and draws the target around where most of his bullets hit.

Effective risk managers determine what "right looks like" before the data and reports start flowing in and we become enamored with selected success stories. As the staff of the DoD inspector general in Afghanistan said about its boss, "He doesn't get down in the weeds; he gets under the roots and digs them up!" That's what risk managers need to do: root out things that could go wrong and mitigate either the causal mechanisms or the effects.

Sometimes in our efforts to mitigate risks, various positions may be offered from the contractor, the government's engineering team, or any other interested party. As the program manager, you have to make the call, sometimes a hard call, on what you deem the probability and consequence of the risk to be. But be aware of the "Argumentum ad Temperantiam Fallacy." This fallacy is where one picks the middle ground between two extreme positions to be the correct position just because it's "in the middle." Sometimes the extreme position may be the more correct position on a risk. Maybe slightly left or right of center is better. But splitting the "baby," as in the story of Solomon, benefits neither side nor the program!

## The Reward of Now

*Hard work pays off eventually, but procrastination pays off now!*

*—Paraphrase of sociologist Larry Kersten*

Honestly, in college, how many times did you complete your term paper or project weeks ahead of the due date? You likely had these due dates listed in the syllabus when the class started, yet you probably were still working on them the night before they were due. If so, you fell ill to the "Student Syndrome," which occurs when people only fully apply

themselves at the last possible moment before a deadline. Commonly, you'll hear that it will only take an hour if you only have an hour!

Unfortunately, effective risk management is highly susceptible to the "Student Syndrome" for three major reasons. First, unlike a term paper, a risk may never "come due." All risks have a probability of happening, and, so, by definition, many never will actually become an issue.

Second, many of these risks may not occur for years into the future. Given the proximate threats of the daily issues, it is very tempting to put risk management on the back burner as we are rated on how well we solve our problems (i.e., issues) annually. The short-term gains often are given precedence over long-term growth as sometimes evident in American corporations' dealings with stockholders.

Finally, there is a dilution of accountability and rewards within government service. This dilution may pervert incentives that lead you away from risk management and more to success in things that are clearly attributed to you that can be captured in an annual appraisal or military report. Similarly, risks typically happen in the future, hence the annual appraisal cycle and frequent personnel moves effectively shield leaders from ever realizing these risks. All these reasons are perfectly rational from an individual's perspective!

## "Embrace the Madness"

Embrace your irrational and biased self! Understand yourself and how and why you make decisions. Only through critical self-awareness can you become an objective and effective risk manager. By cleaning up our logic and zeroing out our biases, we can come to a better objective truth of the real risks and probabilities of those risks within our programs.

Many of the cognitive economic studies show how experience trains an ancient structure within our brains called the amygdala. This small walnut-size portion of our brain recognizes situational patterns, can unconsciously process enormous amounts of data, and gives us our "gut feeling." In the Army, soldiers perform battle drills to commit combat skills to "muscle memory." Training is a first step, but practice, practice, practice is what eventually trains our instinct. As we consciously think and recognize our biases and fallacious thinking, we can train ourselves to be more objective and critical thinkers.

Biases and fallacies tend to lure us into the path of least resistance. As stated in James Womack and John Shook's book *Gemba Walks*, "Humans will try anything easy that doesn't work before they will try anything hard that does work." Effective risk management is hard. It takes time, lots of it, and the majority of the risks that you track and mitigate may never occur. But the programmatic discipline required by risk management provides structure to the program's effective management. By effective risk management, we can move from "firefighting" to "fire prevention," a much more cost-effective and less traumatic event. Then we can truly say, "Heads or tails ... it doesn't matter, beause we were prepared for either."

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# On the Job With Emotional Intelligence

*Stan Emelander*

**"The leader's fundamental act is to induce people to be aware or conscious of what they feel—to feel their true needs so strongly, to define their values so meaningfully, that they can be moved to purposeful action."**

**—James MacGregor Burns, *Leadership***

The concept of emotional intelligence continues to gain acceptance as an important factor affecting leader effectiveness. Since the theory's introduction and popularization in the 1990s, numerous studies show that being able to perceive, evaluate, and regulate feelings makes managers and leaders more effective and that team members with a higher sense of emotional awareness and control outperform those lacking these traits.

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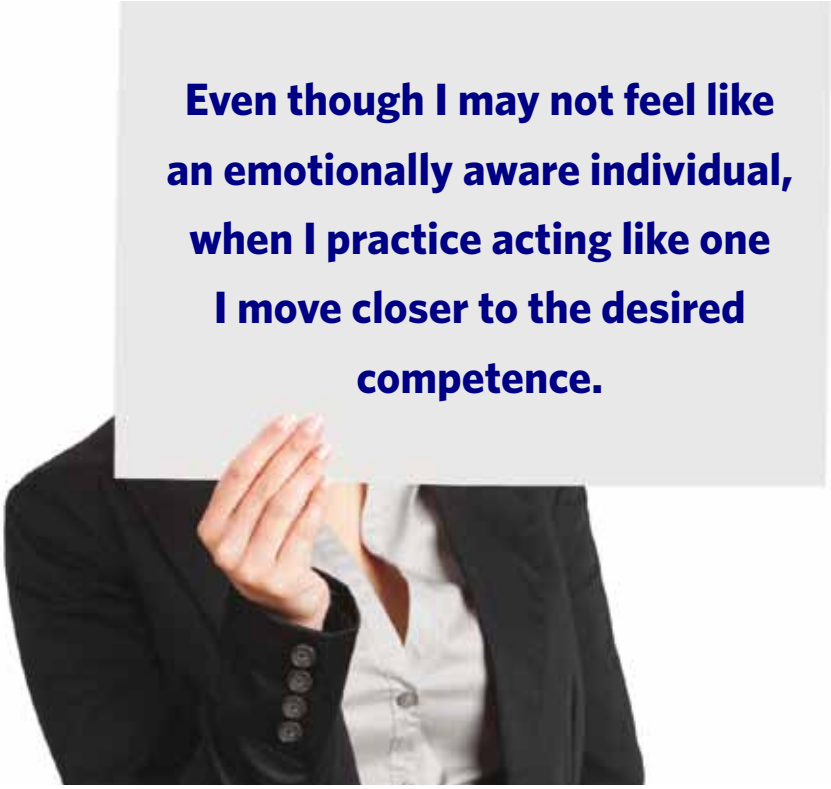


Emotional intelligence, sometimes labeled "social intelligence," seems to have a part in every recent article, study, book, and video on leadership. One of the pioneering researchers and authors on emotional intelligence, Peter Salovey, recently was nominated to be president of Yale University, demonstrating the theory's recognition by the mainstream. There's more to the theory than making people feel good—it draws from behavioral and brain science to describe why feelings arise as well as the importance of managing them. This article provides an orientation to emotional intelligence and offers advice on how to build capacity for it and put it to use. As a start, we can note that emotions have only recently been recognized as having a legitimate role in the workplace.

The development of management theory began with a mechanistic, relatively simple perspective toward workers. The traditional command-and-control (Theory X) perspective toward motivation holds that employees dislike working, require close supervision, and are best encouraged with explicit material rewards. In this scenario, all people are thought to be out for themselves, with economic gain providing their core motivation. Theory X managers believe that employees find work disagreeable, resulting in cynicism and other emotions that should be suppressed. This perspective fits neatly with scientific management, the study of work flows and physical movements, with a goal of maximizing efficiency of production. In my experience, although the Theory X approach is viewed as outdated and even quaint in academia, it is alive and well in the workplace.

Progressing beyond the mechanistic perspective, multiple research-supported theories from the 1950s to the present increasingly emphasize aligning individual and organizational values, and the relationship between worker fulfillment and organizational effectiveness. All post-Theory X approaches to work recognize motivation and engagement as important components of worker effectiveness and organizational achievement. Perhaps the most popular theory, Transformational Leadership, was introduced by Pulitzer Prize-winner James McGregor Burns in his seminal 1978 book *Leadership*. Engagement, as noted by Burns, happens at an emotional level. Feelings are a part of what motivates us, and managers, especially those one level above any worker (e.g., many project managers), play an outsized role in shaping feelings and influencing how employees feel about their work.

## Emotional Intelligence Attributes

Inquiry into emotional intelligence began with observations that people seem to possess intelligence in diverse areas such as language, mathematics, and music. Whether these are true intelligences, or the application of general intelligence in different domains (i.e., learned skills), is a topic of debate. What's undebatable is that people, depending on their focus and native skill, have different levels of ability. Some people possess a high native sensitivity and capability for successfully perceiving and dealing with emotions. This capability—emotional intelligence—applies to both one's self and others, and it includes the perception, interpretation, regulation, and response to emotions.

The above definition encompasses two dimensions—objects and capabilities. Objects include one's self and others, while capabilities include awareness and response. The interaction between these dimensions results in four attributes, directed towards one's self and others, described as follows:

- **Self-awareness**—recognizing your own emotions and how they affect your thoughts and behavior, knowing your strengths and weaknesses, and possessing awareness of how you respond in different circumstances.
- **Self-management**—controlling impulsive feelings and behaviors; managing emotions in healthy ways, resulting in self-confidence and motivation. This includes taking the initiative, following through on commitments, and adapting to changing circumstances.
- **Other awareness (empathy)**—understanding the emotions, needs, and concerns of other people; picking up on emotional cues; feeling comfortable socially; and recognizing the power dynamics in a group or organization.
- **Relationship management**—knowing when the introduction of emotion is effective and beneficial. Includes developing and maintaining good relationships, communicating clearly, inspiring and influencing others, working well in teams, and managing conflict.

Whether emotional intelligence is true intelligence or a learned skill is a subject of debate, but its effectiveness in the workplace is well recognized.

## Applying Emotional Intelligence

Perhaps the most intuitive application of emotional intelligence is in continually sensing and responding effectively to others' emotions. This use builds morale in individuals and contributes to employee impressions of the workplace as a place of support. One of the foremost benefits of emotional intelligence is trust building. Trust results from the favorable assessment of another's intentions, reliability, and effectiveness. The first two components relate to the emotional attribute of self-management. Expressions of support and good intentions, for instance, are only effective when communicated at the right time with genuine feeling. This genuineness of expression is a facet of emotional intelligence.

Often, it is episodes of high emotion, including outbursts or put-downs, that create the most lasting impressions about the work environment, and particularly about managers.

Unpleasant events, particularly shocks or outbursts, are deeply memorable because they stimulate the amygdala, an area of the brain responsible for intense emotional reactions. The amygdala is responsible for the "fight or flight" response that includes redirection of blood away from the brain to muscles and the release of adrenaline. When we perceive a threat that stimulates the amygdala, referred to as an "amygdala hijack," a term coined by Daniel Coleman in his 1996 book *Emotional Intelligence*, the emotion is accompanied by physical changes that include strong sensations. The sensations can reinforce our feelings and cognitions about the threat, making it a truly memorable experience. With our blood-depleted brains and a system awash in adrenaline, we are in poor shape to make a reasoned response to the threat. Self-monitoring to recognize symptoms of feeling threatened (including dry mouth, flushed skin, and raised voices) and framing an appropriate response (stepping back from a confrontation, making the conversation safe) can help put the thinking part of our brains, the neocortex, back in charge. Emotional intelligence also has exceptional application for team-based work leaders, including project and program managers.

At least two aspects of teamwork suggest a strong role for emotional intelligence. The first is the team life cycle model (storming, norming, performing, adjourning) pioneered by Bruce Tuckman in 1965. Appropriately handling emotions during the storming and norming phases is an asset for helping teams transition quickly to effective performance. The second aspect concerns team decision making and creativity, often achieved through constructive conflict. Teams always have the potential to be more creative than individuals—if they are not torn apart by disagreement. Potentially beneficial conflict is directed toward issues and concepts, while disruptive disagreement is directed toward persons, provoking animosity and hindering team effectiveness. Disagreements always carry the seeds of stress, and emotional intelligence can be essential for keeping team conflict healthy and focused on issues, not on individuals.

**Teams always have the potential to be more creative than individuals— if they are not torn apart by disagreement.**

## Building Emotional Intelligence

Similar to how active listening skills can grow with practice, emotional intelligence skills can become habits with practice over time. A difference with emotional intelligence is that half of the skill building will be inner-directed.

I am a fan of the "fake it until you make it" method. Even though I may not feel like an emotionally aware individual, when I practice acting like one, I move closer to the desired competence. To employ this tactic, it's most useful to have a template of behavior, such as the following:

- Assess your feelings throughout the day, looking for sources of your moods and feelings. Is your mood the same at a day's beginning and end? Before and after lunch or a long meeting? Learn how to label your emotions.
- Observe your reactions to other people; note the physical signs and sensations. Do you raise your voice when upset? What happens when you lower it?
- Assess your behavior in your environment, including attention seeking, humility, and selflessness. Ask, "How am I showing up?"

- Identify the positive emotional results from making decisions or achieving goals.
- Attend to your reactions to stressful circumstances.
- Look for positives, not just negatives, in situations and work outcomes. How can challenges lead to improvements?
- Assume responsibility for your actions; engage in active problem solving rather than worry.
- Before you act, assess how your behaviors will affect others.
- Identify leaders who model the behaviors to which you aspire.

## Emotional Intelligence and Leadership

Emotional intelligence is related strongly to leadership; indeed, it is often identified as the most important attribute of successful leaders. Leadership is sometimes defined as the ability to motivate people to action, even in the absence of the leader; and it's the emotional appeal of a leader's values, goals, and vision that stirs followers.

The transformational leadership model, emphasizing the leader's communication of a vision and development of followers, shares much in common with emotional intelligence theory. The core appeal of the leader's vision is emotional and value-based; lacking those qualities, the vision can ring hollow. The follower's buy-in to the leader's program of self-development depends on the authenticity of the message, which in turn depends on the perceived genuineness and trustworthiness of the leader. Charisma, the quality of providing attractive emotional stimulation, is identified with the most successful transformational leaders. Charisma can be thought of as the exercise of the relationship management dimension of emotional intelligence. The goal of transformational leadership always entails change, both for the organization as a whole and for individual followers. Planning and leading change relies on effectively communicating the rationale for change and expressing support and optimism—emotional intelligence skills for those being affected. Leadership development includes modeling desired behaviors, most of which are related to emotional intelligence.

I recently attended a workshop in which government managers were asked to list three attributes of leaders they worked with and admired. The attributes then were sorted into three categories and added. The scores were: Intelligence Related–10; Technical Skill–20; Emotion Related–42. When I ask students to name the attributes of leaders they most admire, answers like "supportive," "approachable," and "trustworthy" dominate. The results of these informal surveys underscore to me the importance of emotional intelligence. The feelings they inspire in us are more important than raw ability or technical know-how. Leaders need to realize that a memorable legacy is founded on what they cause followers to feel, and attending to emotional intelligence can help achieve that goal.

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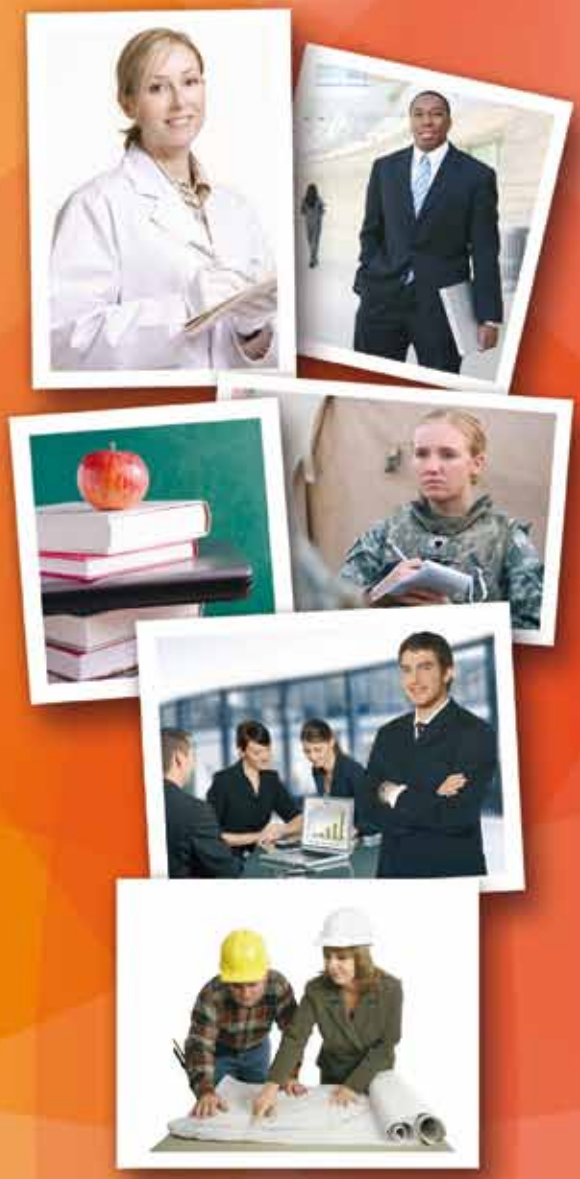
# OSD Unmanned Warfare Directorate Develops Online Catalog Database

Since 2000, the Office of the Secretary of Defense (OSD) has been regularly publishing a 25-year roadmap for unmanned systems. Inclusive of the 2009 edition, these roadmaps had evolved to include an ever-growing list of Department of Defense (DoD) unmanned systems.

With the rapid development and increased acquisition of unmanned systems over the last decade, these roadmap catalogs provided a useful but quickly outdated DoD unmanned systems snapshot, encompassing not only unmanned aircraft systems but unmanned ground vehicles and unmanned maritime systems. The Unmanned Warfare Directorate in Acquisition, Technology and Logistics recognized the need for timely updates to the unmanned systems database and modified the roadmap format by extracting the unmanned systems catalog portion into an easily accessible database.

The new online catalog database was launched in conjunction with the 2011 Unmanned System Integrated Roadmap. It now is part of the CAC-protected Unmanned Warfare Information Repository (UWIR) website (https://extranet.acq.osd.mil/uwir)—a one-stop shop for all things unmanned, including Unmanned Aircraft Systems Task Force information, roadmaps, references, and summary charts. The site allows quick and easy comparisons/analysis and reporting on many variables across all systems of an unmanned domain. For example, a user can quickly produce all engine performance and manufacturer information for all unmanned aircraft systems. The individual system pages are expansive, including system information, background, design parameters, performance, attributes, and images.

"This new catalog is a great resource for providing detailed system capabilities to the broader defense community, all at a single location," stated David Ahern, deputy assistant secretary of defense for strategic and tactical systems. This useful tool is maintained by the OSD Unmanned Warfare directorate and is slated to become the authoritative source for unmanned system data. Further inquiries can be made at UWcatalog@osd.mil and https://extranet.acq.osd.mil/uwir



**DoD Acquisition**
**Best Practices Clearinghouse (BPCh)**
*https://bpch.dau.mil*

## *DoD Acquisition*
# Best Practices Clearinghouse (BPCh)

A single, authoritative source of useful, validated, actionable practice information

### *Do these issues sound familiar?*

- There are many practice lists to choose from but no guidance for selecting specific practices.
- "Proof of practice" effectiveness is usually not available.
- The connection between practices and specific program risks are undefined.
- Success factors for practices are not well documented.
- Implementation guidance is often missing.
- The cost and timeliness associated with implementing and using the practices are often not specified.

### *The BPCh can help by*

- Serving as the authoritative source for practices in DoD and industry;
- Targeting the needs of the software; acquisition, software development, systems engineering, program management, and logistics communities;
- Connecting communities of practice, centers of excellence, academic and industry sources, and practitioners; and
- Promoting and assisting in the selection, adoption, and effective use of best practices and supporting evidence.

For more information, visit the BPCh website at https://bpch.dau.mil, or contact:

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# Defense AT&L

# Writers' Guidelines in Brief

## Purpose

*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.

## Submission Procedures

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

Receipt of your submission will be acknowledged in 5 working days. You will be notified of our publication decision in 2 to 3 weeks. All decisions are final.

## Deadlines

Note: If the magazine fills up before the author deadline, submissions are considered for the following issue.

| 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.

## Style

*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.

The magazine does not print academic papers; fact sheets; technical papers; white papers; or articles with footnotes, endnotes, or references. Manuscripts meeting any of those criteria are more suitable for DAU's journal, *Defense Acquisition Research Journal (ARJ).*

*Defense AT&L* does not reprint from other publications. Please do not submit manuscripts that have appeared elsewhere. *Defense AT&L* does not publish endorsements of products for sale.

## Length

Articles should be 1,500–2,500 words.

## Format

Send submissions via e-mail as Microsoft Word attachments.

## Graphics

Do not embed photographs or charts in the manuscript. Digital files of photos or graphics should be sent as e-mail attachments. **Each figure or chart must be saved as a separate file in the original software format in which it was created.**

TIF or JPEG files must have a resolution of 300 pixels per inch; enhanced resolutions are not acceptable; and images downloaded from the Web are not of adequate quality for reproduction. Detailed tables and charts are not accepted for publication because they will be illegible when reduced to fit at most one-third of a magazine page.

Non-DoD photos and graphics are printed only with written permission from the source. It is the author's responsibility to obtain and submit permission with the article. **Do not include any classified information.**

## Author Information

Contact and biographical information will be included with each article selected for publication. Please include the following information with your submission: name, position title, department, institution, address, phone number, and e-mail address. Also, please supply a short biographical statement, not to exceed 25 words. We do not print author bio photographs.

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