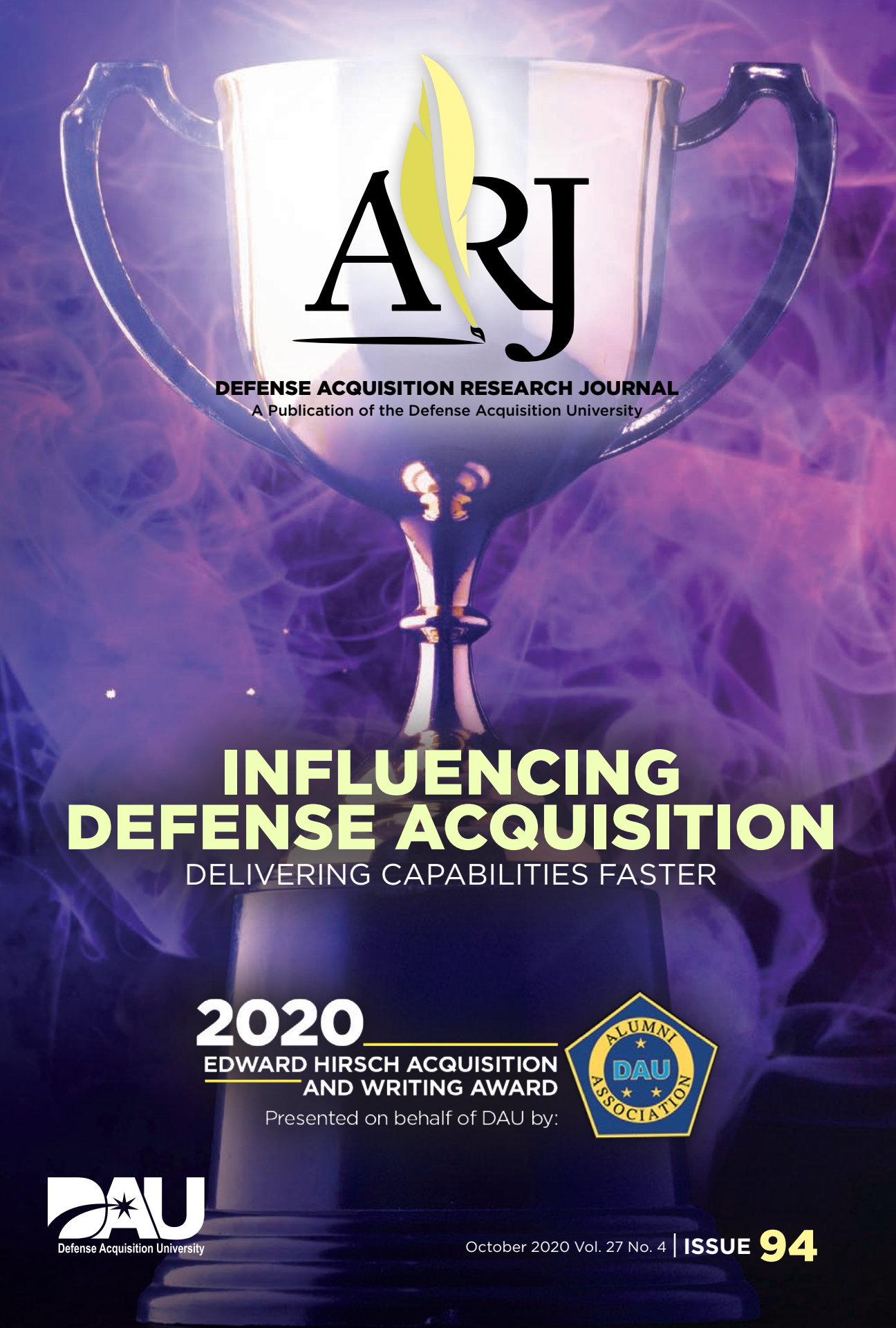

DEFENSE ACQUISITION RESEARCH JOURNAL
A Publication of the Defense Acquisition University

INFLUENCING DEFENSE ACQUISITION

DELIVERING CAPABILITIES FASTER

2020
EDWARD HIRSCH ACQUISITION AND WRITING AWARD
Presented on behalf of DAU by:

Defense Acquisition University

October 2020 Vol. 27 No. 4 | ISSUE 94

Camouflage Combat Uniform
COL Robert F. Mortlock, USA (Ret.)

Measuring the Impact of Innovation Activities in Government
Justin F. Brunelle, Daniel Frisk, Benjamin Mayer, Paula Randall, and Awais Sheikh

Delivering Capability Through Competition in Defense Contracting: Does Policy Drive Results?
Lt Col Brian Duddy, USAF (Ret.), Lt Col Timothy Landucci, USAF, and Lt Col Julie A. Knechtel, USAF

ARTICLE LIST

ARJ EXTRA

The Defense Acquisition Professional Reading List
Call Sign Chaos: Learning to Lead
Written by Jim Mattis and Bing West
Reviewed by David Riel

DEFENSE ACQUISITION RESEARCH JOURNAL
A Publication of the Defense Acquisition University

We're on the Web at:
http://www.dau.edu/library/arj

ISSN 2156-8391 (print) ISSN 2156-8405 (online)
DOI: https://doi.org/10.22594/dau.042020-94.27.04

The *Defense Acquisition Research Journal*, formerly the *Defense Acquisition Review Journal*, is published quarterly by the Defense Acquisition University (DAU) Press and is an official publication of the Department of Defense. Postage is paid at the U.S. Postal facility, Fort Belvoir, VA, and at additional U.S. Postal facilities. Postmaster, send address changes to: Editor, *Defense Acquisition Research Journal*, DAU Press, 9820 Belvoir Road, Suite 3, Fort Belvoir, VA 22060-5565. The journal-level DOI is: https://doi.org/10.22594/dauARJ.issn.2156-8391. Some photos appearing in this publication may be digitally enhanced.

DEFENSE ACQUISITION RESEARCH JOURNAL
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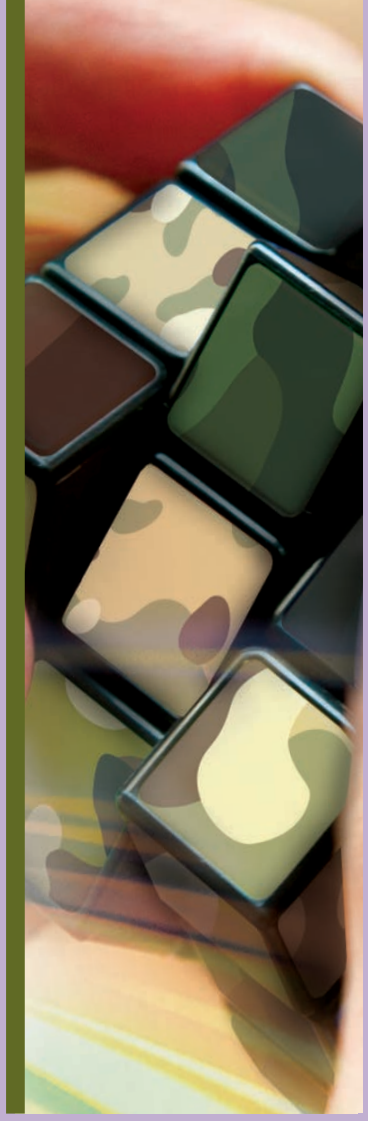

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COL Robert F. Mortlock, USA (Ret.)

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Justin F. Brunelle, Daniel Frisk, Benjamin Mayer, Paula Randall, and Awais Sheikh

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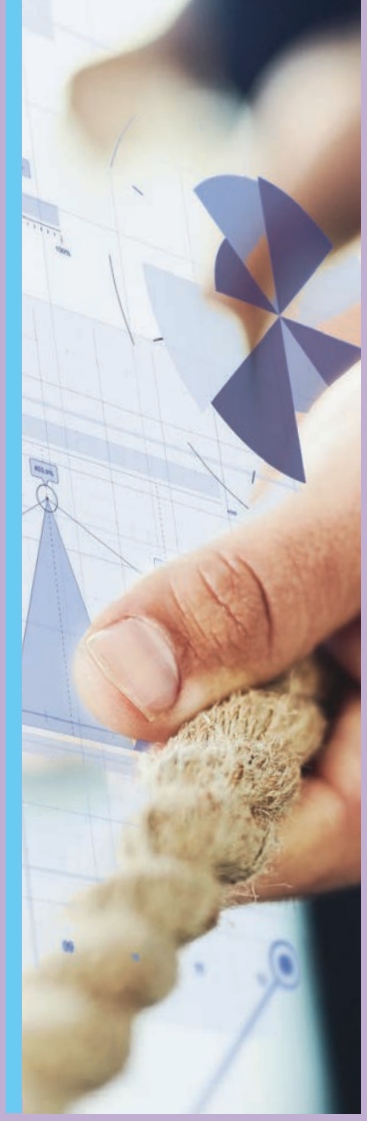

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Delivering Capability Through Competition in Defense Contracting: Does Policy Drive Results?

Lt Col Brian Duddy, USAF (Ret.), Lt Col Timothy Landucci, USAF, and Lt Col Julie A. Knechtel, USAF

As the largest federal obligator of contracted dollars, the Department of Defense (DoD) is rightly scrutinized over contractual spending. The results of this study highlight competition trends across DoD contracts, identify barriers, and inform recommendations to promote future competition.

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FROM THE CHAIRMAN AND EXECUTIVE EDITOR

Dr. Larrie D. Ferreiro

The theme for this issue is "Influencing Defense Acquisition," in recognition of the fact that this issue's papers were selected as winners of the 2020 Defense Acquisition Alumni Association (DAUAA) Hirsch Acquisition and Writing Competition, and celebrated in the annual ceremony "DAU Influencer Awards," which recognizes those who have made a significant contribution to DAU or the profession of acquisition. The three award winners were selected from a strong field of entrants.

The first-place winner, and recipient of the Jacques S. Gansler Award, is Robert F. Mortlock, for his paper "Camouflage Combat Uniform." This case history studies the Army's decision to change the camouflage pattern on combat uniforms. The case allows acquisition professionals to analyze the Army acquisition decision-making process, specifically focusing on skills in critical thinking, problem solving, resource management, stakeholder engagement, and strategic communication.

Second prize goes to Justin F. Brunelle, Daniel Frisk, Benjamin Mayer, Paula Randall, and Awais Sheikh, for "Measuring the Impact of Innovation Activities in Government." This paper presents the results

of a study on the current state of pursuing and measuring innovation in government, and provides recommendations for metrics based on the different types of innovation organizations.

Third prize goes to Brian Duddy, Timothy Landucci, and Julie Knechtel for "Delivering Capability Through Competition in Defense Contracting: Does Policy Drive Results?" This study reports competition trends across Department of Defense (DoD) contracts, which are the largest federal obligator of contracted dollars, then identifies barriers to that competition and makes recommendations to promote future competition.

This issue's Current Research Resources in Defense Acquisition focuses on Agile Software Development.

The featured work in the Defense Acquisition Reading List book review is *Call Sign Chaos: Learning to Lead* by Jim Mattis and Bing West, reviewed by David Riel.

Dr. Larrie D. Ferreiro
Chairman and Executive Editor
Defense ARJ

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Join the Success Network!

The DAU Alumni Association opens the door to a worldwide network of Defense Acquisition University graduates, faculty, staff members, and defense industry representatives—all ready to share their expertise with you and benefit from yours.

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- Stay connected to DAU and link to other professional organizations.
- Keep up to date on evolving defense acquisition policies and developments through DAUAA newsletters and the DAUAA LinkedIn Group.
- Attend the DAU Annual Acquisition Training Symposium and bimonthly hot topic training forums—both supported by the DAUAA—and earn Continuous Learning Points toward DoD continuing education requirements.
- Take advantage of scholarship opportunities for dependent graduating high school seniors of current members.

Membership is open to all DAU graduates, faculty, staff, and defense industry members. It's easy to join right from the DAUAA website at *www.dauaa.org*, or scan the following QR code:

For more information, call 703-960-6802 or 800-755-8805, or e-mail dauaa2@aol.com.

DAU CENTER FOR DEFENSE ACQUISITION

RESEARCH AGENDA 2020

This Research Agenda is intended to make researchers aware of the topics that are, or should be, of particular concern to the broad defense acquisition community in the government, academic, and industrial sectors. It is compiled using inputs from Subject Matter Experts (SMEs) across those sectors. These topics are periodically vetted and updated as needed to ensure they address current areas of strategic interest.

The purpose of conducting research in these areas is to provide solid, empirically based findings to create a broad body of knowledge that can inform the development of policies, procedures, and processes in defense acquisition, and to help shape the thought leadership for the acquisition community. These research topics should be considered guidelines to help investigators form their own research questions. Some questions may cross topics and thus appear in multiple research areas.

Potential researchers are encouraged to contact the DAU Director of Research (research@dau.edu) to suggest additional research questions and topics. They are also encouraged to contact the Point(s) of Contact (POC), who may be able to provide general guidance as to current areas of interest, potential sources of information, etc. Contact information for the POCs is available on the DAU Research website at ***https://www.dau.edu/library/research/p/Research-Areas***.

Affordability and Cost Growth

- Define or bound "affordability" in the defense portfolio. What is it? How will we know if something is affordable or unaffordable?
- What means are there (or can be developed) to measure, manage, and control "affordability" at the Program Office level? At the industry level? How do we determine their effectiveness?
- What means are there (or can be developed) to measure, manage, and control "Should Cost" estimates at the Service, Component, Program Executive, Program Office, and industry levels? How do we determine their effectiveness?
- What means are there (or can be developed) to evaluate and compare incentives for achieving "Should Cost" at the Service, Component, Program Executive, Program Office, and industry levels?
- Recent acquisition studies have noted the vast number of programs and projects that don't make it through the acquisition system and are subsequently cancelled. What would systematic root cause analyses reveal about the underlying reasons, whether and how these cancellations are detrimental, and how acquisition leaders might rectify problems?
- Do joint programs—at the inter-Service and international levels—result in cost growth or cost savings compared with single-Service (or single-nation) acquisition? What are the specific mechanisms for cost savings or growth at each stage of acquisition? Do the data lend support to "jointness" across the board, or only at specific stages of a program, e.g., only at Research and Development (R&D), or only with specific aspects, such as critical systems or logistics?
- Can we compare systems with significantly increased capability developed in the commercial market to Department of Defense (DoD)-developed systems of similar characteristics?
- Is there a misalignment between industry and government priorities that causes the cost of such systems to grow significantly faster than inflation?
- If so, can we identify why this misalignment arises? What relationship (if any) does it have to industry's required focus on shareholder value and/or profit, versus the government's charter to deliver specific capabilities for the least total ownership costs?

Industrial Productivity and Innovation

Industry insight and oversight

- What means are there (or can be developed) to measure the level of insight and/or control that government has over subcontractors?
- What means are there (or can be developed) to measure costs of enforcement (e.g., auditors) versus actual savings from enforcement?
- What means are there (or can be developed) to evaluate and compare incentives for subcontractor/supply chain competition and efficiencies?
- What means are there (or can be developed) to evaluate and compare market-based incentives with regulatory incentives?
- How can we perform institutional analyses of the behaviors of acquisition organizations that incentivize productivity?
- What means are there (or can be developed) to evaluate and compare the barriers of entry for SMEs in defense acquisition versus other industrial sectors?

- Is there a way to measure how and where market incentives are more effective than regulation, and vice versa?
- Do we have (or can we develop) methods to measure the effect of government requirements on increased overhead costs, at both government and industrial levels?
- Examine the possibilities to rationalize and balance the portfolio of capabilities through buying larger quantities of common systems/subsystems/components across Defense Agencies and Services. Are there examples from commercial procurement and international defense acquisition that have produced positive outcomes?
- Can principal-agent theory be used to analyze defense procurement realities? How?
- What means are there (or can be developed) to measure the effect on defense acquisition costs of maintaining the industrial base in various sectors?
- What means are there (or can be developed) of measuring the effect of utilizing defense industrial infrastructure for commercial manufacture, particularly in growth industries? In other words, can we measure the effect of using defense manufacturing to expand the buyer base?
- What means are there (or can be developed) to measure the breadth and depth of the industrial base in various sectors that go beyond a simple head count of providers?
- Has change in the industrial base resulted in actual change in output? How is that measured?

Independent Research and Development

- What means do we require to measure the cost-effectiveness or Return on Investment (ROI) for DoD-reimbursed Independent Research and Development (IR&D)?
- Can we properly account for sales and revenues that are products of IR&D?
- Can we properly account for the barriers to entry for SMEs in terms of IR&D?
- Examine industry trends in IR&D, for example, percentage of revenue devoted to IR&D, collaboration with academia. How do they vary by industry sector—in particular, those associated with defense acquisition?
- What means are there (or can be developed) to measure the ROI for DoD-reimbursed IR&D versus directly funded defense R&D?
- What incentive structures will motivate industry to focus on and fund disruptive technologies?
- What has been the impact of IR&D on developing disruptive technologies?

Competition

Measuring the effects of competition

- What means are there (or can be developed) to measure the effect on defense acquisition costs of maintaining an industrial base in various sectors?
- What means are there (or can be developed) for measuring the effect of utilizing defense industrial infrastructure for commercial manufacture, particularly in growth industries? In other words, can we measure the effect of using defense manufacturing to expand the buyer base?

- What means are there (or can be developed) to determine the degree of openness that exists in competitive awards?
- What are the different effects of the two best value source selection processes (tradeoff versus lowest price technically acceptable) on program cost, schedule, and performance?

Strategic competition

- Is there evidence that competition between system portfolios is an effective means of controlling price and costs?
- Does lack of competition automatically mean higher prices? For example, is there evidence that sole source can result in lower overall administrative costs at both the government and industry levels, to the effect of lowering total costs?
- What are long-term historical trends for competition guidance and practice in defense acquisition policies and practices?
- To what extent are contracts awarded noncompetitively by congressional mandate, for policy interest reasons? What is the effect on contract price and performance?
- What means are there (or can be developed) to determine the degree to which competitive program costs are negatively affected by laws and regulations such as the Berry Amendment, Buy American Act, etc.?
- The DoD should have enormous buying power and the ability to influence supplier prices. Is this the case? Examine the potential change in cost performance due to greater centralization of buying organizations or strategies.

Effects of industrial base

- What are the effects on program cost, schedule, and performance of having more or fewer competitors? What measures are there to determine these effects?
- What means are there (or can be developed) to measure the breadth and depth of the industrial base in various sectors, that go beyond a simple head count of providers?
- Has the change in industrial base resulted in actual change in output? How is that measured?

Competitive contracting

- Commercial industry often cultivates long-term, exclusive (noncompetitive) supply chain relationships. Does this model have any application to defense acquisition? Under what conditions/circumstances?
- What is the effect on program cost performance of awards based on varying levels of competition: (a) “Effective Competition” (two or more offers; (b) “Ineffective Competition” (only one offer received in response to competitive solicitation; (c) “Split Awards” versus winner take all; and (d) “Sole Source.”

Improve DoD outreach for technology and products from global markets

- How have militaries in the past benefitted from global technology development?
- How/why have militaries missed the largest technological advances?

- What are the key areas that require DoD focus and attention in the coming years to maintain or enhance the technological advantage of its weapons systems and equipment?
- What types of efforts should DoD consider pursuing to increase the breadth and depth of technology push efforts in DoD acquisition programs?
- How effectively are DoD's global Science and Technology (S&T) investments transitioned into DoD acquisition programs?
- Are managers of DoD's applied R&D (i.e., acquisition program) investments effectively pursuing and using sources of global technology to affordably meet current and future DoD acquisition program requirements? If not, what steps could DoD take to improve its performance in these two areas?
- What are the strengths and weaknesses of DoD's global defense technology investment approach as compared to the approaches used by other nations?
- What are the strengths and weaknesses of DoD's global defense technology investment approach as compared to the approaches used by the private sector—both domestic and foreign entities (companies, universities, private-public partnerships, think tanks, etc.)?
- How does DoD currently assess the relative benefits and risks associated with global versus U.S. sourcing of key technologies used in DoD acquisition programs? How could DoD improve its policies and procedures in this area to enhance the benefits of global technology sourcing while minimizing potential risks?
- How could current DoD/U.S. Government Technology Security and Foreign Disclosure (TSFD) decision-making policies and processes be improved to help DoD better balance the benefits and risks associated with potential global sourcing of key technologies used in current and future DoD acquisition programs?
- How do DoD primes and key subcontractors currently assess the relative benefits and risks associated with global versus U.S. sourcing of key technologies used in DoD acquisition programs? How could they improve their contractor policies and procedures in this area to enhance the benefits of global technology sourcing while minimizing potential risks?
- How could current U.S. Government Export Control system decision-making policies and processes be improved to help DoD better balance the benefits and risks associated with potential global sourcing of key technologies used in current and future DoD acquisition programs?

Comparative studies

- Compare the industrial policies of military acquisition in different nations and the policy impacts on acquisition outcomes.
- Compare the cost and contract performance of highly regulated public utilities with nonregulated "natural monopolies" (e.g., military satellites, warship building).
- Compare contracting/competition practices between DoD and complex, custom-built commercial products (e.g., offshore oil platforms).
- Compare program cost performance in various market sectors: highly competitive (multiple offerors), limited (two of three offerors), or monopoly?
- Compare the cost and contract performance of military acquisition programs in nations having single "purple" acquisition organizations with those having Service-level acquisition agencies.

Acquisition of Services

Metrics

- What metrics are currently collected and available on services acquisition:
  - Within the Department of Defense?
  - Within the U.S. Government?
  - Outside of the U.S. Government?
- What and how much do these metrics tell us about services acquisition in general and about the specific programs for which the metrics are collected?
- What are the possible metrics that could be used in evaluating services acquisition programs?
  - How many metrics should be used?
  - What is the efficacy of each metric?
  - What is the predictive power of each metric?
  - What is the interdependence (overlap) between metrics?
- How do we collect data for services acquisition metrics?
  - What is being done with the data currently being collected?
  - Are the data being collected on services acquisition reliable?
  - Is the collection process affecting the data collected for services acquisition?
- How do we measure the impact of different government requirements on overhead costs and rates on services contracts?

Industrial base

- What is the right amount of contracted services for government organizations?
  - What are the parameters that affect Make/Buy decisions in government services?
  - How do the different parameters interact and affect government force management and industry research availability?
- What are the advantages, disadvantages, and impacts of capping pass-through costs, and how do they change with the value of the pass-through costs?
- For Base Operations and Support (BOS) contracts, is there a best size? Should large BOS contracts be broken up? What are the parameters that should be considered?
- In the management of large services contracts, what is the best organization? Is the System Program Office a good model? What parameters should be used in evaluating the advantages and disadvantages of an organization to manage large services contracts?
- What effect does strategic sourcing and category management have on small business if the small business is a strategic source or whether the small business is not a strategic source?
- Do the on-ramping and off-ramping requirements of some service contracts have an effect on the industrial base? If so, what are the impacts?

Industry practices

- What private sector business practices, other than maximizing profit, can the government effectively use to incentivize performance and otherwise improve business relationships with vendors?
- What are the best methods for evaluating different incentives to encourage small businesses to participate in government services contracts?
- What potential benefits can the government achieve from long-term supply chain relationships? What are the disadvantages?
- What benefits does industry get from the use of category managers and functional domain experts, and can the government achieve the same benefits?
- How can the government best capture, validate, and use demand management strategies?
- Are current services acquisition taxonomies comprehensive, or can they be improved?

Make/Buy

- What methods can best be used to define the cost value relationship in different classes of service contracts?
- Can we develop a method for determining the "should cost" of different services?
- Can we define and bound affordability of specific services?
- What are the characteristics of "inherently governmental" activities, and how can we evaluate the value of these services based on comparable characteristics in a competitive labor market?
- In services contracts, what are the inherent life-cycle costs, and how do we capture the life-cycle costs in make/buy decision making?
- In the case of government services contracting, what are the factors that contribute to less-than-optimum make/buy decision making?

Category management/strategic sourcing

- What effect does strategic sourcing/category management have on competition?
    - Effects on short term versus long term.
    - Effects on competition outside of the strategic sourcing/category management area of consideration.
- What metrics do different industries use for measuring the effectiveness of their supply chain management?
- Would the centralization of services acquisition contracts have measurable impacts on cost performance? Why or why not?
- What are the fundamental differences between the services taxonomy and the category management taxonomy, and are there means and good reasons to align the two taxonomies?

Contract management/efficacy

- What are the best ways to address the services parts of contracts that include both services and products (goods)?
- In the management of services contracts, what are the non-value-added tasks, and are there realistic ways to reduce the impact of these tasks on our process?

- When funds for services are provided via pass-throughs (i.e., from another organization), how are the requirements tracked, validated, and reviewed?
- Do Undefinitized Contract Actions have an effect on contractor pricing and willingness, or lack of willingness to provide support during proposal analysis?
- For multiaward, Indefinite-Delivery, Indefinite-Quantity (IDIQ)-type contracts, is there a method for optimizing the different characteristics (number of vendors, timelines, on-ramping, off-ramping, etc.) of these contracts?

Policy

- What current government policies inhibit alignment of contractors' approaches from aligning with the government's services acquisition programs?

Administrative Processes

- What means are there (or can be developed) to measure the efficiency and effectiveness of DoD oversight, at the Component, Service, and Office of the Secretary of Defense levels?
- What measures are there (or can be developed) to evaluate and compare the costs of oversight versus the cost savings from improved processes?
- What means are there (or can be developed) to empirically establish oversight process metrics as a basis for comparison? Can these be used to establish the relationship of oversight to cost/schedule/performance outcomes?
- What means are there (or can be developed) to study the organizational and governance frameworks, resulting in successful change management?
- To what extent (investment and performance) can scenario/simulations testing improve the delivery of complex projects?
- Is there a comparative statistical divergence between organizational honesty (reality) and contractual relationships (intent) in tendering?
- How does one formulate relational contracting frameworks to better account and manage risk and liability in a collaborative environment?

Human Capital of Acquisition Workforce

- What means are there (or can be developed) to measure ROI for acquisition workforce training?
- What elements of the Professional Military Education framework can be applied to the professionalization of the civilian defense acquisition workforce?
- What factors contribute to the management and successful delivery of modern complex project management, including performance over the project life cycle?
- What behavioral leadership characteristics can be commonly observed in successful complex projects, contrasted against unsuccessful complex projects?
- What is the functional role of talent management in building organizational sustainability, performance, and leadership?
- How do we create incentives in the acquisition workforce (management, career, social, organizational) that provide real cost reductions?

Defense Business Systems

Organizational structure and culture in support of Agile software development methodologies

- At the beginning of the Business Capability Acquisition Cycle (BCAC) process, various steps are used to ensure accurate requirements are thoroughly documented and supported throughout the software development life cycle. How can these documentation requirements and processes be streamlined to support more direct-line communication between the end-user and software engineers? What are the hurdles to implementing these changes and how are they overcome? What are the effects of these changes on the organization or agency?
- Regarding new starts, how can the BCAC be modified specifically to support Agile development? How are these changes advantageous or disadvantageous to the customer and organization? Would these changes be helpful or detrimental with R&D versus a concurrent design and engineering software project?
- Generally, readiness review briefings within the BCAC are used to determine if a project is at an acceptable state to go to the next step in the process. If software is developed and released to production within a single Sprint (potentially every 2 weeks), how are Test Readiness Reviews, Systems Requirements Reviews, and Production Readiness Reviews handled? How have the changes to these events made them more or less relevant?
- How are organizations and agencies structured to support concurrent software design and development? What organizational structure would support R&D and non-R&D information technology (IT) capabilities?
- What steps are used to choose Agile as the default software development process versus any other software development methodology (e.g., Waterfall, Spiral, or Incremental) for your organization? What are the effects on project cost, schedule, and performance?
- Within DoD agencies and military branches, has the adaption of Agile resulted in faster deployment of new IT capabilities to the customer? How is this determined and measured?
- Industry often produces software using Agile. The DoD's BCAC process can be a process that produces an abundance of bureaucracy counter to Agile principles. How does hiring a contractor to implement or maintain IT capabilities and introducing Agile software development methods within a BCAC non-Agile process create conflict? How are these conflicts resolved or reconciled?
- How is IT engineering investment and innovation supported throughout DoD? What organizational or cultural aspects of an agency are specific to that support?

Defense Acquisition and Society

- To what extent should the DoD use the defense acquisition process to effectuate various social policies? The existing procurement regime favors a dizzying array of private interests ranging from organized labor; domestic manufacturers and firms located in areas of high unemployment; small businesses, including disadvantaged and women-owned firms; blind, severely handicapped, and prison industries; and, most recently, environmentally friendly vendors. Affirmatively steering the government's business from the open marketplace to preferred providers adds complexity, thus increasing transaction costs throughout the procurement process, which absorbs scarce resources. (Source: IBM Center for the Business of Government, http://www.businessofgovernment.org)

- How significant are the transaction costs resulting from the administration's commitment to transparency (generally, and specifically in the context of stimulus or recovery spending)? In a representative democracy, transparency is critical. But transparency is expensive and time-consuming, and the additional resources required to comply with the recently enhanced disclosure standards remain an unfunded mandate. Thus, the existing acquisition workforce must devote scarce resources to an (admittedly legitimate) end other than the pursuit of value for money or customer satisfaction. Is there an optimal balance or a point of diminishing returns? In other words, at what point does the cost of developing transparent systems and measures exceed the benefits of that transparency? (Source: IBM Center for the Business of Government, http://www.businessofgovernment.org)

Potential authors are encouraged to peruse the DAU Research website (***https://www.dau.edu/library/research/p/Research-Areas***) for information on contacting the POC for each content area.


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We are currently soliciting articles and subject matter experts for the 2020-2021 *Defense Acquisition Research Journal (ARJ)* print year.

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For submissions, please contact the *Defense ARJ* managing editor at ***DefenseARJ@dau.edu*** and visit the *Defense ARJ* Submissions page at ***https://www.dau.edu/library/arj/p/Defense-ARJ-Submissions***

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ISSUE 94
OCTOBER 2020
VOL. 27 NO. 4

CAMOUFLAGE COMBAT UNIFORM

COL Robert F. Mortlock, USA (Ret.)

The development, testing, and fielding of combat uniforms for soldiers offer acquisition professionals an opportunity to analyze how programs progress through the U.S. defense acquisition system. This case centers on the U.S. Army's decision to change the camouflage patterns on combat uniforms and equipment for soldiers. The case is broadly applicable to project managers, business managers, engineers, testers, and logisticians involved in project management, while specifically targeting defense acquisition professionals. Emphasis is placed on the development of critical thinking and analysis skills in the areas of stakeholder management, resource management, and decision making in a complex environment. The case is developed in two distinct parts. Part I provides an analysis of the Army's development of a plan with an increased chance of success in meeting desired objectives. Part II analyzes how the Army decided to change the camouflage pattern on combat uniforms through an informed, knowledge-based process.

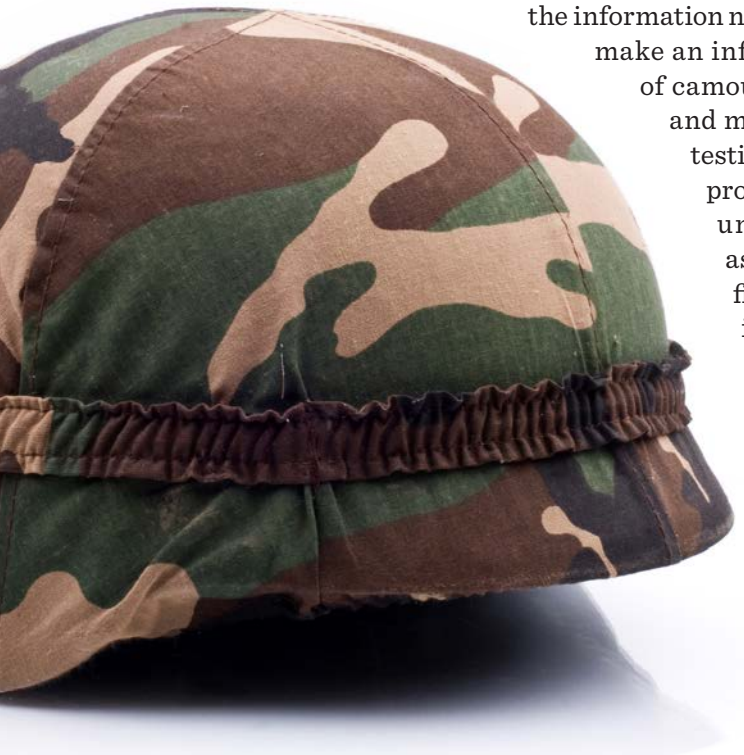
DOI: *https://doi.org/10.22594/dau.20-854.27.04*
Keywords: *Critical Thinking, Decision Making, Problem Solving, Stakeholder Engagement, Resource Management, Strategic Communication*

Image designed by Michael Bubar-Krukowski

The Situation, October 2013

The Army Program Manager for Soldier Protection and Individual Equipment (PM SPIE) sat in his office at Fort Belvoir in total disbelief as he read an email from the contracting officer stating that a contract for the Army to purchase the camouflage pattern had never actually been accepted by the contractor. The email came after the PM asked the contracting officer to send a copy of the signed contract. The contracting officer's response was delayed by several weeks because Department of Defense (DoD) agencies were resuming normal operations after being shut down (October 1–16), with most federal employees furloughed, because neither an appropriations act nor a continuing resolution was enacted for Fiscal Year (FY) 2014. On the Friday afternoon before the shutdown, the contracting office reported the successful award of a contract to a commercial vendor for its camouflage pattern, commercially known as MultiCam©. Because of significant Army senior leader and congressional interest, notification of the contract award was documented in Significant Activity Reports to the Chief of Staff of the Army (CSA) and Secretary of the Army (SecArmy) levels.

Now, the PM faced the dilemma of how to notify Army senior leaders that the contract had not been awarded and that his team would have to develop options for the Army to consider going forward—both of these tasks were significant events considering the importance of the Army combat uniform (ACU) camouflage decision. The Army had completed the extensive combat uniform camouflage testing—testing that began in 2009 with reviews and a decision process that finally resulted in the selection of an acceptable camouflage pattern for ACUs. The PM started to consider all the information needed to help Army senior leaders make an informed decision: the importance of camouflage to soldier force protection and mission effectiveness, camouflage testing basics, the history of the testing program, the status of soldier combat uniforms, and the affordability aspects of the decision. First things first—the PM asked his deputy to immediately draft a notice to inform senior leaders that the previously announced award of the contract was premature.



Background

It's Only Camouflage—How Important Can It Be on the Modern Battlefield?

The protection of American soldiers in combat was a top priority for senior leaders in the U.S. Army, the DoD, and Congress. The DoD committed considerable resources and funding over the years to research and development, resulting in advanced materials and manufacturing processes. These investments increased the combat effectiveness of soldiers and their units. The force protection of soldiers was considered as a layered approach. The outer force protection layer for soldiers was situational awareness. The inner force protection layer was personal protective equipment, like helmets and ballistic vests with ceramic plate inserts. The middle force protection layer was concealment. Camouflage on combat uniforms remained the most important contribution to the overall concealment of individual soldiers on the battlefield.

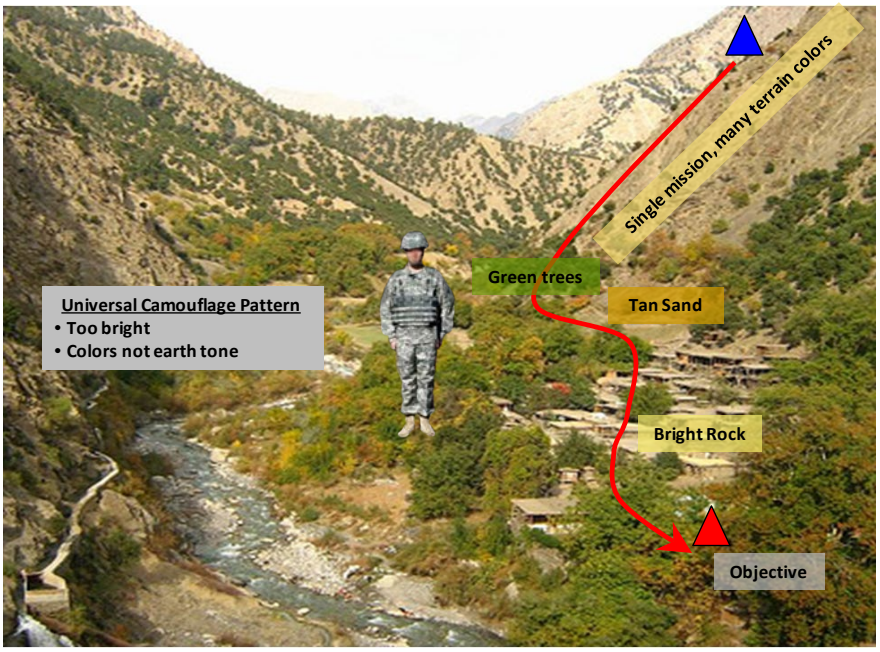
"Anecdotal evidence from soldiers on the importance of camouflage came from recounted combat missions in which they were close enough to the enemy to hear conversations without being seen—particularly during night operations.

Reinforcing the importance of camouflage was the result of postcombat surveys from soldiers deployed to Iraq and Afghanistan, in which the majority of soldiers indicated that better camouflage on combat uniforms contributed to increased combat effectiveness. Anecdotal evidence from soldiers on the importance of camouflage came from recounted combat missions in which they were close enough to the enemy to hear conversations without being seen—particularly during night operations. This contributed to the dominance of U.S. soldiers and the "we own the night" tactical advantage of U.S. forces. Basically, the enemy cannot kill what they cannot see. Effective combat uniform camouflage remained a significant combat multiplier for soldiers, thus increasing mission accomplishment.

Army soldiers in Afghanistan faced diverse battlefield operating environments in combat operations (Figure 1).[1] During a single mission, soldiers faced many different terrains across various environmental backgrounds. Each of these environmental backgrounds contained different earth-tone colors, which required different matching earth-tone colors

in the combat uniform to effectively conceal a soldier from detection or observation. Soldiers who wore combat uniforms and equipment with the universal camouflage pattern (UCP), a three-color digital pattern adopted by the Army in 2005, did not effectively blend into the diverse backgrounds typical during combat missions. The UCP colors were not earth-tone and were generally too bright—making soldiers easy to detect and providing ineffective concealment.

FIGURE 1. WHY THE U.S. ARMY NEEDED A DIFFERENT CAMOUFLAGE PATTERN

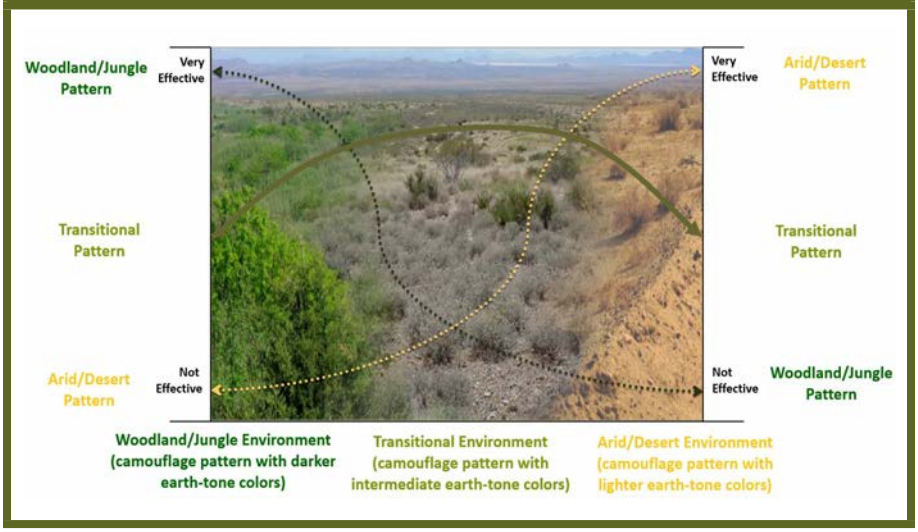


Note. Adapted from PM SPIE, personal communication, April 11, 2013.

The Army faced a critical question with respect to providing soldiers with effective camouflage on combat uniforms and equipment—how many camouflage patterns should be adopted? Soldiers operating in diverse operating environments had proven that the most effective camouflage pattern matches the colors of the background environment. A "chameleon" camouflage pattern eluded the Army due to low technological maturity level—basically, it was just not feasible to have a combat uniform with chameleon camouflage that would change color on its own to fit into its environment. Logistical and affordability considerations limited the Army from adopting a specific camouflage pattern for every combat environment. The Army settled on a strategy considering three camouflage patterns—one suited for the woodland/jungle environments, one suited for desert/arid environments, and a transitional pattern suited for most other environments.

In support of the combat uniform camouflage effort, the Army initiated an assessment of terrain throughout the globe. The Army Corps of Engineers classified the Army military operating environments across the combatant commands as 44% transitional, 37% woodland/jungle, and 19% desert/arid environments (PM SPIE, personal communication, April 11, 2013).[2] A woodland camouflage pattern would be very effective against backgrounds of darker brown and green colors and ineffective in dry arid regions (Figure 2).[3] On the other hand, a desert camouflage pattern would be very effective against backgrounds of lighter tan/sand colors and ineffective in woodland/jungle terrains. Finally, a transitional camouflage pattern would provide reasonable concealment against a broad range of environmental backgrounds. Seasonal considerations broke down the woodland/jungle and transitional backgrounds even further to dormant (without leaves on trees) and verdant (with leaves on trees) classifications.

FIGURE 2. EFFECTIVENESS OF CAMOUFLAGE PATTERNS IN DIFFERENT ENVIRONMENTS



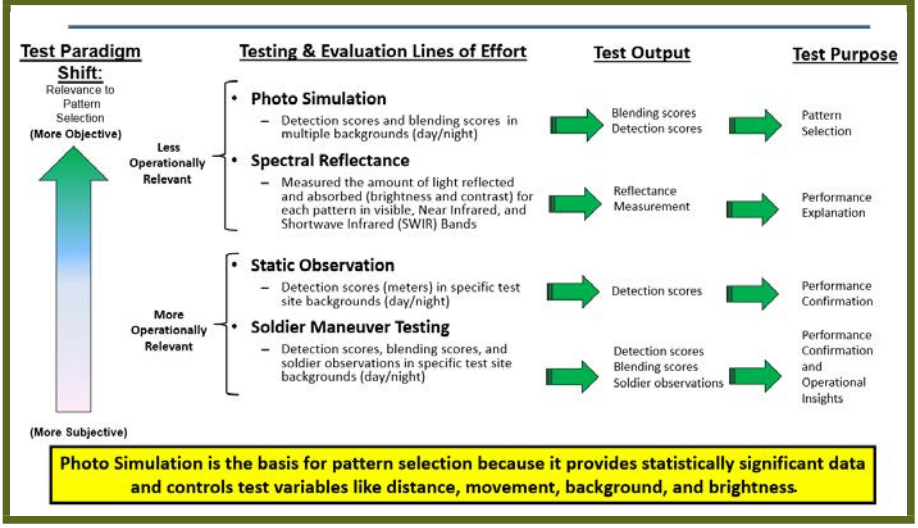
Note. Adapted from PM SPIE, personal communication, April 11, 2013.

Camouflage Testing Basics

The Army recognized that advancing the science of combat uniform camouflage testing was vitally important to enabling knowledge-based decisions on the most effective camouflage pattern. It further acknowledged that it was unaffordable to field-test various camouflage patterns in every possible environment and background. To gain a statistically robust data set to support decision making, the Army developed a test and evaluation strategy that involved a paradigm shift (Figure 3).[4] The strategy leveraged four mutually supporting lines of effort. Technical development testing

consisted of photo simulation for pattern selection and spectral reflectance measurements for performance insights. Operational field testing with soldiers consisted of static observation tests for pattern performance confirmation and maneuver tests for both pattern performance confirmation and operational insights.

FIGURE 3. CAMOUFLAGE TEST AND EVALUATION STRATEGY



Note. Adapted from PM SPIE, personal communication, April 11, 2013.

Normally, operationally realistic field testing carried the most weight in decision making over less operationally realistic developmental testing, which might rely on modeling and simulation. For camouflage testing, however, a much more extensive data set could be obtained if computer-based testing techniques were used in which soldiers observed photos of soldiers in camouflaged uniforms in many different backgrounds representing the Army's diverse military operating environments. The main effort for the test and evaluation strategy centered on the use of photo simulation to compare the effectiveness of camouflage patterns.

Two different criteria existed to compare the effectiveness of camouflage: detection and blending. Camouflage testing determined detection and blending scores for various camouflage patterns in relevant military operating environments. Detection is the ability to pick out the camouflage pattern measured at different distances, and blending is how well the camouflage pattern matches the background once detected at a specific range. Photo simulation evaluations allowed for collection of significant data in many backgrounds and controlled variables (such as distance,

movement, background, and brightness), so the difference in detection and blending scores could be attributable to different camouflage patterns (U.S. Army Natick Soldier Research, Development and Engineering Center [NSRDEC], 2009). The word "simulation" referred to the fact that the technique simulated soldiers being outside at the various sites by looking at computer screens displaying photos of soldiers in camouflage uniforms. Camouflage pattern selection criteria were based on both detection scores (at ranges up to 450 meters during the day and to 250 meters at night) and blending scores (at 50 meters during the day and at 25 meters during the night).[5] (Refer to Appendix A for a more detailed explanation of combat uniform testing basics.)

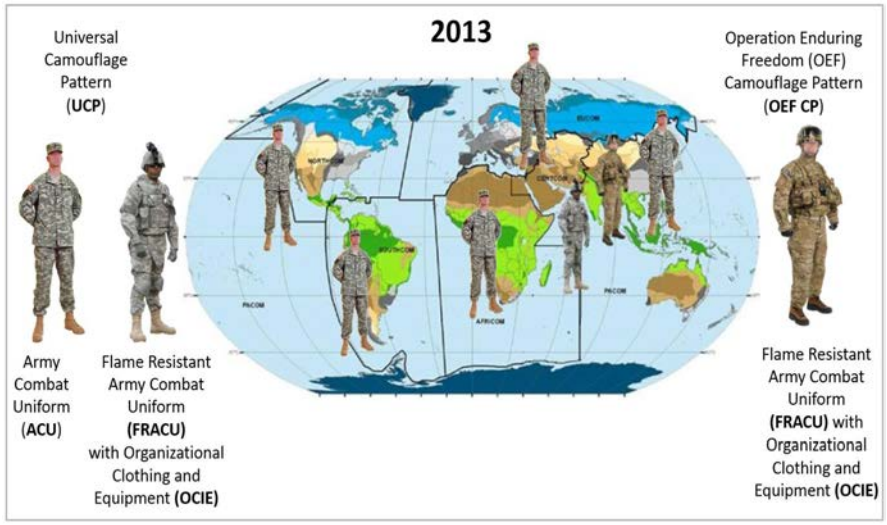
Basic Overview of Army Combat Camouflage Uniforms

After basic initial entry training, the Army issues uniforms and other essential combat equipment to soldiers. This was classified as organizational clothing and individual equipment (OCIE) and was generally referred to as the soldier's clothing bag. Part of this issue to soldiers was the ACU. The ACU was the uniform that soldiers wore in daily garrison operations when not deployed to combat operations. The ACU fabric was a 50-50 mix of cotton and nylon, and it came with the UCP, selling in the Military Clothing Store for about $90 for a coat and trouser set (PM SPIE, personal communication, July 15, 2014).[6] After their clothes wore out, soldiers used their clothing replacement allowance to buy new sets of uniforms. Examples of OCIE included the seven-layer, generation III extended cold weather clothing system (ECWCS), the field pack or rucksack (part of the modular lightweight load-carrying equipment [MOLLE]), and the ballistic vests (part of the improved outer tactical vest [IOTV])—all issued with the UCP.

Beginning in mid-2005, the Army recognized the importance of protecting soldiers from battlefield hazards and included specific uniform requirements for protection against insects (resulting in permethrin treatment) and fire (resulting in flame-resistant fabrics). When soldiers deployed to combat, the Army issued them the flame-resistant Army combat uniform (FRACU) with the UCP. The FRACU was made of 65% rayon, 25% para-aramid, and 10% nylon. The price of a FRACU set of coat and trousers averaged about $180 (PM SPIE, personal communication, July 15, 2014).[7] Additionally, soldiers received the flame-resistant environment ensemble (FREE)—the flame-resistant version of the ECWCS. Soldiers did not normally deploy with the clothing bag-issued ACU and ECWCS—those were for daily wear in garrison operations and in training. In 2011, the Army issued soldiers deploying to Afghanistan for Operation Enduring Freedom (OEF) the FRACUs and OCIE with the OEF camouflage pattern (OEF CP).

Figure 4[8] displays a pictorial representation of the uniforms soldiers would typically have worn in the summer of 2013 around the world. Soldiers wore the ACU with UCP in most regions of the world, except in the Middle East. Soldiers wore the FRACU with UCP when deployed to combat operations in Iraq and Kuwait, while soldiers supporting combat operations in OEF wore the FRACU in OEF CP.

FIGURE 4. COMMON OPERATION PICTURE FOR ARMY COMBAT UNIFORMS

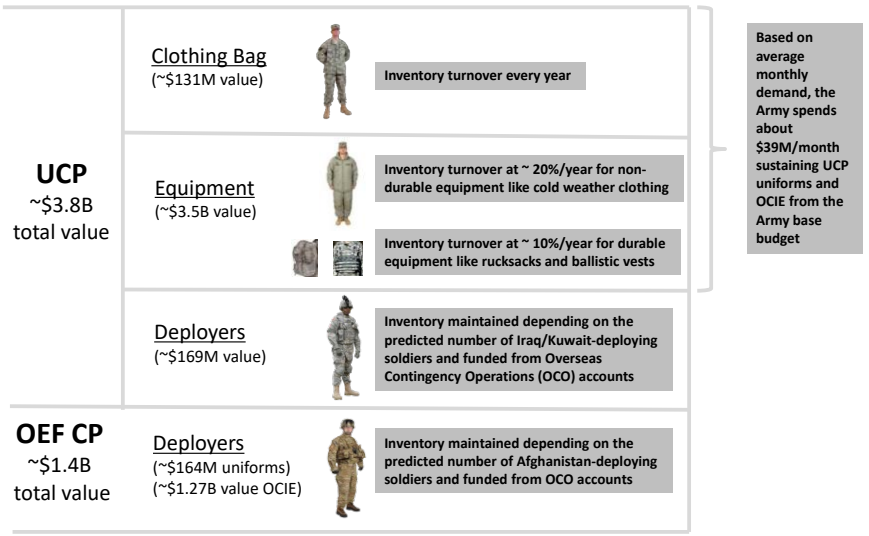


Note. Adapted from PM SPIE, personal communication, April 11, 2013.

The Army remained very cognizant of the value of the combat uniforms and OCIE worn by soldiers and in the inventory. For example, based on the number of active, reserve, and National Guard soldiers, both nondeployed and deployed, the ACUs worn by soldiers in their clothing bags are valued at about $131 million and turn over every year (PM SPIE, personal communication, May 2, 2014).[9] The value of OCIE worn by soldiers or in inventory with UCP totaled about $3.5 billion and turned over every 5 to 10 years, depending on the durability of the items (PM SPIE, personal communication, May 2, 2014).[10] Soldiers deploying to Iraq and Kuwait had another $170 million worth of UCP uniforms and OCIE (PM SPIE, personal communication, May 2, 2014).[11] Uniforms and OCIE with the UCP totaled over $3.8 billion in value (Figure 5).[12] To support soldiers deploying to Afghanistan, the Army maintained uniforms and OCIE with the OEF CP, with a value of about $1.4 billion. Based on the average monthly demand, the Army spent approximately $39 million per month sustaining UCP uniforms

and OCIE from the Army base operations and maintenance (O&M) budget for an Army of approximately 1 million soldiers (active, guard, and reserve components) (PM SPIE, personal communication, May 2, 2014).[13]

FIGURE 5. VALUE OF CAMOUFLAGE ARMY COMBAT UNIFORMS AND EQUIPMENT



Note. Adapted from PM SPIE, personal communication, May 2, 2014.

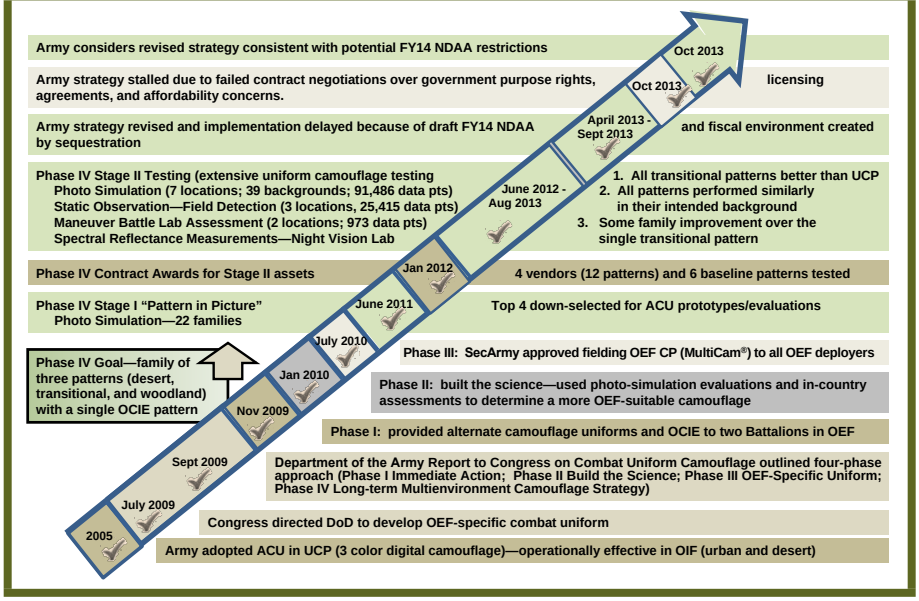
Army Combat Uniform Evolution

Figure 6[14] presents a brief recent history of ACUs since the adoption of the ACU with the UCP. In 2005, the Army adopted the ACU to replace the battle dress uniform (BDU) with the woodland camouflage pattern and desert camouflage uniform (DCU) with the desert camouflage pattern. The ACU was produced with the UCP—a digital pattern of three colors (urban gray, desert sand, and foliage green; U.S. Army NSRDEC, 2005). The Army wanted a single combat-uniform design with a single camouflage pattern. Field camouflage tests at Fort Lewis, Washington, the National Training Center at Fort Irwin, California, and the Joint Readiness Training Center at Fort Polk, Louisiana, confirmed the following (U.S. Army NSRDEC, 2004):

- In woodland environments, the ACU was equally effective as the BDU.
- In a desert environment, the ACU was as close to effective as the DCU.
- In an urban environment, the ACU was equally effective as the BDU or DCU.

Additionally, in camouflage blending tests (day and night) using photo simulation techniques, UCP provided the best average performance across desert, woodland, and urban environments compared to 10 other patterns. These patterns were the U.S. Marine Corps (USMC) marine pattern-desert (MARPAT-D), marine pattern-woodland (MARPAT-W), Scorpion (a pattern developed under a contract with the Army), desert brush, desert track, desert/urban track, standard desert (DCU), woodland track, standard woodland (BDU), and woodland brush (U.S. Army NSRDEC, 2004). The Army's decision to adopt a digital pattern (UCP) was influenced by the success of the USMC digital patterns—MARPAT-W and MARPAT-D. Ultimately, in testing, UCP provided better or equal concealment than other patterns in urban and desert terrains—obviously very important to the Army embroiled in combat operations in Iraq.

FIGURE 6. ARMY CAMOUFLAGE UNIFORM TIMELINE



Note. Adapted from PM SPIE, personal communication, April 16, 2013.

After the adoption of the ACU in 2005 and until 2009, the Army received overwhelmingly negative feedback from soldiers in combat operations in Afghanistan about the suitability of the FRACUs in UCP for the diverse Afghan backgrounds, terrains, and environments (Figure 1). As a result, in the FY 2009 Supplemental Appropriations Act, Congress directed the Army to take immediate action to provide effective camouflage for personnel deployed to Afghanistan (H.R. Rep. No. 111-151, 2009). In September 2009,

the Army submitted a Report to Congress on Combat Uniform Camouflage that outlined a four-phase approach: Phase I Immediate Action, Phase II Build the Science, Phase III OEF Specific Camouflage, and Phase IV Army Combat Uniform Decision for a Long-term Multienvironment Camouflage (Office of the SecArmy, 2009).

In November 2009, the Army completed Phase I by fielding two Army battalions (approximately 2,000 soldiers) with uniforms and OCIE in two different patterns. One camouflage pattern was universal camouflage pattern-Desert (UCP-D)—a variant of UCP with coyote brown color added and less sand color—and the other pattern was commercial camouflage called MultiCam©. MultiCam©—a seven-color pattern that was in use at the time with U.S. Special Forces in Afghanistan—was a variation of the original Scorpion pattern considered by the Army earlier in the UCP decision (U.S. Army NSRDEC, 2012).

From November 2009 to January 2010, the Army conducted Phase II, which involved soldier feedback of the two fielded patterns (MultiCam© and UCP-D), as well as photo simulation (pattern-in-picture) evaluations by soldiers of six camouflage patterns—UCP, MultiCam©, UCP-D, Mirage, Desert Brush, and a Navy pattern referred to as Area of Responsibility 2 (AOR2), which encompassed temperate/tropical forested terrain regions inserted into photographs of eight different OEF sites (U.S. Army NSRDEC, 2012). Soldiers overwhelmingly preferred both MultiCam© and UCP-D, with an edge in preference toward MultiCam©. The photo simulation involved assessments of both the detectability (range at which the pattern was detected) and blending performance (qualitative measure of how well the pattern blended into background). MultiCam© was harder to detect and blended slightly better than the other five camouflage patterns.

In February 2010, initiating Phase III, the Army selected MultiCam© as the pattern to be used on the FRACU and OCIE for deploying soldiers to Afghanistan. The Army named the commercially available MultiCam© pattern as the OEF CP. Because schedule and speed of delivery were critical, the Army encouraged separate licensing agreements between the MultiCam© commercial vendor and the companies that printed the OEF CP on fabric used for FRACUs and OCIE.

In July 2010, the Army began fielding uniforms and OCIE in the OEF CP to deploying OEF soldiers. The Army was not privy to the specifics of the licensing agreements. However, it ended up paying about a 10% premium on every uniform or piece of equipment that was camouflaged with OEF CP compared to every uniform or piece of equipment that was camouflaged with UCP (PM SPIE, personal communication, December 19, 2013).[15]

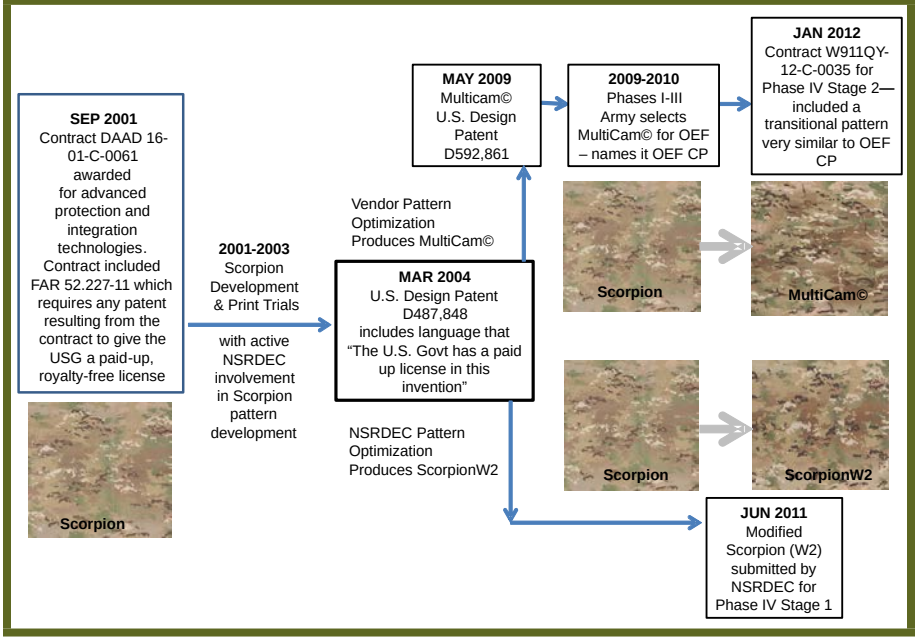
At the time, scheduling and the fielding of updated camouflaged uniforms and equipment as quickly as possible trumped affordability concerns, especially considering that uniforms for combat operations in Afghanistan were funded by overseas contingency operations (OCO) accounts without the restrictions contingent on the Army's base budget.

In December 2010, the Maneuver Center of Excellence (MCoE) outlined an 18-month-long competitive effort to lead a camouflage integrated product team through the Phase IV effort for the Army's selection of the long-term combat uniform and OCIE camouflage strategy to be effective in desert/arid, transitional, and woodland/jungle environments. The goal was to present the results to Army leadership in the fall of 2012 for a decision.

From January to June 2011, the Army scoped the Phase IV camouflage effort. Based on work performed by the NSRDEC and completed in 2009, the Army knew that environmentally specific camouflage patterns outperformed (meaning provided more effective concealment) than a single "universal" pattern (Hepfinger et al., 2010). The objective of Phase IV was to develop a "family" of three uniform camouflage patterns with a single coordinated pattern for OCIE to provide effective concealment across the globe in woodland/jungle, transitional, and desert/arid environments. A total of 22 family submissions from industry and the government competed in the first stage of Phase IV—18 family submissions were found to be technically acceptable (PM SPIE, personal communication, July 15, 2014).[16] These families of patterns were evaluated to determine blending scores using photo simulation techniques. The patterns were judged based on the best legacy patterns in the DoD inventory (desert versus a Navy pattern called Area of Responsibility 1, or AOR1 [desert/arid terrain regions], transitional versus OEF CP, and woodland versus a Navy pattern called AOR2), with family scores weighting the woodland, transitional, and desert environments.

Five families of patterns (four commercial vendors and one NSRDEC submission) performed as well as or better than the legacy family of patterns (PM SPIE, personal communication, July 15, 2014).[17] It is noteworthy that three patterns were visually similar in appearance: OEF CP (a baseline pattern), the transitional pattern proposed by one of the vendors, and the transitional pattern submitted by NSRDEC named ScorpionW2. Each of these patterns was developed, changed, and optimized independently from the same base pattern called Scorpion—a pattern developed by a commercial vendor in the early 2000s under contract with the U.S. Army. Figure 7[18] depicts relationships and differences between the Scorpion, MultiCam© (OEF CP), Phase IV transitional, and ScorpionW2 camouflage patterns.

FIGURE 7. TIMELINE OF SCORPION PATTERN DERIVATIVES



Note. Adapted from PM SPIE, personal communication, May 2, 2014. Govt = government; USG = U.S. Government.

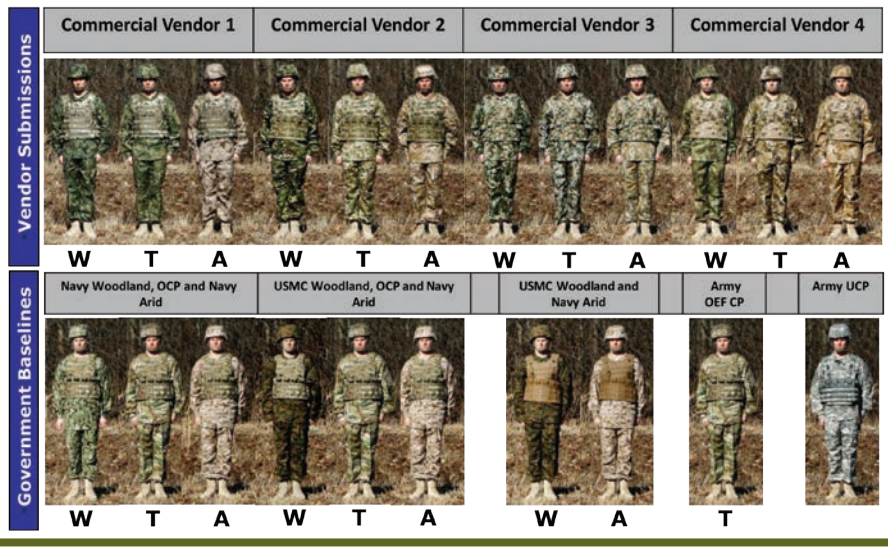
All three patterns performed similarly in testing, which served as a built-in, internal verification of the validity of the testing. At the time, even though the NSRDEC family performed well in source selection photo simulation testing, the Army decided not to continue to allow the NSRDEC family of patterns to participate in Stage II Phase IV testing. It was determined that the family of patterns lacked consistent matching geometric shapes—one of the Army criteria in the contracts with the four commercial vendors.

In January 2012, Phase IV contracts were awarded to the four down-selected vendors to produce fabric for test articles (both uniforms and OCIE) for the second stage of Phase IV. This stage included field testing, extensive photo simulation evaluations, and lab testing. Each of the four vendors had firm fixed price (FFP) contracts, with periods of performance not to exceed 30 months, to supply the Army with 1,000 yards of fabric. This would be used by the Army to fabricate test uniforms and OCIE under separate "cut & sew" contracts (U.S. Army Contracting Command, 2012a, 2012b, 2012c, 2012d). Included in the contracts were FFP options for the government to procure the nonexclusive license rights for each of the proposed camouflage patterns.

The competitive range to buy the license rights from the four vendors for a single camouflage pattern ranged from $25,000 to $2.1 million (U.S. Army Contracting Command, 2012a, 2012b, 2012c, 2012d). Each of the four vendors signed a nonexclusive license agreement that provided the Army the option to obtain (for a single lump sum) the rights to use the material for the production of patterns for printing on an unlimited number of uniforms, individual equipment, and unit-level equipment for U.S. Government purposes (i.e., Army, Navy, Marine Corps, Air Force, and Coast Guard, including their active and reserve components) excepting foreign military sales with successive renewable 10-year periods (U.S. Army Contracting Command, 2012a, 2012b, 2012c, 2012d).

From July 2012 to March 2013, the Army conducted the most extensive uniform camouflage testing ever undertaken. The 12 commercial vendors' patterns (each of the four vendors had a woodland, transitional, and desert pattern along with a matching transitional OCIE pattern) and six reference patterns (UCP, OEF CP, MARPAT-W, MARPAT-D, AOR1, and AOR2) were printed on fabric, and the fabric was assembled into uniforms and OCIE (Figure 8).[19]

FIGURE 8. PHASE IV CAMOUFLAGE PATTERNS TESTED



Note. **W** refers to woodland, **T** refers to transitional, and **A** refers to arid. Adapted from PM SPIE, personal communication, April 11, 2013.

The photo simulation evaluations collected 91,486 data points in detection and blending tests (both day and night) using 39 different backgrounds from seven global locations. Field tests for static observation detections were conducted at three different locations, resulting in the collection of an additional 25,415 data

points (Hanlin et al., 2013). Operational field tests with force-on-force soldiers were conducted at two locations, gathering another 973 data points. Finally, the spectral reflectance measurements were conducted by the U.S. Army Night Vision Laboratory (now the U.S. Army Night Vision and Electronic Sensors Directorate) to assess pattern "brightness" in visual, near infrared (NIR), and short wave infrared (SWIR) bands.

"From July 2012 to March 2013, the Army conducted the most extensive uniform camouflage testing ever undertaken.

The results of this extensive testing showed that all the vendor patterns in their intended backgrounds performed better than UCP—confirming the Army's intent to replace UCP (Mazz & Rowe, 2013). All the vendor patterns performed similarly in their intended backgrounds—this "tight shot" group gave the Army many options and confirmed that overall pattern colors and brightness were much more important than pattern design when assessing concealment effectiveness. Slight improvement was evident in the effectiveness of a family of patterns in their intended backgrounds over the performance of a single transitional pattern across the three background classes; however, the operational relevance of this improved performance proved difficult to quantify.

In May 2013, Army senior leaders approved the expanded use of OEF CP outside of OEF and the purchase of nonexclusive government license rights to one of the competing vendors' patterns (the transitional pattern that was very similar and visually indistinguishable from OEF CP), which was offered as an option in one of the Phase IV contracts. Because all of the vendor patterns performed similarly in testing, the decision was based on other considerations, primarily affordability—the Army could leverage existing inventories of OEF CP OCIE and reduce the overall implementation costs to the Army.

However, the announcement of the decision and implementation was delayed. Army senior leaders hesitated to announce a uniform change decision during a time of intense budget pressure and with the threat of sequestration looming. More importantly, the draft FY2014 National Defense Authorization Act (NDAA) was released, and it potentially limited the Army's camouflage flexibility by prohibiting any new camouflage patterns unless all Services adopted the new pattern. At the time, it was unclear whether the camouflage patterns tested in the Phase IV effort would potentially violate the NDAA restrictions.

In August 2013, to avoid the threat of protests by Phase IV vendors and subsequent lengthy contractual challenges, and to avoid potential violations of the new statutory restrictions in the pending NDAA, the Army changed its contracting strategy. Instead, it pursued a sole-source contract for the nonexclusive license rights (i.e., government purpose rights) to OEF CP and delayed exercising any remaining Phase IV contract options until the FY14 NDAA language was final. The vendor indicated to the Army that the price for OEF CP would be similar to the price offered to the Army for the transitional pattern nonexclusive license rights in the Phase IV contract (PM SPIE, personal communication, August 11, 2013).[20]

"The results of this extensive testing showed that all the vendor patterns in their intended backgrounds performed better than UCP—confirming the Army's intent to replace UCP (Mazz & Rowe, 2013).

In October 2013, the vendor balked at the terms of the contract proposed by the Army for OEF CP. The contract terms for the nonexclusive license rights were identical to the Phase IV contract option terms. The vendor now wanted considerably more money for its OEF CP transitional pattern than the terms specified in the Phase IV contract option.

Part I: Path Forward, Development of a Strategy, Fall 2013

All this information swirled around in the PM's head as he prepared to meet in the Pentagon with Army senior leaders. Fortunately for the PM, the CSA's office wanted the following points to be specifically addressed in the meeting scheduled for December 2013:

- How did this happen? What was the impact of the pending NDAA restrictions, and how would the Army keep Congress informed? What was the impact on the Phase IV contracts?
- What was the schedule and path toward an Army decision? What were the camouflage options, as well as key program and testing events, considering the performance, cost, and schedule implications?
- What were the risks associated with this camouflage decision?

Based on the guidance from leadership, the PM and his team put together some options for the Army to consider (PM SPIE, personal communication, January 29, 2014)[21]:

- Option 1: Continue to negotiate with the vendor for the nonexclusive rights for OEF CP. The initial price quoted started at $65 million, but it was later reduced to a lump sum of $24 million or 1% royalty on the price of each camouflaged uniform or piece of equipment.
- Option 2: Exercise the Phase IV contract option for nonexclusive rights to a transitional pattern.
- Option 3: Renegotiate all the Phase IV contract options for the nonexclusive rights for the patterns with all four vendors and try to select a pattern after the renegotiations.
- Option 4: Take a strategic pause and consider existing government patterns and patterns in which the government has license rights—for example, the NSRDEC pattern ScorpionW2.

The PM asked his team if there were any other options and what the decision criteria would be to compare these courses of action. Performance of the patterns remained the Army's most important criteria. However, cost/affordability was important, as well as schedule, congressional considerations (adherence to law), and litigation considerations such as the chance of protests and lawsuits challenging intellectual property rights to potential patent, copyright, and trademark issues.

The PM realized this would not be an easy set of meetings at the Pentagon. Despite the importance of combat uniform camouflage, efforts to change camouflage faced similar challenges that all programs within the DoD faced: a complex, bureaucratic, defense acquisition institution. (Refer to Appendix B for a description of the defense acquisition institution.) Any decision to change Army camouflage crossed multiple chains of command with different decision makers because it affected both uniforms and equipment. Uniform changes were approved by the CSA—and sometimes the SecArmy, if there was intense congressional, public, or media interest—after an approval recommendation from the Army Uniform Board. But camouflage also went on OCIE, and each piece of soldier kit (cold weather clothing, rucksacks, weapons, bags for night vision sights, etc.) had a different program decision maker—either a program executive officer (PEO) or the Army Acquisition Executive (AAE), depending on the acquisition category. The PM labored

over how to pull together this information to enable an informed decision and what recommendation he would make when invariably asked by Army senior leaders.

Analysis of the Army's Decision, Part I

The following section provides an analysis of how the Army made its decision. The discussion is framed by addressing key management considerations for the program management team as they prepared senior Army leaders to make the most informed decision possible.

In the general area of stakeholder management/engagement, identification of the key stakeholders and analysis of their concerns were essential. The following were the key stakeholders:

- Warfighters/Soldiers wanted camouflage uniforms to provide effective concealment in all military operating environments. Soldiers were not concerned with affordability at the Army level but were concerned about uniforms' costs when they must buy replacement uniforms. Performance was a critical decision criterion from the soldier perspective.

- Army Leadership/Decision Maker/CSA/SecArmy served as the decision authority and approved the path forward. Uniform changes must all be reviewed by the Army Uniform Board, which then made a recommendation to the CSA. In the case of uniform camouflage, the SecArmy was involved because of the sensitivity of this topic with Congress, the media, and the American public. The uniform was essentially the public face of the Army. The Army wanted to ensure that any uniform changes, particularly camouflage, were done for the right reasons, that is, to increase combat effectiveness and improve soldier protection; and that these uniform changes were executed in a fiscally responsible manner—especially at a time of budget austerity with the threat of sequestration looming. The perception of a frivolous uniform change would not pass the "*Washington Post* test" and could be a public affairs quagmire. This led to performance, cost/affordability, legal/contractual considerations, congressional considerations, and public perception considerations being important decision criteria.

- Congress wanted to support the warfighter with improved uniforms. Congress also supported the Army with resources (funding) but was concerned about the proliferation of different

combat camouflage uniforms across the Services—so much so that the NDAA restricted the adoption of new camouflage patterns unless all Services adopted the new pattern. The Army needed to ensure that Congress was well informed through required reports, hearings, and testimonies so that Congress could properly perform its crucial defense oversight mission.

- The PM ultimately was responsible for the uniform camouflage program cost, schedule, and performance. The PM had to remain neutral—trying not to advocate for any particular option so that the other stakeholders and, ultimately, senior Army leaders had ownership of the program, decision, and path forward. The PM was charged with delivering improved uniforms for soldiers as soon as possible within performance and cost constraints; and with acting as the key information source about consequences with respect to performance and cost/affordability, as well as the second-order effects of legal/contractual, public perception, and congressional implications.

The ultimate decision maker for the camouflage effort was unclear. A change in camouflage affected not only uniforms but all camouflaged soldier equipment across the Army. Typically, there would be a single decision authority for an acquisition program. For uniforms, the Army Uniform Board made a recommendation to the CSA for final approval; however, the SecArmy pulled the decision to his level. For each separate piece of equipment (that happened to be camouflaged), an assigned PM was responsible for cost, schedule, and performance. Those PMs reported to a PEO, who reported to the Assistant Secretary of the Army for Acquisition, Logistics and Technology. The bottom line is that the camouflage PM needed to get a decision from the highest levels of Army leadership and then coordinate that decision with multiple chains of command throughout the Army.

A paradigm shift required Army senior leaders to accept that the less realistic photo simulation testing was much more relevant for the selection of a camouflage pattern than more realistic field testing. It was counterintuitive, but necessary to recognize in this case. The performance of the camouflage patterns was measured in terms of detection and blending scores. These scores depended directly on important variables like the actual camouflage pattern (the colors and geometric shapes), distance, movement, lighting, and backgrounds. Field testing was extremely limited because it was nearly impossible to tightly control all the variables so that

the differences in detection and blending scores were attributed only to the change in the camouflage patterns and not to one of the other variables. Photo simulation allowed for testing in many backgrounds and tightly controlled other variables like movement, distance, and lighting, so that any change in blending or detection performance was attributed to the change in camouflage pattern. Photo simulation allowed testers to collect a statistically robust sample set.

Despite the logic in this strategy, senior Army leaders remained uncomfortable when the field testing from one specific site contradicted the photo simulation results. The PM had to build a foundation of trust so that senior leaders not only understood the strategy but accepted it and overcame the institutional barriers and cultural resistance to change.

The Army considered the following options (PM SPIE, personal communication, January 29, 2014)[22]:

- Option 1: Continue to negotiate for the nonexclusive rights for OEF CP.
- Option 2: Exercise the Phase IV contract option for nonexclusive rights for the transitional pattern.
- Option 3: Renegotiate all the Phase IV contract options for the nonexclusive rights for the patterns with all four vendors and try to select a pattern after the renegotiations.
- Option 4: Take a strategic pause and consider existing government patterns and patterns in which the government has license rights—for example, the NSRDEC pattern ScorpionW2.

To compare the options and ultimately decide on a path forward, the Army developed decision criteria. Unfortunately, PMs had no standard, formalized decision-making model or process to follow that was uniformly applied and accepted within the DoD. Some projects may be supported by a business case analysis or a cost-benefit analysis. But in this case, there was not enough information to perform these types of analyses because the benefits were qualitative and difficult to monetize. The decision was made by comparing (listing advantages and disadvantages) alternative options (or courses of action) against decision criteria. To fairly evaluate the various courses of action, discriminating decision criteria were defined. These criteria were derived from the constraints, considerations, and stakeholder concerns.

Clearly, the warfighter was most concerned with performance. However, all the options involved camouflage patterns that provided better performance than the current UCP in use, and all the camouflage patterns performed similarly. Therefore, a performance criterion was nondiscriminating. The Army decided the path forward based on the following: cost/affordability, schedule, adherence to the NDAA, and the potential for litigation. Using these criteria, the options were compared by listing the advantages and disadvantages of each option. Each criterion showed up as an advantage or disadvantage for each option. Table 1[23] lists the pros and cons of each option.

TABLE 1. PART I OPTION COMPARISON

Options	Pros	Cons
Option 1: Negotiate for nonexclusive rights for OEF CP ($24M or 1% royalty)	• Schedule (testing completed) • Adherence to the NDAA • Litigation risk is low/moderate (from contract protests)	• Cost/Affordability ($24M is above the competitive range established in the Phase IV contracts, and a 1% royalty would add a bill of $390K/month to the already overextended Army base budgets in perpetuity)
Option 2: Exercise existing Phase IV contract option for nonexclusive rights to transitional pattern ($200K)	• Schedule (testing completed)	• Cost/Affordability (less costly than Option 1 but unknown recurring license fees) • Adherence to the NDAA • Litigation risk is high (from contract protests)
Option 3: Readdress the Phase IV contracts of all four vendors with clarified contract clauses	• Litigation risk is low (from contract protests)	• Cost/Affordability (unknown) • Schedule (for contract negotiations) • Adherence to the NDAA
Option 4: Pursue existing government patterns to which the government has rights	• Cost/Affordability • Adherence to the NDAA	• Schedule (testing not completed) • Litigation risk is moderate (from intellectual property and patent challenges)

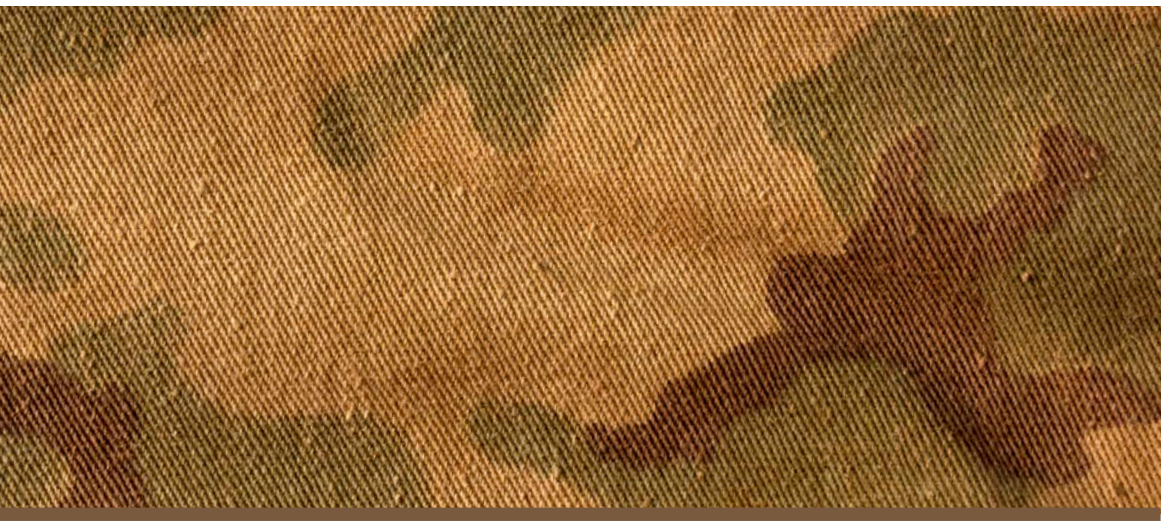
Note. Adapted from PM SPIE, personal communication, January 29, 2014.

Just using this comparison approach, the Army found it difficult to determine which option was best. Comparing the options using a decision criterion in a decision matrix allowed the options to be qualitatively ranked against one another. For each criterion, the options were ranked from best to worst with scores from 1 to 4 (1 being the best and 4 being the worst). An average score was used for options that scored the same for a criterion. Table 2 presents the decision matrix that helped the Army determine the path forward.

TABLE 2. PART I DECISION MATRIX

Decision Matrix (Qualitative Ranking of Options)						Option Scores (Lower is Better)	
Options \ Criteria		Cost / Affordability	Schedule	NDAA Adherence	Litigation Risk	unweighted	weighted
	Criteria Weighting -->	3	1	2	1		
Negotiate for OEF CP rights	unweighted ranking -->	4	1.5	1.5	2	9	
	weighted ranking -->	12	1.5	3	2		18.5
Phase IV contract for transitional pattern	unweighted ranking -->	2	1.5	3.5	4	11	
	weighted ranking -->	6	1.5	7	2		16.5
Renegotiate Phase IV contracts	unweighted ranking -->	3	3	3.5	1	10.5	
	weighted ranking -->	9	3	7	1		20
Pursue existing Government patterns	unweighted ranking -->	1	4	1.5	3	9.5	
	weighted ranking -->	3	4	3	3		13

Using the criteria of cost/affordability, schedule, NDAA adherence, and litigation risk, the unweighted rankings of the options scored similarly (scores from 9 to 11)—making selection of a recommendation difficult and confirming the results from the comparison of advantages and disadvantages. Weighting of the criteria allowed the scores of the options to separate based on the importance of the criteria to the decision. For example, schedule and litigation risk were not as important in this decision as cost/affordability and NDAA adherence. When cost/affordability was weighted three times as important and NDAA adherence was weighted two times as important as schedule and litigation risk, the option scores separated. This analysis forced decision makers to critically think about why a certain option was favored over other options.

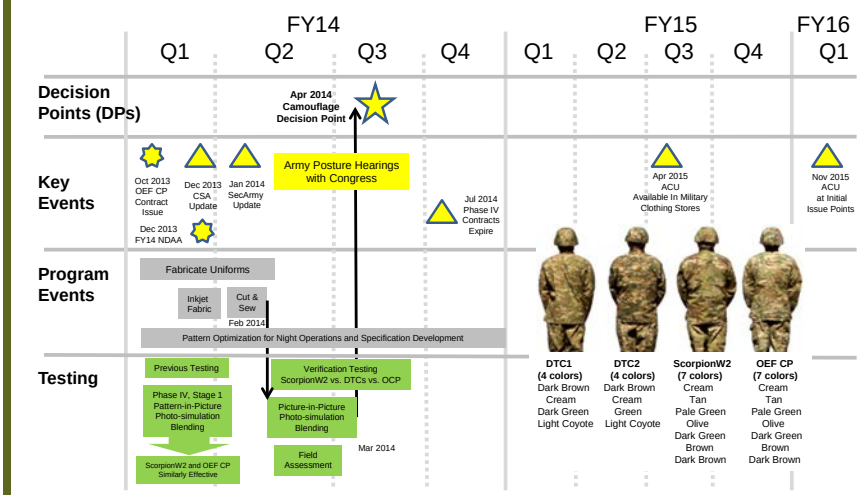


The Army chose Option 4 (take a strategic pause and consider existing government patterns and patterns in which the government has license rights); subsequently, a sensitivity analysis in which the weightings of the criteria were changed confirmed the Army's decision (PM SPIE, personal communication, January 29, 2014).[24] From this part of the case history, a key defense acquisition and program management lesson learned is not rushing to failure. The Army faced a complex and challenging problem but decided that it was best not to be schedule-driven and resolved against rushing a decision because the situation seemed urgent. In this part of the case, it was probably best for the Army to take a strategic pause to let the NDAA become final and allow time to test additional patterns for which the government had data rights.

Part II: Camouflage Decision, Winter 2013 to Spring 2014

Following a series of meetings in the Pentagon with Army senior leaders, the CSA issued the following guidance: delay any immediate decision, ensure that all options for the Army moving forward were rigorously tested, ensure that the options considered met the intent of the NDAA by pulsing congressional professional staff members, and provide an update to the SecArmy. The SecArmy subsequently approved the testing of transitional pattern alternatives for March 2014 with an anticipated decision pending successful and positive testing results in April 2014 (Figure 9).[25]

FIGURE 9. APPROVED REVISED ARMY PLAN



Note. Adapted from PM SPIE, personal communication, January 29, 2014.

After being reprimanded for lack of proper program oversight and damaging the reputation of Army acquisition leaders in the Pentagon, the PM led his team to execute another revised strategy for combat uniform camouflage testing. In December 2013, the FY14 NDAA became final and officially prohibited the Services from adopting new camouflage patterns unless all the Services adopted the new pattern (NDAA, FY 2014). This new law restricted the number of camouflage patterns considered going forward. The intent of the new strategy was to consider alternatives to OEF CP that provided equivalent or better performance, were affordable/fiscally responsible to implement, and complied with the FY14 NDAA. The testing included three baseline reference patterns (UCP, MARPAT-W, and MARPAT-D), OEF CP, and viable OEF CP alternatives. These alternatives were the ScorpionW2 pattern and two digital transitional camouflage patterns—referred to as DTC1 and DTC2—patterns based on USMCMARPAT but with four earth-tone-based colors (Figure 10).[26] The Army had a series of meetings with congressional members who sponsored the NDAA legislation and professional staff members who wrote the actual language to ensure the patterns considered were within the intent of the law. Congressional leaders considered the DTC1 and DTC2 patterns in a "gray area" of the new restrictions and were noncommittal regarding whether these patterns met the intent of the law. Nevertheless, the Army decided to test these patterns along with the other patterns.

FIGURE 10. PATTERNS TESTED BY THE ARMY AT FORT BENNING IN APRIL 2014

Note. Adapted from PM SPIE, personal communication, January 29, 2014.

In April 2014, the Army tested alternative transitional patterns at Fort Benning, Georgia, in operational field tests with U.S. Army Sniper School Cadre and in photo simulation assessments using soldiers from the 75th Ranger Regiment (Figures 11 and 12). The testing to support an Army

decision was rigorous and met the intent of the CSA. The testing used sniper experts to assess the operational relevance of the patterns in operational field tests and 106 soldiers as observers of the patterns in 46 separate backgrounds in photo simulation evaluations—collecting 19,474 data points (Lacey & Rogers, 2014; Mazz, 2014).

FIGURE 11. OPERATIONAL FIELD TEST RESULTS

Assessment Summary:

- 7 patterns, U.S. Army Sniper School cadre, 2 locations at Fort Benning, GA, on March 18, 2014
- Mostly dormant wooded and transitional terrains out to 695m
- Sensors included unaided eye and 10x binoculars—daytime visual only

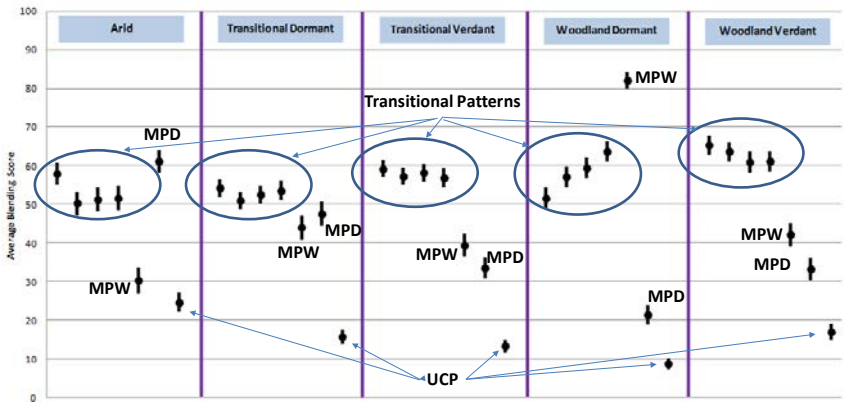
Observer Key Findings:

- After 300m, all the transitional patterns appeared the same with the naked eye. With binoculars, they were able to identify DTC2. This is mostly due to the color contrast in the pattern.
- DTC1, ScorpionW2, and OEF CP were said to be very similar; differences were difficult to detect.
- With binoculars, OEF CP, Scorpion, and DTC 1 rated higher than Woodland MARPAT and DTC2 at most stationary locations.

MARPAT Woodland (MPW)	MARPAT Desert (MPD)	UCP	DTC2	DTC1	ScorpionW2 (SCORP)	OEF CP
Performance was highly dependent on immediate background	Too bright throughout the assessment	Too bright throughout the assessment	High internal color contrast was evident more than others	Performance was similar to OEF CP and ScorpionW2	Performance was similar to OEF CP and DTC1	Performance was similar to DTC1 and ScorpionW2

Note. Adapted from Lacey & Rogers (2014); Mazz (2014).

FIGURE 12. PHOTO SIMULATION TEST RESULTS



Conclusions:

- UCP performed poorly in all five backgrounds.
- OEF CP, ScorpionW2, DTC1, and DTC2 scored similarly across all five backgrounds.
- USMC MARPAT Woodland performed well in the Woodland dormant backgrounds.
- USMC MARPAT Desert performed well in arid backgrounds.

Assessment Summary:

- Purpose: assess from a blending perspective the OEF CP, ScorpionW2, and DTC transitional uniform camouflage pattern candidates
- 7 patterns were assessed by 106 Soldiers from 3/75th Ranger Battalion Headquarters, Fort Benning March 30–April 2, 2014
- Pictures of Uniformed Individuals placed into 46 backgrounds; each photo viewed at least 57 times
- Total data points = 19,474

Note. Adapted from Lacey & Rogers (2014); Mazz (2014).

From the results shown in Figures 11 and 12, the Army came to the following conclusions: UCP performed poorly in all backgrounds (confirming prior results); OEF CP, ScorpionW2, DTC1, and DTC2 scored similarly across all background types; USMC MARPAT-W performed well in woodland dormant backgrounds; and USMC MARPAT-D performed well in arid environments. The results confirmed that there was a "tight shot" group for the effectiveness and performance of the transitional patterns. The Army decision came down to other considerations like affordability, cost, implementation and execution ease, schedule, contracting challenges, and intellectual property rights concerns (potential patent, trademark, and copyright challenges).

Again, the PM assembled his team to consider the following options for CSA and SecArmy to consider:

- Option 1: Do nothing. Make no decision at this time and continue the current situation of issuing soldiers UCP uniforms and equipment for all missions, except in Afghanistan where they would continue to get OEF CP uniforms and equipment.
- Option 2: Select OEF CP, accept the vendor's terms, and expand its use beyond Afghanistan as the standard pattern for all Army uniforms and equipment.
- Option 3: Select ScorpionW2 and replace worn-out UCP uniforms and equipment over time.
- Option 4: Select the DTC1 pattern and replace worn-out UCP uniforms and equipment over time.

The PM and his team considered these options the main courses of action for Army senior leaders. The team debated the following decision criteria to apply to these options: performance, schedule, affordability/cost, legal risk, and the perspectives of key stakeholders such as soldiers, Congress, the Marine Corps, and the media.

The PM prepared for another challenging set of meetings with Army senior leaders in the Pentagon. This would be the third time he attempted to get a decision on camouflage for Army uniforms and equipment. However, he knew that the decision was of utmost importance for soldiers in combat. Effective camouflage increases soldier combat effectiveness and improves force protection—saving soldiers' lives in battle. The PM thought about the decision in terms of return on investment (ROI). From 2009 to 2014 (over 6 years), the Army spent less than $10 million in the research, development, and testing of camouflage patterns, but a camouflage change would affect the purchase of $5.2 billion of uniforms and equipment over the next 5 to 10 years. The PM considered the research, development, and testing of camouflage patterns a wise investment for soldiers and for the American taxpayer.

Analysis of the Army's Decision, Part II

Countless Government Accountability Office (GAO) reports have documented waste of resources in the acquisition of particular DoD services and products. With respect to the combat camouflage uniforms specifically, a GAO Report entitled *Warfighter Support: DOD Should Improve Development of Camouflage Uniforms and Enhance Collaboration among the Services,*

highlighted the fragmented approach taken by the Army, Navy, Air Force, and Marine Corps to develop camouflage uniforms (GAO, 2012). The report stressed the potential for tens of millions of dollars of cost savings in the development, testing, logistics, and inventory control costs for combat uniforms. For the Army, the decision to change camouflage patterns on uniforms and equipment affected an approximate $5 billion inventory. The transition timeline involved up to 10 years as soldiers and the Army gradually replaced worn-out uniforms and equipment with the new camouflage uniforms and equipment. The appropriate question included the following: Is a $5 billion inventory change, over 10 years, worth a $10 million study over 6 years? What is the ROI? ($10 million/6 years)/($ 5,000 million/10 years) x 100% = ($1.67 million/year)/($500 million/year) x 100% = 0.334%. Would a private company spend less than 1% to get a significant financial decision correct? Obviously, this was not a typical ROI calculation because the future effort was used in place of a true "return," but it did put the $10 million research, development, and testing effort into perspective for its potential impact on a $5 billion decision.

Additionally, these types of calculations also did not account for the other benefits of improving camouflage, including increased mission effectiveness, improved force protection and safety, reduced casualties, and improved soldier confidence. Finally, the Army considered this question in terms of a project's total life-cycle costs (TLCC). For typical defense acquisition projects, the TLCC were about 10% in research, development, test, and evaluation (RDT&E) costs, 30% in procurement/production costs, and as much as 60% in operations and support (O&S) costs. For this camouflage effort, the TLCC split was <1% in RDT&E costs and >99% in combined procurement/production and O&S costs.

Within the DoD, soldier uniforms and equipment were procured with annual funding from Congress in the appropriations acts with what was called O&M dollars. These funds are appropriated annually and must be spent annually. The Army planned and submitted an annual budget request, which was approved by the Office of the Secretary of Defense and submitted to Congress as part of the President's budget. Congress used the President's budget request to write the annual appropriations act, which eventually was signed by the President and provided funding to the Army. This was all part of the Army's base budget, which remained fairly consistent over time. Separate from the base budget funding, Congress also appropriated OCO funds. These funds were not tracked as part of the DoD budget and were not subject to the constraints of sequestration or the Budget Control Act. This

funding was incredibly important because it funded war efforts around the globe, and it came with fewer strings attached and less oversight but also less transparency and accountability.

The Army decision to adopt OEF CP for Afghanistan operations was driven by performance and schedule. The Army needed to fix the camouflage issue as soon as possible. The soldier uniforms and equipment for Afghanistan operations came from OCO funds, which were plentiful. The Army accepted nearly 10% premiums for all camouflaged uniforms and equipment. Furthermore, only a subset of the entire Army force deployed to Afghanistan. On the other hand, the decision to change the camouflage pattern for all Army uniforms and equipment to be used in daily garrison operations must be funded through the base Army budget. The number of soldiers affected is 10 times higher, and adding an unfunded liability to the already strapped Army base budget was something that was studied to see if the benefits outweighed the costs.

Related to the source funding considerations was the fact that the Army was spending approximately $39 million per month to maintain the UCP inventory from its base budget (PM SPIE, personal communication, January 29, 2014).[27] If the Army were to expand the use of OEF CP beyond Afghanistan under the existing contractual and resulting fee arrangements, it would have added a $3.9 million monthly bill to the Army budget in perpetuity. Even a 1% fee of $390,000 per month was hard to justify in the base budget. From 2011 to 2014, the Army procured about $1.4 billion of OEF CP camouflaged uniforms and equipment. Moreover, it paid about $140 million in license fees for this inventory—a high number justified by the urgency of combat operations in Afghanistan and the availability of OCO funding. The OEF CP commercial vendor stated that it did not control the 10% premium paid by the Army. It further argued that other companies in the supply chain (prime contractors, fabric makers, "cut & sew" vendors) received most of the 10% premium. Eventually, the vendor guaranteed the Army a 1% royalty fee of camouflaged uniforms and equipment with OEF CP. However, if it did not control the fees the Army paid, it could not guarantee a 1% premium—an argument that didn't pass the common sense test for Army leaders (PM SPIE, personal communication, July 15, 2014).[28]

Important contractual and legal considerations complicated this decision as well. The Phase IV contracts were awarded by the Army in January 2012 and contained contract options that expired in July 2014 for the Army to purchase the nonexclusive license rights for each of the camouflage patterns (U.S. Army Contracting Command, 2012a, 2012b, 2012c, 2012d). The Army

thought that these options would allow the Army to print the patterns on an unlimited number of uniforms and equipment without paying licensing fees to the printers. However, the Army used nonstandard contract clauses and nonstandard licensing agreements in the Phase IV contracts, and legal reviews revealed that the contract options were not executable as written without a high risk of protests. Additionally, the FY2014 NDAA language prohibited the use of any of the Phase IV camouflage patterns unless all the Services adopted the new pattern, which was unlikely.

“Despite the logic in this strategy, senior Army leaders remained uncomfortable when the field testing from one specific site contradicted the photo simulation results.

The Army tried to buy the nonexclusive license rights to OEF CP in September 2013, using the same licensing agreement previously agreed upon for the similar Phase IV transition pattern. However, when vendors realized that they would no longer be getting the licensing fees, they balked at the terms of the agreement and eventually offered the Army the OEF CP pattern for a lump sum of $24 million or 1% end-product royalty fees (PM SPIE, personal communication, January 29, 2014).[29] This situation left the Army unsure about exactly what they were getting for their money.

The Army decision to reconsider the ScorpionW2 pattern presented intellectual property infringement concerns. In the early 2000s, the Scorpion pattern was developed under contract with the Army (U.S. Army NSRDEC, 2005). The vendor later received a patent for the Scorpion pattern. The Scorpion pattern was under consideration by the Army when UCP was adopted. UCP was favored because it was a digital pattern and performed particularly well in desert/arid and urban environments.

Independent from the Army, the same vendor produced the MultiCam© pattern from the Scorpion pattern and received a patent for MultiCam©—first used by some U.S. Special Forces in Afghanistan. In 2011, the Army adopted the MultiCam© pattern for all Army soldiers deploying to Afghanistan. The vendor then established licensing agreements with the camouflage printers of MultiCam©. The Army called MultiCam© the OEF CP. Subsequently, a similar pattern was submitted as a transitional pattern in the Phase IV contracts. In the Phase IV contracts, the vendor offered the Army nonexclusive license rights to the transition pattern for $200,000 (U.S. Army Contracting Command, 2012c). Independently, the U.S. Army

Research, Development and Engineering Center at the Natick Soldier Center produced a pattern called ScorpionW2 from the Scorpion pattern. ScorpionW2 was submitted as an Army, government-owned pattern for a transitional pattern in the Phase IV camouflage improvement effort. It is important to note that the OEF CP, the vendor Phase IV transitional pattern, and the ScorpionW2 pattern were all developed from the base Scorpion pattern, and all are visually indistinguishable. The testing showed that the patterns performed similarly. When the Army announced its decision to consider the ScorpionW2 pattern, its OEF CP vendor indicated potential issues with their existing licensing agreements with printers, as well as concerns with potential patent and copyright infringement—presenting the Army with high legal risk for the ScorpionW2 option.

The Army considered the following options:

- Option 1: Do nothing. Make no decision at this time and continue the current situation of issuing soldiers UCP uniforms and equipment for all missions, except in Afghanistan where they would continue to get OEF CP uniforms and equipment.
- Option 2: Select OEF CP, accept the vendor's terms, and expand its use beyond Afghanistan as the standard pattern of all Army uniforms and equipment.
- Option 3: Select ScorpionW2 and replace worn-out UCP uniforms and equipment over time.
- Option 4: Select a DTC1 pattern and replace worn-out UCP uniforms and equipment over time.

The Do Nothing option was considered to ensure the Army was not headed on the "Road to Abilene." The OEF CP, ScorpionW2, and DTC options were certainly viable. To be viable, the alternatives needed to be consistent with the Army camouflage improvement history and the general cost, schedule, and performance constraints. Options like restarting the competition were not considered because the Phase IV effort had just resulted in the best options that commercial industry had to offer. High-technology solutions like "chameleon" camouflage were not considered because these solutions were decades away from being mature.

For this decision, the Army compared the options using the following decision criteria: performance, schedule, cost/affordability, soldier/media perspective, congressional perspective, legal risk, and USMC perspective. Improving the concealment of soldiers remained a top priority for the Army,

which eliminated the Do Nothing option as a realistic option, and that option was subsequently eliminated from consideration. The remaining three options all had patterns that performed similarly in testing; therefore, the performance criterion was nondiscriminating. The remaining three options had similar implementation schedules; thus, schedule was also a nondiscriminating criterion.

The Army considered the advantages, disadvantages, and second-order implications of various courses of actions for the path forward. Table 3 summarizes the pro and cons of each of the three options. The OEF CP option had strong support from soldiers and the media and adhered to the NDAA constraints; the USMC had no issues with this option. With respect to disadvantages, this option had significant long-term unfunded liabilities and a high risk of legal battle. The ScorpionW2 option had advantages of affordability and low cost, adherence to the NDAA, and no USMC opposition. On the con side, soldier and media support was less than enthusiastic, and the legal risks were high. The DTC1 or DTC2 option was affordable with low cost and low legal risk as well. The cons of this option included negative reactions from soldiers and media still reeling from the UCP decision, an uncertain compliance with the intent of the NDAA, and strong USMC opposition.

TABLE 3. PART II OPTION COMPARISON

Options	Pros	Cons
Option 1: OEF CP	• Soldier/Media (strong support for OEF CP) • Congressional Perspective (adherence to the NDAA) • USMC perspective (no opinion)	• Affordability/Cost ($24M up-front cost or 1% royalty) • Legal risk is high (high likelihood and high win probability)
Option 2: ScorpionW2	• Affordability/Cost (no cost or royalty fees) • Congressional perspective (adherence to the NDAA) • USMC perspective (no opinion)	• Soldier/Media (lukewarm support because of the unknown) • Legal risk is high (high likelihood and high win probability)
Option 3: DTC1 or DTC2	• Affordability/Cost (no cost or royalty fees) • Legal risk is low (low likelihood and high win probability)	• Soldier/Media (negative because of the Army's UCP history) • Congressional perspective (adherence to the NDAA questionable) • USMC perspective (strong opposition)

From the comparison table alone, it remained unclear which option was preferred for the Army. To overcome this shortfall of a simple comparison listing advantages and disadvantages, the options were compared using

the decision criteria in a decision matrix. Table 4 presents the results of the Army decision matrix. Using the criteria of affordability/cost, soldier/media perspective, legal risk, congressional perspective, and USMC perspective, the unweighted rankings of the options indicated that the ScorpionW2 option was preferred, but the scores of the options were close. While affordability/cost was weighted three times as important, soldier/media perspective was weighted two times as important; congressional perspective was weighted two times more important than legal risk; and USMC perspective, the preferred option, remained the same. This type of analysis forced Army senior leaders to take an objective look at the comparison to either support their intuition or question why a particular option was preferred.

TABLE 4. PART II DECISION MATRIX

Decision Matrix (Qualitative Ranking of Options)							Option Scores (Lower is Better)	
Criteria / Options		Affordability/ Cost	Soldier/Media Perspective	Legal Risk	Congressional Persepctive	USMC Perspective	unweighted	weighted
	Criteria Weighting -->	3	2	1	2	1		
OEF CP	unweighted ranking -->	3	1	2.5	1.5	1.5	9.5	
	weighted ranking -->	9	2	2.5	3	1.5		18
ScorpionW2	unweighted ranking -->	1.5	2	2.5	1.5	1.5	9	
	weighted ranking -->	4.5	4	2.5	3	1.5		15.5
DTC1 or DCT2	unweighted ranking -->	1.5	3	1	3	3	11.5	
	weighted ranking -->	4.5	6	1	6	3		20.5

The second part of this case emphasized some key program management lessons learned. Even though performance and schedule were important considerations, the preferred option for the path forward was decided by other criteria. PMs and acquisition professionals in general must bring together the information for the most informed decision possible. In this case, the PM had to understand the affordability/cost implications, legal risk, and the perspectives of key stakeholders including Congress, soldiers, the USMC, and the media.

Conclusions/Epilogue

"The rest of the story" as Paul Harvey would say, or what the Army actually did, is presented not as the "right answer" but to provide closure. Many paths can lead to similar end results for acquisition development programs. The case study provided the epilogue to the first key decision on how the Army proceeded when the strategy hit the contracting barrier. For the second key decision point, the Army selected the ScorpionW2 pattern and named it the Operational Camouflage Pattern (OCP) to emphasize that the pattern's reach extended beyond Afghanistan to other Army military operating environments (Figure 13).

FIGURE 13. PICTURES OF THE OPERATIONAL CAMOUFLAGE PATTERN (OCP) ON THE ARMY COMBAT UNIFORM (ACU)

Because the four transitional patterns all tested similarly, the decision came down to other considerations. The digital patterns that were based on the USMC MARPATs were never seriously considered because Army senior leaders were concerned about the following three things: strict literal compliance to the restrictions in the Fiscal Year 2014 NDAA, the backlash from the USMC leadership (who did not favor the Army leveraging the MARPATs), and the soldier/public perception of the Army choosing another "digital" pattern after the tepid response to the UCP adoption. Because of affordability concerns, the OEF CP pattern (commercially known as MultiCam©) was not chosen. The Army accepted the 10% licensing fees on all camouflaged uniforms and equipment for Afghanistan in OEF CP because funding for Afghanistan operations came from OCO accounts and not from the Army's base budget funding. Transitioning the entire Army to a different camouflage pattern for use in both garrison and deployments was a completely different effort (orders of magnitude larger in scale) than fielding uniforms and equipment to soldiers for one particular operation. The Army was spending approximately $39 million per month maintaining uniforms and equipment of approximately 1 million active duty, reserve, and National Guard soldiers. When buying camouflaged uniforms and equipment, perpetual monthly licensing fees were deemed unaffordable. Choosing OCP resulted in soldiers' benefiting from an effective camouflage pattern and the nation benefiting from the best use of limited resources. The Army has continued to work on improving the force protection and concealment of soldiers through more effective camouflage for uniforms and equipment. Specifically, the Army is considering camouflage tailored for woodland/jungle and desert/arid military operating environments.

References

Government Accountability Office. (2012). *Warfighter support: DOD should improve development of camouflage uniforms and enhance collaboration among the Services* (Report No. GAO-12-707). https://www.gao.gov/products/GAO-12-707

Hanlin, S., Rogers, G., & Freeney, R. (2013, September). *Final report for Phase IV camouflage stage II pattern testing for army combat uniform (ACU)* (Report No. ATC-11250). Aberdeen Proving Ground, MD: U.S. Army Aberdeen Test Center.

Hepfinger, L. Stewardson, C., Rock, K., Kramer, F. M., McIntosh, S., Patterson, J., Isherwood, K., Lesher, L., Rogers, G., & Nguyen, H. (2010, November 29–December 2). *Soldier camouflage for Operation Enduring Freedom (OEF): Pattern-in-picture (PIP) technique for expedient human-in-the-loop camouflage assessment.* 27th Army Science Conference, Orlando, FL. https://apps.dtic.mil/sti/citations/ADM002341

H.R. Rep. No. 111-151 (2009). https://www.congress.gov/congressional-report/111th-congress/house-report/151

Lacey, D., & Rogers, G. (2014, June). *Addendum to the final report for the phase IV camouflage pattern testing, stage II pattern testing for the Army combat uniform (transitional alternatives)* (Report No. ATC-11250). Aberdeen Proving Ground, MD: U.S. Army Aberdeen Test Center.

Mazz, J. (2014, August). *Data analysis for the Army camouflage uniform improvement project: Phase IV, transitional pattern assessment* (Technical Report No. TR-2014-39). Aberdeen Proving Ground, MD: U.S. Army Materiel Systems Analysis Activity.

Mazz, J., & Rowe, P. (2013, July). *Data analysis for the Army camouflage uniform improvement project: Phase IV, Stage 2* (Technical Report No. TR-2013-39). Aberdeen Proving Ground, MD: U.S. Army Materiel Systems Analysis Activity.

Mortlock, R. (2016, October–December). *Transfer MDA from top-level OSD and Service officials and put it where it fits best: With the PEOs. Army AT&L*, 120–124. https://www.researchgate.net/publication/309458302_Transfer_MDA_from_top-level_OSD_and_service_officials_and_put_it_where_it_fits_best_with_the_PEOs

National Defense Authorization Act for Fiscal Year 2014, Pub. L. 113-66 § 352, 127 Stat. 742 (2013). https://www.congress.gov/113/plaws/publ66/PLAW-113publ66.pdf

Office of the Secretary of the Army. (2009, September). *Department of Army report to Congress on combat uniform camouflage.* Washington, DC: Author.

U.S. Army Contracting Command. (2012a). *U.S. Army camouflage improvement effort* [Contract Award No. W911QY-12-C0033]. U.S. Army Natick Contracting Division. http://www.fbodaily.com/archive/2012/01-January/12-Jan-2012/a-awd.htm

U.S. Army Contracting Command. (2012b). *U.S. Army camouflage improvement effort* [Contract Award No. W911QY-12-C0034]. U.S. Army Natick Contracting Division. http://www.fbodaily.com/archive/2012/01-January/12-Jan-2012/a-awd.htm

U.S. Army Contracting Command. (2012c). *U.S. Army camouflage improvement effort* [Contract Award No. W911QY-12-C0035]. U.S. Army Natick Contracting Division. http://www.fbodaily.com/archive/2012/01-January/12-Jan-2012/a-awd.htm

U.S. Army Contracting Command. (2012d). *U.S. Army camouflage improvement effort* [Contract Award No. W911QY-12-C0036]. U.S. Army Natick Contracting Division. http://www.fbodaily.com/archive/2012/01-January/12-Jan-2012/a-awd.htm

U.S. Army Natick Soldier Research, Development & Engineering Center. (2004, December 15). *Universal camouflage for the future force warrior* [PowerPoint slides]. Briefing prepared for International Soldier Conference and Exhibition. Natick, MA: Author.

U.S. Army Natick Soldier Research, Development & Engineering Center. (2005). *Development process of the universal camouflage for the future force warrior* (Technical Report No. Natick/TR-05/014L). Natick, MA: Author.

U.S. Army Natick Soldier Research, Development & Engineering Center. (2009). *Photosimulation camouflage detection test* (Technical Report No. Natick/TR-09/021L). https://soldiersystems.net/wp-content/uploads/2009/09/photosimulation-camouflage-detection-test.pdf

U.S. Army Natick Soldier Research, Development & Engineering Center. (2012). *Science supporting camouflage* (Draft Technical Report No. Natick/TR-12/022L). Natick, MA: Author.

Endnotes

[1] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2013, April 11). *Army camouflage decision brief* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Ibid.

[6] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2014, July 15). *Combat uniform camouflage effort* [Memorandum]. Fort Belvoir, VA.

[7] Ibid.

[8] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2013, April 11). *Army camouflage decision brief* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

[9] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2014, May 2). *Combat uniform camouflage update and decision brief* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

[10] Ibid.

[11] Ibid.

[12] Ibid.

[13] Ibid.

[14] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2013, April 16). *Army clothing update for SECARMY* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

[15] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2013, December 19). *Army phase IV camouflage update to the CSA* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

[16] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2014, July 15). *Combat uniform camouflage effort* [Memorandum]. Fort Belvoir, VA.

[17] Ibid.

[18] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2014, May 2). *Combat uniform camouflage update and decision brief* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

[19] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2013, April 11). *Army camouflage decision brief* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

[20] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2013, August 11). *Army phase IV camouflage update to SECARMY* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

[21] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2014, January 29). *Army phase IV camouflage update to SECARMY* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

[22] Ibid.

[23] Ibid.

[24] Ibid.

[25] Ibid.

[26] Ibid.

[27] Ibid.

[28] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2014, July 15). *Combat uniform camouflage effort* [Memorandum]. Fort Belvoir, VA.

[29] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2014, January 29). *Army phase IV camouflage update to SECARMY* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

[30] Program Manager Soldier Protection and Individual Equipment, Program Executive Office Soldier. (2013, April 11). *Army camouflage decision brief* [PowerPoint slides]. Briefing prepared for Army Senior Leadership. Washington, DC.

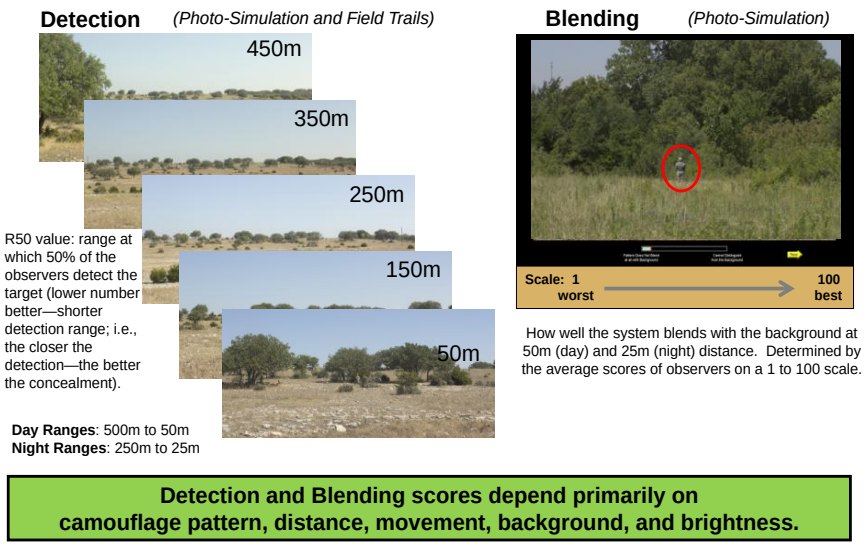
[31] Ibid.

APPENDIX A

Camouflage Testing Basics

Pattern testing and selection criteria were based on both detection (ability to detect the pattern at ranges out to 450 meters day and 250 meters night) and blending (ability to match the background environment at 50 meters in daylight and 25 meters at night) (Hanlin et al., 2013). Detection is the ability to pick up the camouflage pattern measured at different distances, and blending is how well the camouflage pattern matches the background once detected at a specific close range (Figure A-1).[30]

FIGURE A-1. CAMOUFLAGE PATTERN TESTING CRITERIA

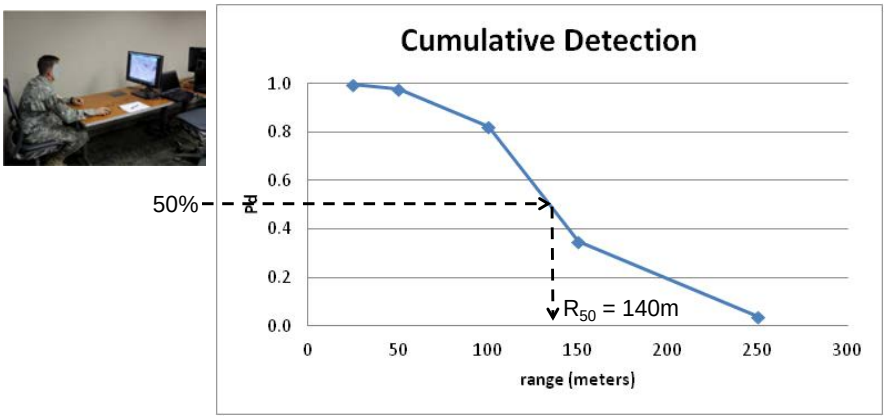


Note. Adapted from PM SPIE, personal communication, April 11, 2013.

Camouflage pattern testing used a combination of field trials and photo simulation evaluations. The field trials included day and night testing, squad-on-squad battle drill lanes, movement to contact drills, and individual soldier detection/acquisition at varying distances and varying soldier positions (prone, kneeling, and standing). The soldier photo simulation evaluations included feedback from soldiers who assessed the camouflage's detection and blending capability using calibrated images of uniformed individuals in arid, woodland, and transitional backgrounds. Photo simulation evaluations allowed for collection of significant data in many backgrounds. These evaluations also controlled variables (such as distance, movement, background, and brightness) so that change in detection and blending scores was only attributable to different camouflage patterns. The word *simulation* in this case really just means simulating soldiers being outside at the various sites by taking images of soldiers and

challenging other soldiers to detect them (Figure A-2).[31] Soldiers scored images of real camouflaged personnel in real outdoor scenes (day and night) on a computer monitor. Detection scores came in the form of R50 values, which is the range at which 50% of the observers detect the target (lower numbers are better, meaning shorter detection ranges—in other words, the closer the detection, the better the concealment) (U.S. Army NSRDEC, 2009).

FIGURE A-2. EXAMPLE PHOTO SIMULATION TEST AND TEST OUTPUT AND THE PROBABILITY OF DETECTION (PD) VS. DETECTION RANGE



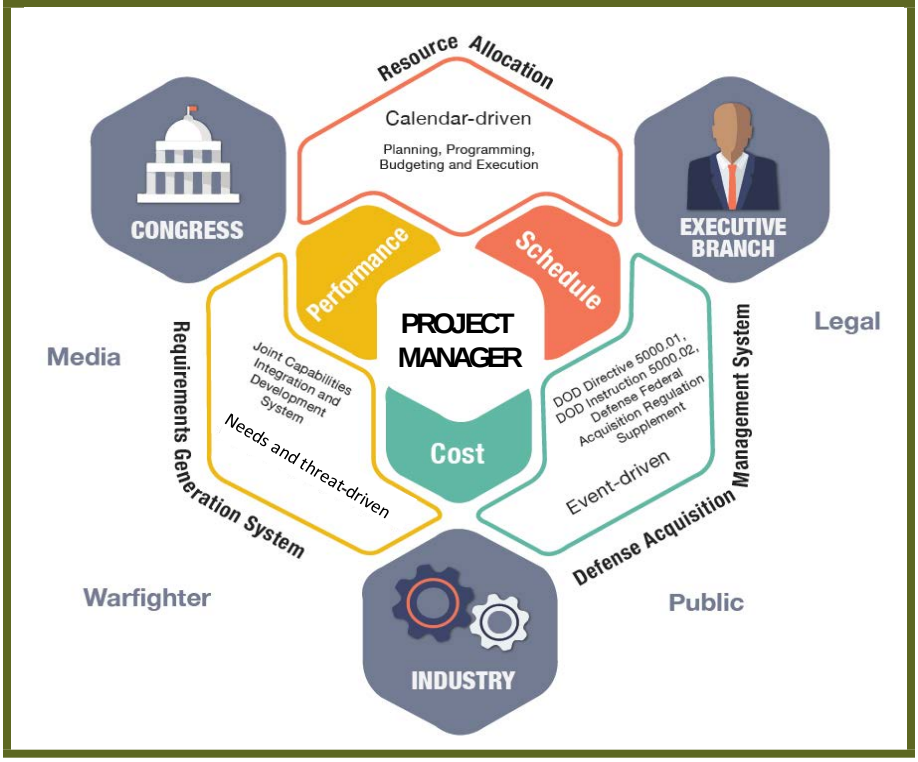
Note. Adapted from PM SPIE, personal communication, April 11, 2013.

APPENDIX B

U.S. Defense Acquisition Institution

Within the DoD, the development, testing, procurement, and fielding of capability for the warfighter operates within a complex decision-making framework. Within the private sector, similar frameworks exist. The U.S. defense acquisition institution has three fundamental support templates that provide requirements, funding, and management constraints. The executive branch, Congress, and industry work together to deliver capability, with the program manager (PM) as the central person responsible for cost, schedule, and performance. Figure B-1 depicts this framework.

FIGURE B-1. DEFENSE ACQUISITION INSTITUTION



Note. Adapted from Mortlock (2016).

The government PM is at the center of defense acquisition, which aims to deliver warfighter capability. The PM is responsible for cost, schedule, and performance (commonly referred to as the "triple constraint") of assigned projects—usually combat systems within the DoD. The executive branch of government provides the PM a formal chain of command in the DoD. The PM typically reports directly to a program executive officer, who reports to the Service Acquisition Executive (an

assistant secretary for that Service—either Army, Navy, or Air Force), who reports to the Defense Acquisition Executive (the Under Secretary of Defense for Acquisition and Sustainment). Depending on the program's visibility, importance, and/or funding levels, the program decision authority is assigned to the appropriate level of the chain of command.

Programs within defense acquisition require resources (for funding) and contracts (for execution of work) with industry. Congress provides the resources for the defense programs through the annual enactment of the Defense Authorization and Appropriations Acts, which become law and statutory requirements. The PM, through warranted contracting officers governed by the Federal Acquisition Regulation, enters into contracts with private companies within the defense industry. Other important stakeholders include actual warfighters, the American public, the media, and functional experts (like engineers, testers, logisticians, cost estimators, etc.), as well as fiscal and regulatory lawyers.

As a backdrop to this complicated organizational structure for defense PMs, there are three decision support templates: one for the generation of requirements, a second for the management of program milestones, and a third for the allocation of resources. Each of these decision support systems is fundamentally driven by different and often contradictory factors. The requirements generation system is driven primarily by a combination of capability needs and an adaptive, evolving threat. The resource allocation system is calendar-driven by Congress writing an appropriations bill—providing control of funding to Congress and transparency to the American public and media for taxpayer money. The defense acquisition management system is event-driven by milestones based on commercial industry best practices of knowledge points and off-ramps supported by the design, development, and testing of the systems as technology matures.

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Measuring the Impact of INNOVATION ACTIVITIES IN GOVERNMENT

Justin F. Brunelle, Daniel Frisk, Benjamin Mayer, Paula Randall, and Awais Sheikh

As the government increasingly allocates resources to innovation, questions arise as to how innovation organizations measure their performance, and ultimately their effectiveness, in supporting government missions. Innovation organizations are expected to demonstrate their impact. Researchers from the MITRE Corporation assessed how government-focused innovation organizations advance innovation and evaluate their results. The research team collected information from a total of 39 government innovation organizations to understand their roles, activities, and measures of success. This article presents MITRE's findings on the current state of pursuing and measuring innovation in government, as well as recommendations for metrics based on the different types of innovation organizations. MITRE recommends that innovation organizations focus on identifying and collecting outcome metrics that are critical to aligning innovation activities and products with government missions.

DOI: *https://doi.org/10.22594/dau.19-849.27.04*
Keywords: *Metrics, Acquisition, Research, Innovation, Innovation Organizations*

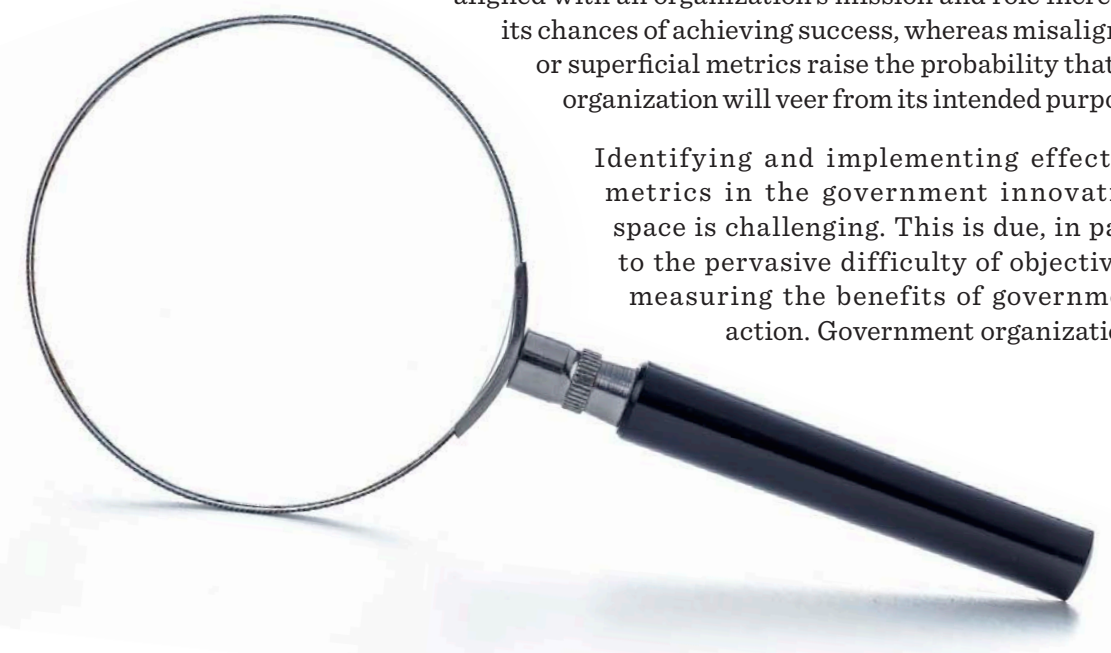
Image designed by Michael Bubar-Krukowski

Government increasingly emphasizes innovation, long considered the province of industry and research institutions. Government organizations are recognizing the need to innovate to more effectively fulfill their missions. Agencies across government are seeking new approaches and solutions to challenges such as improving services for citizens, countering growing capabilities of foreign adversaries, and adapting to the accelerating rate of technological change.

Traditional government organizations are replicating industry practices with the goal of achieving results such as faster development cycles, cross-domain collaboration, and more efficient acquisition (Observatory of Public Sector Innovation, 2018). Many of the approaches and techniques that have served as innovation catalysts for commercial companies (e.g., providing maker spaces, hosting challenges and events, promoting networking) are being translated to public sector organizations. New positions seen in industry, such as chief management officer, chief data officer, and chief innovation officer, are becoming more prevalent in the government.[1] In addition to organizational restructuring, agencies have also created or affiliated with numerous new offices or organizations (referred to in this article as "innovation organizations") focused on accelerating the development and adoption of innovative tools and practices.

As government innovation organizations proliferate, their parent agencies expect to see results from their investments. Innovation organizations are therefore tasked with determining how to effectively measure themselves.

Appropriate metrics enable organizations to track progress, identify their most effective activities, and communicate results and value to both the creators and consumers of innovative solutions. Moreover, metrics can drive the direction of the organization. Measures that are properly aligned with an organization's mission and role increase its chances of achieving success, whereas misaligned or superficial metrics raise the probability that an organization will veer from its intended purpose.



Identifying and implementing effective metrics in the government innovation space is challenging. This is due, in part, to the pervasive difficulty of objectively measuring the benefits of government action. Government organizations

typically do not measure success using financial metrics like revenue and profit that are common in industry. Furthermore, government innovation activities frequently involve multiple organizations and stakeholders, each with their own definitions of success. For example, leadership may be most interested in justifying an organization's budget, a program manager may be primarily concerned with reaching test and evaluation milestones on schedule, and an engineer may be focused on technical performance measures. Even if stakeholders can agree on appropriate measures, consistently collecting and analyzing metrics requires organizational attention and resources, often in competition with other priorities. Another challenge to metric collection is that programs can have vastly different timeframes, with some innovations making an immediate impact and others requiring years or even decades to demonstrate value.

Researchers at the MITRE Corporation assessed how government-focused innovation organizations help deliver innovation and how they measure themselves. The research team surveyed government-focused innovation organizations to understand their missions, processes and activities, and measures of success. Based on the findings from the survey and a review of existing literature, this research identified the current state and best practices in advancing and measuring innovation in government. This article also recommends metrics and approaches for government innovation organizations based on the capabilities they provide.

Related Work

A growing body of literature addresses the topic of innovation, both generally and specific to the government. The existing literature offers varying definitions and descriptions of innovation, and many examples are documented of ways the government has approached innovation. Research on specific metrics that can be used to measure the impact of innovation in the government is less common, however. This section briefly summarizes the findings of MITRE's literature review.

Defining Innovation

Beyond standard dictionary definitions, the published literature does not prescribe a universal description of the term "innovation." Rather, interpretations of innovation depend on context. Just as government problem-solving approaches will vary based on desired outcomes, the definition of innovation may be tailored to specific missions, organizations, technologies, industries, or timelines (Liedtka et al., 2018; Observatory of Public Sector Innovation, 2018). The delivery of innovation as a product, service, or process may also evoke different interpretations of the term (Baregheh et al., 2009; Lacity & Willcocks, 2016).

While definitions of innovation vary, the MITRE research team encountered a common theme among them that is applicable to identifying government innovation organizations. Namely, innovation refers to doing something that effects change and is valuable. Some published descriptions of innovation that follow this theme include

- doing things differently or better and then delivering (Lacity & Willcocks, 2016),
- creating more effective processes, products, and ideas (Australian Government, 2018),
- improving or reforming something (Glor, 2019),
- bringing a technology to market (users) (Green, 2013), and
- changing how organizations think about challenges (Ibrahim, 2015; Liedtka et al., 2018).

Increasing Innovation in Government

Observers and researchers have long documented the need to increase innovation in government and recommended approaches for doing so. For example, Nader (2001) identified the capacity of government procurement programs to spur innovation and the challenges of overcoming bureaucratic and political obstacles to leverage large-scale government purchasing power. Recommendations included increasing collaboration between government researchers, improving procurement regulations, and having lawmakers provide guidance to federal agencies. More recently, Hacking for Defense is a prominent example of how the public sector can apply innovative techniques to solve some of the most important challenges in the national security sector.[2] Two high-profile books, *The Startup Way* (Ries, 2017) and *Lean Impact* (Chang & Ries, 2018), also contributed to the discussion of how the public sector can and should push for internal innovation.

Reports indicate that the government is taking action to increase innovation. The Obama administration took multiple steps to foster innovation, including accelerating the establishment of Acquisition Innovation Labs in agencies to implement innovative approaches to acquisition (Rung, 2016).[3] In 2017, the Department of Defense (DoD) created the position of Under Secretary of Defense for Research and Engineering during the restructuring of the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (AT&L) to "better pursue the goals of technological superiority, affordable systems, and well-managed business operations" (DoD, 2017). Another example is the creation of AFWERX, which the Secretary of the

Air Force established in 2017 to serve as "a catalyst for agile Air Force engagement across industry, academia, and nontraditional contributors to create transformative opportunities and foster an Air Force culture of innovation" (Machi, 2018).[4]

Beyond the creation of new organizations, research has also focused on the authorities that innovation organizations use and how they affect the acquisition of technological innovation (Gagnon & Van Remmen, 2018). That research identified the expanded use of nontraditional acquisition authorities between government, industry and academia, and analyzed the role these methods play in the government innovation space.

Measuring the Impact of Government Innovation

The topic of innovation metrics in industry is heavily discussed in research publications, whereas research on government innovation is typically found elsewhere. The pitfalls of measuring innovation are well documented (Kostoff, 1997). For example, a known deficiency exists in tracking the right metrics (Mortensen & Bloch, 2005). Publications such as the *Oslo Manual* encourage establishing better metrics and provide recommended measures based on innovation goals (Blackburn et al., 2017; Mortensen & Bloch, 2005).

Government leaders and researchers also recognize the need to improve metrics for innovation (Blackburn, 2018; Kane, 2019).[5] The U.S. Executive Office of the President, in the National Defense Authorization Act for Fiscal Year 2017, mandated that metrics for research and innovation be improved (Government Accountability Office, 2014; National Defense Authorization Act, 2016). However, many researchers have focused on traditional research and development projects and technology transfer, rather than other types of innovation and metrics (Bozeman, 2000; Smith et al., 2013). For example, one study discussed the government's need to enhance return-on-investment measures for research and development investments and listed several potential metrics for tech transitions, including the number of intellectual property disclosures, copyright assertions, patents, and technologies licensed (Minor, 2019).

According to one researcher, the measures of impact of public sector innovation have focused on organizational functions and successful case studies rather than objectives, people, and structures (Glor, 2019). That may be changing. The Software Engineering Institute published a report on measuring progress for agile development that focused on staffing, schedule, and customer satisfaction as opposed to requirements completion (Forsgren & Kersten, 2018). Similarly, the Defense Innovation Board (DIB) proposed new metrics for measuring

software development, moving away from lines of code and toward metrics such as time to recovery after failure, number of developers, and change rate of the project (Chappellet-Lanier, 2018; DIB, 2018).

Methodology

To investigate how government-focused innovation organizations advance innovation and measure themselves, the MITRE research team developed a survey to gather information on government-focused innovation organizations, their activities, and their metrics. The team identified a group of organizations through established MITRE relationships and referrals, invited them to participate in the survey, and analyzed their responses.

Survey Group

To identify an initial group of possible participating organizations, the research team leveraged previous internal MITRE work that identified and classified innovation organizations. The research team focused on organizations that met the following criteria:

- Organization is a government or nonprofit entity focused on government customers.[6]
- Organization emphasizes innovation in its activities, mission, or value proposition.

This research focused on organizations working within or for the U.S. Federal Government, although the team did collect information from two organizations involved with state government. The team contacted organizations supporting national security, intelligence, and civilian missions. The research team did not solicit participation from national laboratories or federally funded research and development centers, as those organizations typically focus on core research areas and have established processes and budgets. The survey also did not solicit participation from for-profit companies. As the research team contacted potential participating organizations, it received numerous recommendations and points of contact for additional organizations to include in the study.

The research team solicited participation from an original list of 68 government innovation organizations. In its communications with participants, MITRE explained that the purpose of the research was to gather information on innovation practices and metrics, not to assess individual organizations. Further, the information provided in the

survey would be anonymized and aggregated for analysis and reporting.[7] Nevertheless, many organizations did not respond to MITRE's requests to participate; 30 organizations responded, with two declining to provide information. Of the 28 organizations that agreed to participate, 19 completed the survey either in writing or orally, responding to the questions over the phone. Several organizations cited "survey fatigue" due to numerous research efforts and information requests within the government innovation space as a reason not to participate in the MITRE study. This factor may have contributed to a response rate that was lower than anticipated.

To increase its sample size, the MITRE research team augmented its dataset with information collected under an innovation ecosystem study commissioned by the Under Secretary of Defense for Intelligence's Defense Intelligence Innovation Office (DI2O). The DI2O study, contracted to and executed by the Rockwood Company, identified key innovation offices across the DoD and intelligence communities, and collected information on their missions, values, and practices. That study surveyed 28 organizations, including 20 organizations that were not surveyed by the MITRE team. As a result, the MITRE study's dataset includes the 19 responses to the MITRE study and 20 responses to the Rockwood Company effort for a total of 39 responses.

Survey Design

The MITRE research team organized the questions in the innovation survey into five categories: mission, process, metrics, additional information, and organizational details. (The Appendix contains a copy of the survey.) The two-page survey was delivered as a protected Microsoft Word document with editable form fields. It contained open response fields for most questions to avoid influencing participants.

The survey consisted of multiple sections corresponding to various aspects of innovation organizations.

Mission: This section inquired about the purpose and role of the innovation organization. Respondents provided high-level information on their beneficiaries, capabilities, and technical emphases. This section also asked how the organization defined innovation.

Process: This section inquired about the activities, evaluations, oversight, and other practices performed by the innovation organization.

Metrics: This section inquired about how the innovation organization defined and measured success. Respondents provided information on the metrics currently in use as well as additional metrics that should be collected.

Additional Information: This section provided an opportunity for organizations to share information on best practices, areas for improvement, or other topics that would be useful to the government innovation community.

Organization Details: The final section captured basic organizational information such as budget, staffing, locations, and parent organization. This section also asked participants to identify the type(s) of innovation that best described their organization's role. The survey suggested types based on existing MITRE research on categories of innovation and allowed participants to create a new category if the listed categories were insufficient.

The data provided by the Rockwood Company came from interviews that asked questions similar to those in the MITRE survey.[8] However, a subset of the MITRE questions—including some regarding metrics—was not replicated in the Rockwood data. Consequently, the sample size for some of the results reported later in this article may vary. For example, Rockwood did not ask participants to comment on the quality or suitability of their metrics; as such, the MITRE research team excluded Rockwood responses from that portion of the analysis.

Survey Analysis

The research team interpreted the responses to the survey and used a combination of Microsoft and R software to process, analyze, and visualize the data. MITRE did not independently confirm the information provided by organizations, so it is possible that some of the self-responses

are mischaracterizations. While the primary purpose of this study was to understand how government innovation organizations measure their effectiveness, the research team also analyzed the responses detailing activities and missions.

Findings

The MITRE survey addressed multiple aspects of innovation organizations, including basic information (e.g., year founded, budgets, staffing), mission, activities (e.g., hackathons, educational seminars, fellowships), and metrics. The data provided by the Rockwood Company included comparable information in most cases. This section presents MITRE's analysis of the responses from 39 innovation organizations in the combined dataset.[9]

Organizational Characteristics

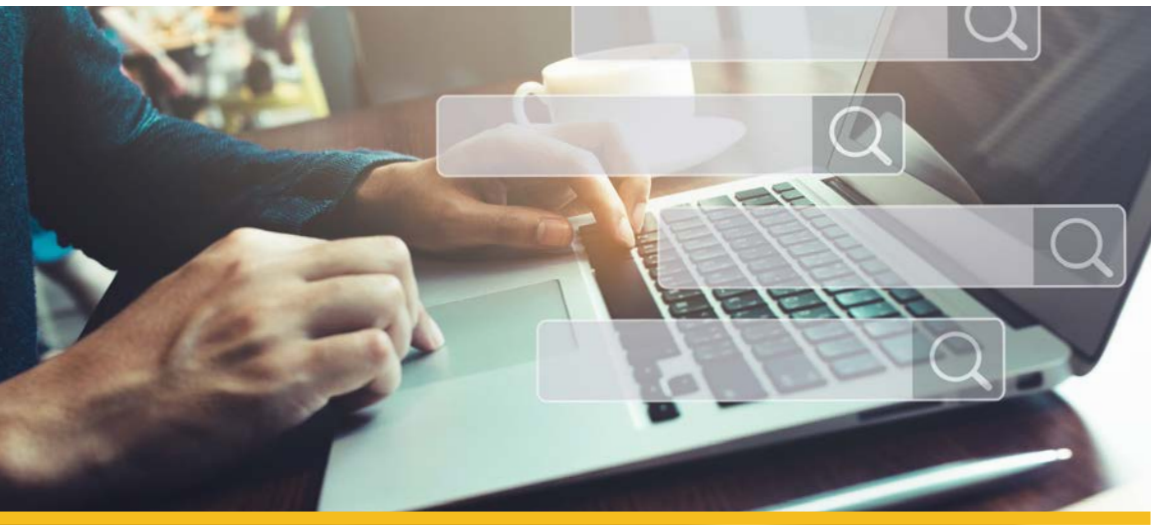
Most of the innovation organizations participating in this research were relatively young and small in size. MITRE anticipated this finding, given the recent government emphasis on creating innovation organizations and the exclusion of more established actors (such as national labs) from the research. The average age of participating organizations was 5 years, and half of the organizations were founded in the last 3 years at the time of the survey (Table 1). The average budget for organizations was about $50 million, and the average staffing level was 18 full-time equivalents (FTEs) including military, civilian, and contractor personnel. The median (midpoint of all responses) budget ($14 million) and staffing levels (12 FTEs) were significantly less than the averages, due to a few, larger outlier organizations in the dataset.

TABLE 1. INNOVATION ORGANIZATION DETAILS FOR PARTICIPANTS IN MITRE & ROCKWOOD COMPANY SURVEYS

Characteristic	Average*	Median*
Organization age	5 years	3 years
Organization size	19 FTE	12 FTE
Organization budget	$50 million	$14 million
Receives funding from parent organization	88% yes (14 of 16)	not applicable
Partners with other innovation organizations	79% yes (15 of 19)	not applicable

Note. *The total number of participating organizations was 39. Rockwood data were excluded if the topic was not explicitly answered.

Most innovation organizations in the dataset reported working primarily for their parent department or agency. However, some organizations also provide support to entities outside of their immediate organization, including industry, other federal agencies, and students. Although the direct beneficiaries of innovation organizations' activities tend to reside in their parent agency, they also indicated a propensity to partner with other innovation organizations in industry or government. Nearly 80% of organizations in the sample stated that they partner with peers to provide innovation and to accomplish their missions. During MITRE's data collection, the frequency with which participating organizations provided points of contact for other organizations indicated the level of connectedness within the government innovation community, even across agencies and technical domains.



Types of Innovation Organizations

The survey responses corroborated MITRE's opening assumption that innovation organizations fall into one of several general types. They include the six predefined groups listed in the "organizational details" section of the survey, plus an additional category for organizations that function as educators or advisors. The categories are based on the roles and activities of the organizations (Table 2). The research team considered adding additional, more specific categories, but concluded that these seven types sufficiently included all roles performed by government innovation organizations.[10]

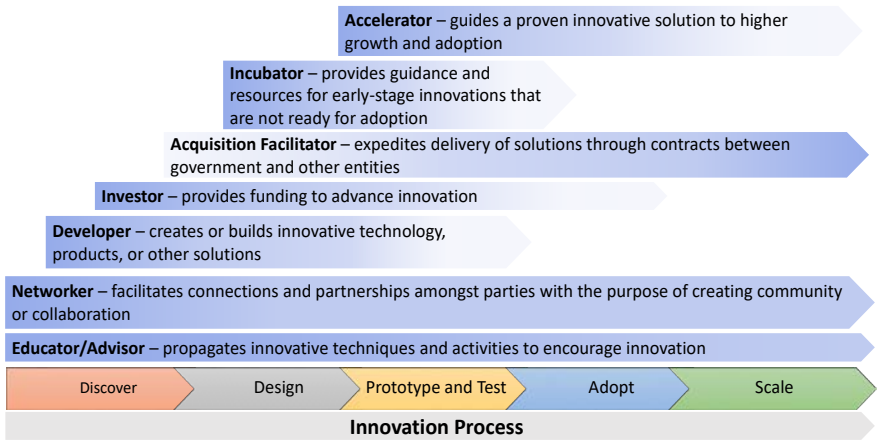
TABLE 2. TYPES OF INNOVATION ORGANIZATIONS

Type	Definition	Primary Role	Percentage of Participating Organizations*
Networker	Facilitates connections and partnerships among parties with the purpose of creating community or collaboration	Creating interactions	67%
Educator/ Advisor	Propagates innovative techniques and activities to encourage innovation	Imparting knowledge and disseminating guidance	56%
Acquisition Facilitator	Expedites delivery of solutions through contracts between government and other entities	Increasing the speed and efficiency of acquisition	46%
Investor	Provides funding to advance innovation	Effectively allocating funding	46%
Incubator	Provides guidance and resources for early-stage innovations that are not ready for adoption	Maturing technologies, products, and processes	41%
Accelerator	Guides a proven solution to higher growth and adoption	Increasing adoption of technologies, products, and processes	23%
Developer	Creates or builds innovative technology, products, or other solutions	Building new technologies and products	15%

Note. *The total number of participating organizations was 39. Organizations can belong to multiple categories.

The most common type of innovation organization was networker, including 26 of the 39 organizations in the dataset. The next most frequent type of organization was educator/advisor, comprising 22 of the organizations in the sample. The frequency of these categories likely indicates those capabilities are in demand within the customer and user communities. However, the frequency could also be partially due to those activities generally not requiring high levels of funding or staffing, making them attractive offerings for newly formed innovation organizations operating with minimal resources.

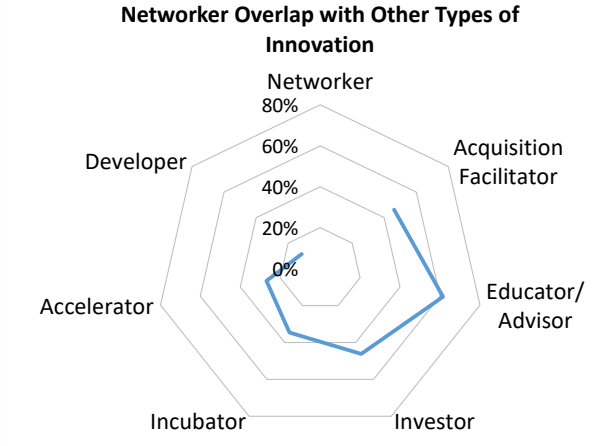
FIGURE 1. ALIGNMENT OF TYPES OF INNOVATION ORGANIZATIONS WITH THE INNOVATION PROCESS



Note. Developed by MITRE. Note the darker shading of the arrows indicates a stronger link between the type of organization and that portion of the innovation process based on MITRE's observations.

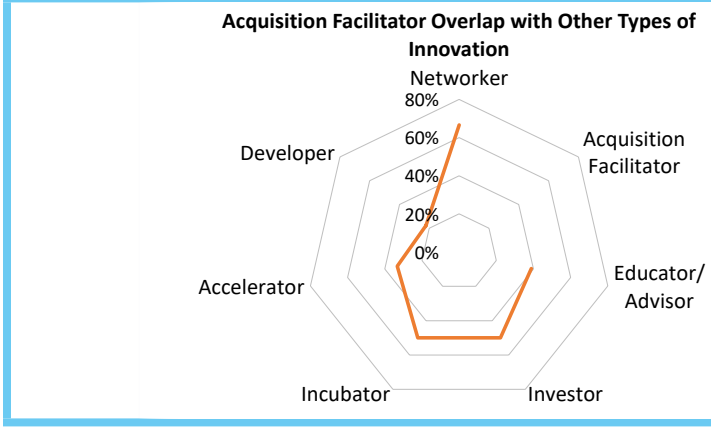
Innovation organizations typically align to certain steps in the innovation process (Figure 1). For example, accelerator organizations are usually involved in the later stages of the process, as innovative solutions are adopted and scaled. Developers, in contrast, are more commonly associated with the early stages of innovation, as solutions are conceived and tested. The exceptions to these affiliations are networker and educator/advisor organizations, whose roles are consistently valuable across all parts of the innovation process.

FIGURE 2A. OVERLAP BETWEEN TYPES OF INNOVATION ORGANIZATIONS



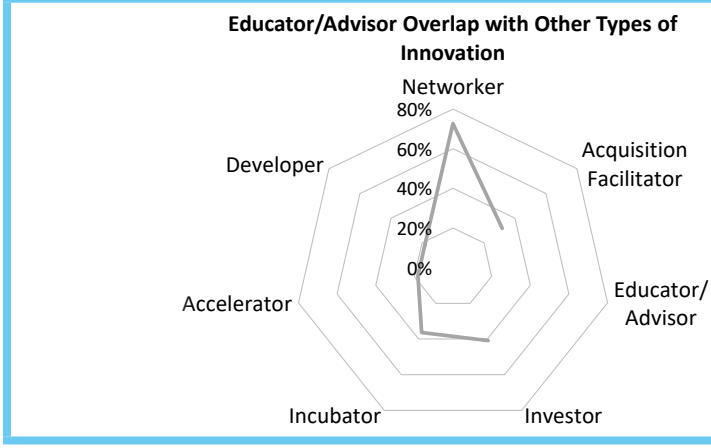
Note. The total number of participating organizations was 39. Organizations can belong to multiple categories.

FIGURE 2B. OVERLAP BETWEEN TYPES OF INNOVATION ORGANIZATIONS



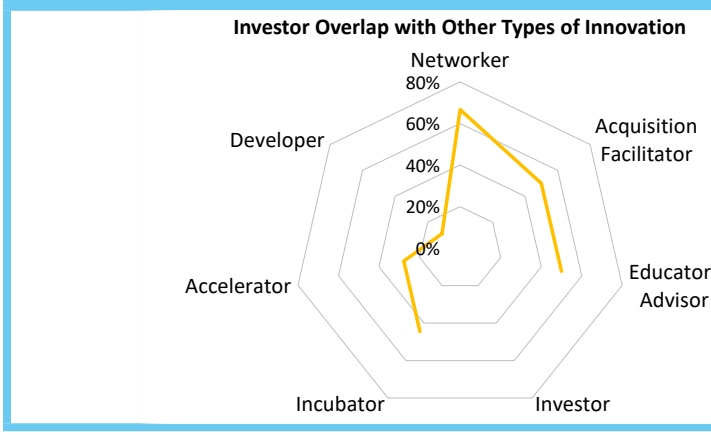
Note. The total number of participating organizations was 39. Organizations can belong to multiple categories.

FIGURE 2C. OVERLAP BETWEEN TYPES OF INNOVATION ORGANIZATIONS



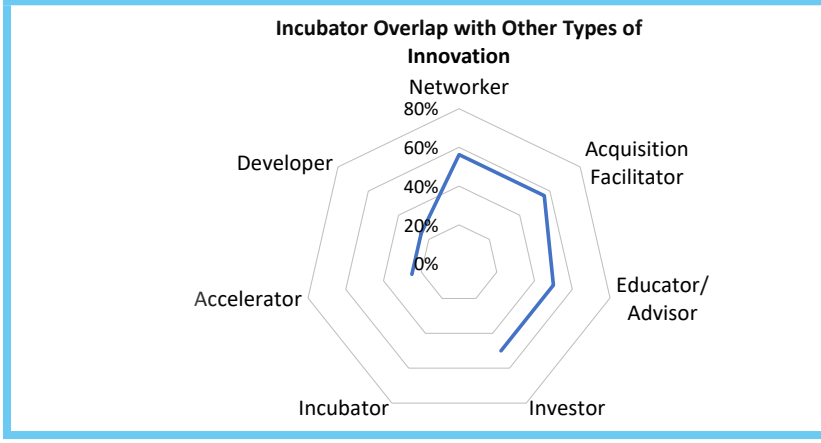
Note. The total number of participating organizations was 39. Organizations can belong to multiple categories.

FIGURE 2D. OVERLAP BETWEEN TYPES OF INNOVATION ORGANIZATIONS



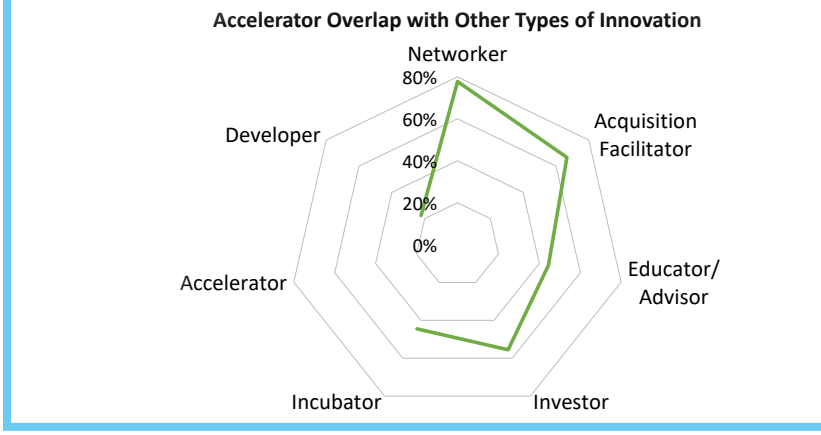
Note. The total number of participating organizations was 39. Organizations can belong to multiple categories.

FIGURE 2E. OVERLAP BETWEEN TYPES OF INNOVATION ORGANIZATIONS



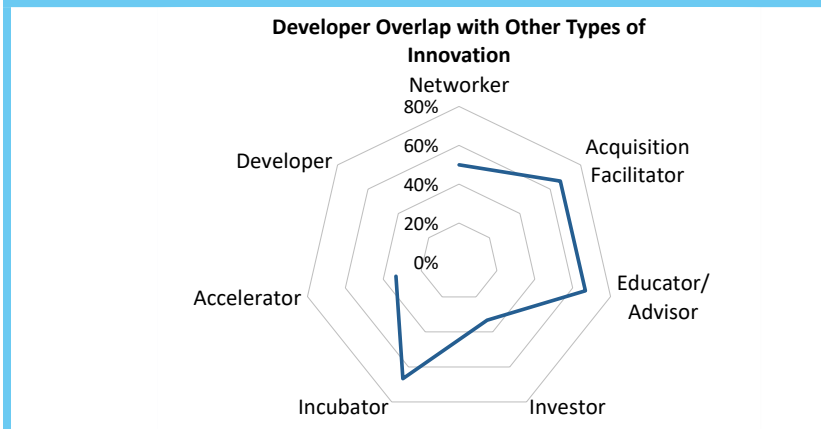
Note. The total number of participating organizations was 39. Organizations can belong to multiple categories.

FIGURE 2F. OVERLAP BETWEEN TYPES OF INNOVATION ORGANIZATIONS



Note. The total number of participating organizations was 39. Organizations can belong to multiple categories.

FIGURE 2G. OVERLAP BETWEEN TYPES OF INNOVATION ORGANIZATIONS



Note. The total number of participating organizations was 39. Organizations can belong to multiple categories.

Innovation organizations in the government space frequently perform roles falling under more than one category. In the data collected for this research, organizations mapped to an average of 2.9 of the seven types of innovation organizations. MITRE tallied the frequency of overlap between types of innovation organizations (Figures 2a–2g). For example, 50% of organizations that fall under the accelerator category also fall under the investor category. Co-occurrence was most common with networker and acquisition facilitator types of organizations. This may be because those roles are a logical pairing with many other innovation activities; incubator, investor, accelerator, and developer organizations all benefit from networking and contracting efforts. Another frequent pairing of note is between educators/advisors and both investors and incubators. Organizations that provide funding or incubation services also appear to tend to offer guidance and information to innovators.

Additional research is needed on how and why government innovation organizations perform roles in multiple innovation categories, with a comparison to industry behaviors and types. One theory is that groupings are the natural outcome of shared activities across categories and help propel solutions through the innovation process. Another theory is that relatively new government innovation organizations are performing a variety of activities to discover what resonates with their customers but will narrow their focus on specific aspects of innovation as they become more established.

Activities Performed by Innovation Organizations

MITRE and the Rockwood Company both asked participating organizations to describe the activities and processes they use to promote innovation. The activities innovation organizations execute should directly support their missions and roles. Additionally, understanding an organization's activities provides insight on appropriate metrics.

The survey responses indicated that government innovation organizations perform a variety of activities to advance innovation. Nearly every participating organization reported carrying out multiple types of activities, a finding consistent with innovation organizations usually fulfilling multiple roles. MITRE grouped reported activities by category (Table 3).[11] Overlap between categories of activities is common. For example, a hackathon may also serve as a networking event, and technology scouting may influence product evaluations.

TABLE 3. ACTIVITIES PERFORMED BY INNOVATION ORGANIZATIONS

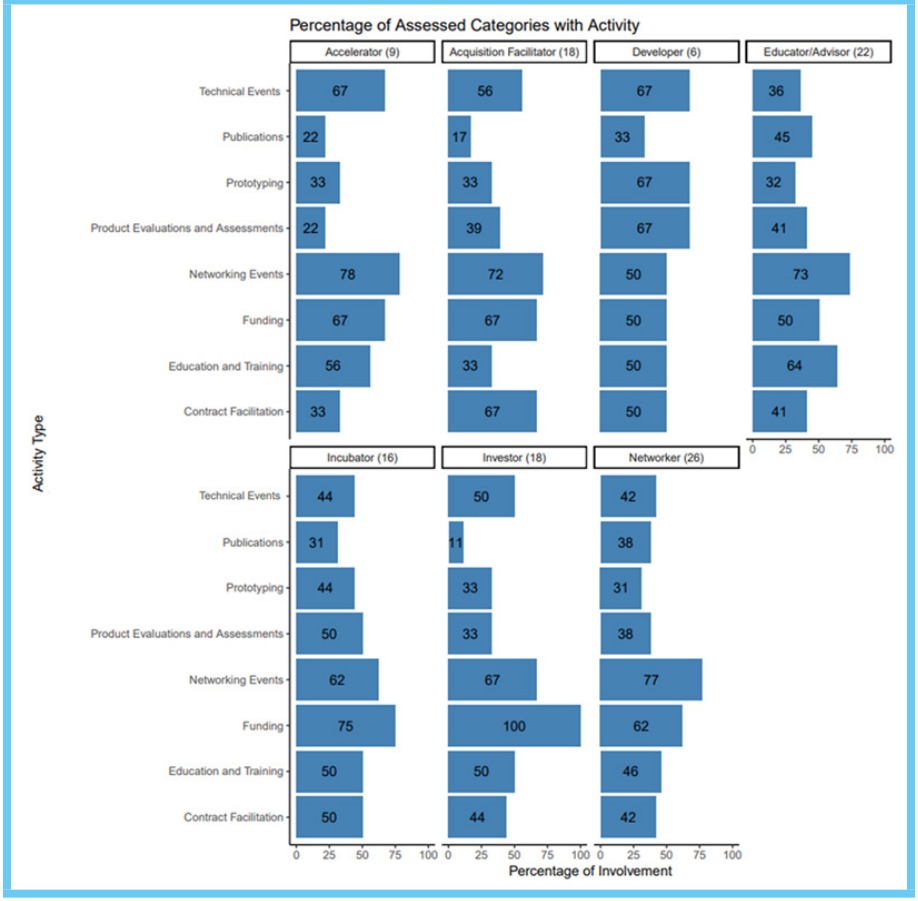
Activity Category	Definition	Subcategory	Percentage of Organizations Reporting Activity*
Networking and Outreach	Increase engagement and collaboration within and across organizations and domains, through events, social media, partnership agreements, etc.	Organize and/or participate in networking events	64%
		Reach out to vendors that do not traditionally work with government	26%
		Build cross-functional teams to accomplish an objective	13%
		Arrange fellowships and exchange programs	10%
Funding	Provide funding to innovators, often through a competitive selection process (e.g., "Shark Tank")		59%
Education and Training	Advance innovative approaches and thinking in government organizations through coaching, workshops, strategic guidance, etc.		46%
Product Evaluations and Assessments	Help innovators test and improve their solutions through technical assessments, red teaming, focus groups, etc.		44%
Contracting and Licensing	Assist innovators with identifying users and reaching contractual agreements	Facilitate pilot contract awards	41%
		Facilitate technology transfer (e.g., licensing government technology for commercial use)	5%
		Administer government requests for information (RFIs)	3%
Technical Events	Organize events around solving specific problems using hackathons, challenges, design sprints, etc.		38%
Research and Publications	Organize events around solving specific problems using hackathons, challenges, design sprints, etc.	Publish innovation playbooks, case studies, market research reports, etc.	36%
		Scout technologies on near-term and long-term horizons	13%
Prototyping	Build prototypes in-house and/or provide prototyping capabilities to others (e.g., maker space)		26%

Note. *The total number of participating organizations was 39.

The organizations participating in this study most frequently used networking and outreach, funding, and education and training activities to perform their roles. This reflects the prevalence of networker, investor, and educator/advisor types of organizations in the dataset. Other frequently reported activities include product evaluations and assessments, facilitation of contracts, and technical events such as hackathons and challenges.

MITRE also cataloged activities by type of innovation organization (Figure 3). Not surprisingly, certain types of activities are more prevalent among certain types of organizations. For example, all investor organizations provided funding, and prototyping activities were most common among developer organizations. However, the data generally do not show substantial differences in the activity profiles for different types of organizations. This could be because government innovation organizations usually had multiple roles, and each role necessitated its own set of activities. The data do not distinguish which activities an organization performed for each of its roles.

FIGURE 3. FREQUENCY OF INNOVATION ACTIVITIES BY TYPE OF ORGANIZATION



Note. Organizations can belong to multiple categories.

Metrics Collected by Innovation Organizations

The primary purpose of MITRE's research was to assess how government innovation organizations measured and evaluated themselves. MITRE collected data from participants on the metrics they used and whether they perceived those measures to be sufficient. The Rockwood Company gathered similar information in its interviews and presented their findings in a field titled "measures of success." This section presents MITRE's analysis of those responses.

Most government innovation organizations reported collecting metrics. Of the participants in the MITRE survey, 17 of 19 organizations (90%) responded that they use metrics to track their performance. Of the two organizations that did not collect metrics, one was newly created and had not yet established metrics that satisfied both leadership and their innovation team. While the data provided by the Rockwood Company did not explicitly address whether organizations collect metrics, all participants provided information on measures of success.[12]

MITRE observed that metrics collected by government innovation organizations fall into four broad categories, each measuring a different aspect of organizations' activity or results.

- **Workload metrics:** These measure an organization's incoming work and ongoing efforts, often in terms of projects, customers, or funding.
- **Engagement metrics:** These measure an organization's success in generating awareness, participation, and collaboration through activities such as networking, partnering, and social media outreach.
- **Output metrics:** These measure an organization's success in delivering information, products, and services to users. Metrics typically track the type of deliverable, frequency, and timeliness.
- **Outcome metrics:** These measure the impact of solutions that are delivered to users. Measured outcomes could include cost savings, mission effectiveness, patient health, or customer satisfaction.

Most participating organizations collected more than one metric. MITRE compiled the responses and grouped similar metrics together (Table 4). For example, the reported metrics "cost per project" and "dollars invested" are variations on measuring the costs to an organization. Organizations most frequently collected output measures, followed by engagement and then workload metrics. Outcome metrics were the least common.

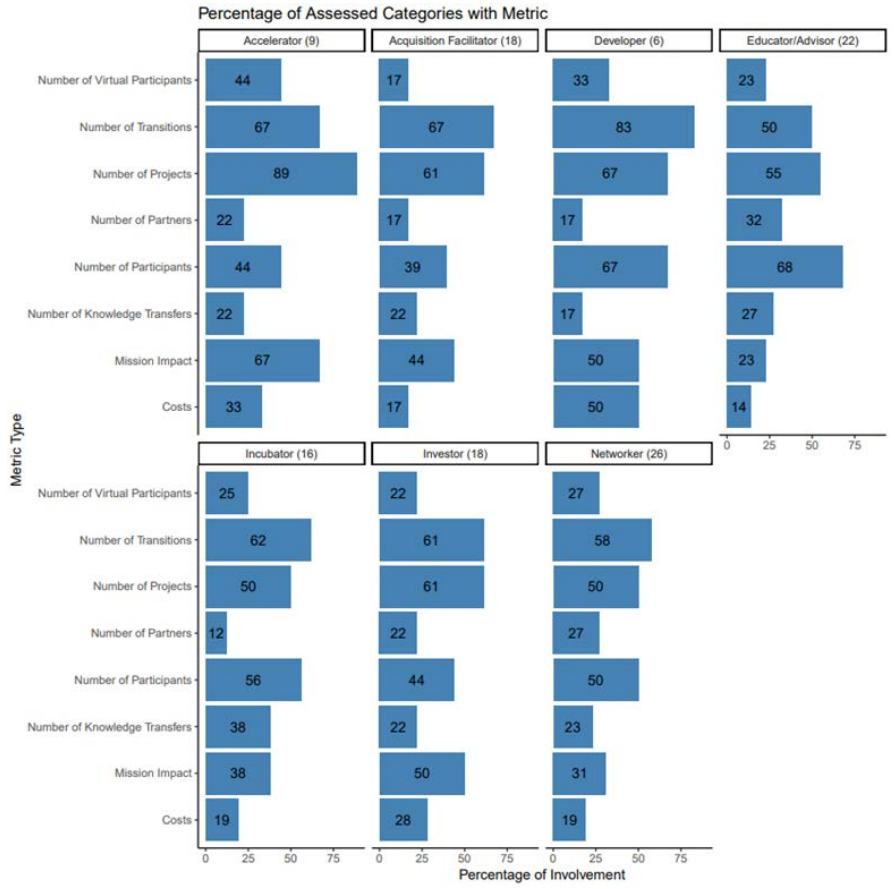
TABLE 4. METRICS REPORTED BY INNOVATION ORGANIZATIONS

Measurement Category	Metric	Description	Percentage of Organizations Reporting Metric*
Workload Metrics	Number of projects	Counts programs, products, pilots, etc.	49%
	Costs	Measures financial obligations, via budgets, costs per project, dollars invested, etc.	15%
	Number of events	Counts networking events, hackathons, challenges, workshops, etc.	10%
	Number of customers	Counts organizations or individuals employing innovation organizations	5%
Engagement Metrics	Number of participants	Counts individuals or organizations participating in innovation events or activities	46%
	Number of partners	Counts partnerships with other organizations, including government, commercial, and nonprofit	21%
	Number of virtual participants	Counts virtual participation, via website traffic, social media followers, online contributors, etc.	18%
	Diversity of customers or innovators	Measures diversity of customers based on organization, technical domain, location, or other classifications	8%
Output Metrics	Number of transitions	Counts transitions of solutions to users, in terms of new programs of record, consignments of tools, etc.	56%
	Number of knowledge transfers	Counts transitions of new insights, ideas, or practices to users	23%
	Adoption rates	Measures extent of a transition's adoption in a user community	18%
	Time to transition	Measures time required to provide a solution to users, generally in comparison to a historical benchmark	15%
	Number of contracts awarded	Counts contracts awarded as a result of efforts by innovation organizations, including pilot contracts	8%
	Number of reports or guidance released	Counts publications for internal use or external release	8%
	Number of gaps informed	Counts instances when innovation organizations passed along information or solutions that directly addressed a user need	5%
Outcome Metrics	Mission impact	Measures contributions of innovative solutions to user's mission success	38%
	Costs saved	Measures dollars saved due to solutions	18%
	Success stories	Anecdotes describing benefits of innovation organization efforts to customers	5%
	Number of startups created	Counts number of new businesses or organizations that arose from innovation organization efforts	5%

Note. *The total number of participating organizations was 39.

MITRE also cataloged reported metrics by type of innovation organization (Figure 4). The metrics frequently used by specific types of organizations generally appear to reflect their roles. However, the results are muddled by the tendency of organizations to fall under multiple innovation categories. The data do not distinguish which metrics an organization collects for each of its roles. Some observations of note follow:

FIGURE 4. FREQUENCY OF METRICS BY TYPE OF ORGANIZATION



Note. Organizations can belong to multiple categories.

- **Networkers:** One-half of networker organizations tracked the number of participants—an important indicator of the reach of networking functions. However, only 27% of networker organizations reported explicitly tracking the number of virtual participants or the number of partners.

- **Educators/Advisors:** More than two-thirds of educator/advisor organizations reported capturing their numbers of participants. However, only 27% of educator/advisor organizations tracked the number of knowledge transfers, and these types of organizations were the least likely in the dataset to collect outcome metrics.
- **Acquisition Facilitators:** Two-thirds of acquisition facilitator organizations reported collecting the number of transitions, although only 17% explicitly tracked the number of contracts awarded. Only 28% of acquisition facilitators captured the time to award or time to transition, despite a key function of an acquisition facilitator being speeding up the procurement process.
- **Investors:** One-half of investor organizations reported tracking mission impact. More than 60% reported collecting metrics on the number of transitions, but only 28% captured project costs.
- **Incubators:** More than 60% of incubator organizations tracked the number of transitions, and about 40% collected the number of knowledge transfers. Nearly 40% of incubators reported measuring mission impact.
- **Accelerators:** Two-thirds of accelerator organizations reported tracking their mission impact—the highest percentage among all types of organizations. Accelerators were also the type of organization to most frequently collect costs saved (33%) and time to transition or adoption (33%).
- **Developers:** One-half of developer organizations reported measuring mission impact. Nearly 90% of developers tracked the number of transitions—the highest percentage among types of innovation organizations.

Nearly 70% of the metrics reported by innovation organizations involved some type of count. Those metrics included the three most frequently used measures: number of transitions (56%), number of projects (49% of respondents), and number of participants (46%). Other common counting metrics included the number of partners and the number of knowledge transfers (a measure similar to the number of transitions but pertaining to concepts and practices rather than products). Counting metrics can often

be collected immediately, during, or following an innovation activity, and do not require significant resources or follow-up. Counting metrics typically provide the most insight when they are used to track trends over time or are compared to established benchmarks.

“Counting metrics typically provide the most insight when they are used to track trends over time or are compared to established benchmarks.

Outcome metrics merit special attention because they are arguably the most important category while simultaneously being the least prevalent among participating organizations. Outcome metrics are critical to connecting the activities of innovation organizations to the missions and goals of their parent organizations. Ultimately, the value of an innovation organization is measured by its ability to generate positive outcomes for its users. Nevertheless, outcome metrics constituted less than 20% of all reported measures. A relatively small number of organizations provided information on specific outcome measures; seven organizations reported tracking cost savings, two tracked customer success stories (which can provide evidence of customer satisfaction), and two counted the number of start-ups created as a result of their work. More generally, almost 40% of organizations collected metrics on the impact of their work on their customers’ missions. However, few organizations specified how they measured that impact. MITRE believes that additional research is necessary to verify that the variables being measured actually represent outcome metrics.

Innovation organizations recognize their current shortfalls in metric collection. Many organizations believe their current metrics are insufficient, including 12 of 15 organizations that directly responded to that question in the MITRE survey. Some of the survey responses indicated that they understand their metrics are not adequately tailored to their mission space. Organizations’ dissatisfaction with their metrics likely reflects the difficulties in selecting and capturing meaningful outcome measures. In order to establish effective outcome metrics, an organization must translate its mission into indicators of success and create processes for ongoing data collection and analysis. Innovation organizations have the added challenge of coordinating with the end users of innovative solutions to capture outcome metrics, possibly for a period well after the innovation organization has transitioned its solution.

General Findings on Government Innovation

MITRE observed that innovation organizations often collaborate and partner, a quality that is particularly evident in the DoD space. Despite this cooperation, no published canonical and comprehensive directory of government innovation organizations exists. Consequently, the burden of discovering innovation organizations and their domains and capabilities largely falls on potential customers, users, and partners looking to engage. While multiple attempts to map and characterize government innovation organizations are underway, the rapidly changing environment exacerbates the challenge of maintaining awareness of players in the space.

Recommendations

MITRE makes several recommendations for government innovation organizations and members of the government innovation community, with an emphasis on recommendations related to metrics. These recommendations are based on MITRE's survey findings, discussions with responding organizations, and other observations made over the course of this research.

Recommendation: Clearly Establish the Role of the Organization and How It Advances Innovation

MITRE observed that individual government innovation organizations often serve multiple roles in the innovation process, such as investor, networker, and advisor. The diversity of roles accentuates the importance for organizations to establish and communicate the types of services they provide. Clearly characterizing the functions of an innovation organization helps broadcast its value and capabilities to potential customers and users. A well-defined role also enables organizations to select the most appropriate activities and metrics.

Recommendation: Identify and Collect Appropriate Metrics

Effective metrics provide insight on the workload, reach, productivity, and impact of an organization. They should align with the organization's role and, most importantly, measure its contribution to intended outcomes. Organizations should avoid collecting metrics solely because of convenience or to fulfill bureaucratic requirements, as such measures may incentivize activity contrary to its goals. Organizations should also consider the costs and benefits of collecting specific metrics and normalize metrics when possible to control for differences in scale. For example, an incubator organization with a $100 million budget would presumably transition a greater number of innovations than a similar organization with a $10 million budget.

MITRE recommends metrics for each type of innovation organization. These recommendations are based on findings from the MITRE and Rockwood Company surveys.

Recommended Networker Metrics

Networkers facilitate connections and partnerships among parties with the purpose of creating communities and collaborations. Networkers increase the opportunity for collisions, especially across different technical domains, locations, and organizations. Their metrics should focus on the breadth and results of those in-person and virtual interactions (Figure 5).

FIGURE 5. RECOMMENDED NETWORKER METRICS

Workload Metrics
- **Number of networking events** – counts in-person and virtual events organized or hosted by organization
- **Number of engagement requests** – counts requests for contacts
- **Resources per activity** – helps inform efficient allocation of networker resources

Engagement Metrics
- **Number of participants** – counts in-person and virtual participants in networking activities
- **Diversity of participants** – tracks participant characteristics like organization, technical domain, location, etc.

Output Metrics
- **Number of collisions** – counts collaborations, partnerships, contracts, or other cooperation among networking participants

Outcome Metrics
- **Participant satisfaction** – measured by participant feedback or number of repeat participants
- **Cost savings** – measures savings resulting in identification of duplicative efforts among participants
- **Mission impact** – outcomes attributable to connections made through networking activities

Recommended Educator/Advisor Metrics

Educator and advisor organizations propagate innovative techniques and practices to individuals and organizations. Their metrics should focus on how broadly and effectively they are imparting knowledge, providing guidance, and affecting organizational culture (Figure 6).

FIGURE 6. RECOMMENDED EDUCATOR/ADVISOR METRICS

Workload Metrics
- **Number of events** – counts workshops, seminars, and other educational and advisory events executed by organization
- **Number of projects** – counts research, how-to guides, and other projects
- **Resources per activity** – helps inform efficient allocation of educator/advisor resources

Engagement Metrics
- **Number of participants** – counts in-person and virtual participants in events
- **Diversity of participants** – tracks participant characteristics like organization, technical domain, location, etc.
- **Number of partners** – counts partnerships with other government, nonprofit, and commercial organizations

Output Metrics
- **Number of knowledge transfers** – counts transitions of new insights, ideas, or practices to participants
- **Number of publications** – counts published reports, guidelines, or other documents related to innovation
- **Adoption rate of innovative practices** – measures use of knowledge transfers

Outcome Metrics
- **Participant satisfaction** – measured by participant feedback or number of repeat participants
- **Mission impact** – outcomes attributable to new insights or practices transferred to and adopted by participants

Recommended Acquisition Facilitator Metrics

Acquisition facilitators expedite the delivery of innovative solutions through contracts between government agencies and other entities. Their metrics should focus on the number of contracts awarded, the speed and efficiency of acquisition, and the resulting impact on mission effectiveness (Figure 7).

FIGURE 7. RECOMMENDED ACQUISITION FACILITATOR METRICS

Workload Metrics
- **Number of customers** – counts organizations or individuals seeking assistance with contracts
- **Resources per customer** – helps inform efficient allocation of acquisition facilitator resources

Engagement Metrics
- **Number of contracting partners** – counts partnerships with government contracting organizations
- **Diversity of contracts** – tracks contract characteristics like organization, technical domain, contract vehicle, etc.

Output Metrics
- **Number of contracts awarded** – counts awards resulting from acquisition facilitator efforts
- **Value of contracts awarded** – measures dollar value of contracts awarded resulting from acquisition facilitator efforts
- **Time to award** – measures time from initial customer engagement to contract award, as compared to historical timelines

Outcome Metrics
- **Mission impact** – user outcomes attributable to solutions acquisition facilitator helped bring on contract
- **Customer satisfaction** – measured by feedback or number of repeat customers

Recommended Investor Metrics

Investors provide financial support to evolve technologies and advance innovation. Their metrics should focus on measuring the impact of funded projects (Figure 8).

FIGURE 8. RECOMMENDED INVESTOR METRICS

Workload Metrics
- **Number of projects** – counts projects the organization has funded
- **Funding per project** – helps inform efficient allocation of investor resources

Engagement Metrics
- **Diversity of portfolio** – tracks funded project characteristics like organization, technical domain, location, etc.

Output Metrics
- **Number of transitions** – counts transfers of funded projects to users, incubators, or accelerators
- **External funding** – measures additional funding captured by innovator through contracts or other investments

Outcome Metrics
- **Mission impact** – user outcomes attributable to funded projects
- **Number of success stories** – counts projects that resulted in a new organization, program of record, or other enduring effort

Recommended Incubator Metrics

Incubators provide guidance and resources for early-stage innovations that are not ready for adoption. Their metrics should focus on the organization's effectiveness in maturing innovative ideas into solutions that can be transitioned to users (Figure 9).

FIGURE 9. RECOMMENDED INCUBATOR METRICS

Workload Metrics
- **Number of projects** – counts projects the organization has incubated
- **Resources per project** – helps inform efficient allocation of incubator resources

Engagement Metrics
- **Diversity of projects** – tracks incubated project characteristics like organization, technical domain, location, etc.

Output Metrics
- **Number of transitions** – counts transfers of funded projects to users or accelerators
- **Time to complete transition** – time from initial project engagement to transition
- **Adoption rate** – measures use of transitioned project
- **Number of knowledge transfers** – counts transitions of new insights, ideas, or practices as a result of incubation activities

Outcome Metrics
- **Mission impact** – outcomes attributable to incubated projects
- **Number of success stories** – counts projects that resulted in a new organization, program of record, or other enduring effort
- **Customer satisfaction** – measured by feedback or number of repeat customers

Recommended Accelerator Metrics

Accelerators guide proven innovative solutions to increased growth and adoption. Their metrics should focus on how effectively the organization identifies and engages with possible users and introduces them to relevant innovative products and services. Accelerator metrics should also track the impact of transitioned products, services, and processes (Figure 10).

FIGURE 10. RECOMMENDED ACCELERATOR METRICS

Workload Metrics
- **Number of projects** – counts projects the organization has accelerated
- **Resources per project** – helps inform efficient allocation of accelerator resources

Engagement Metrics
- **Diversity of projects** – tracks accelerated project characteristics like organization, technical domain, location, etc.
- **Number of partners** – counts number of potential user organizations engaged by accelerator
- **Diversity of partners** – tracks partner characteristics like organization, technical domain, location, etc.

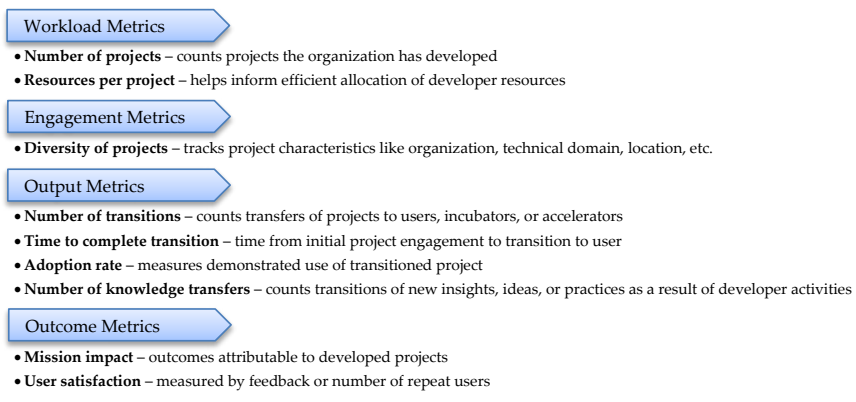
Output Metrics
- **Number of transitions** – counts transfers of funded projects to users
- **Time to complete transition** – time from initial project engagement to transition to users
- **Adoption rate** – measures use of transitioned project

Outcome Metrics
- **Mission impact** – outcomes attributable to accelerated projects
- **Customer and user satisfaction** – measured by feedback or number of repeat customers and users

Recommended Developer Metrics

Developer organizations create and mature innovative technologies, products, or other solutions. Their metrics should reflect the organization's success in developing new solutions that address user needs (Figure 11).

FIGURE 11. RECOMMENDED DEVELOPER METRICS



Recommendation: Collect Metrics as a Part of Regular Operations

Innovation organizations should track metrics and coordinate data collection as part of their operations. MITRE observed that metric selection and collection was ad hoc or underdeveloped for some participating organizations. Establishing a process for collecting metrics early in the life of an organization provides valuable feedback from users and helps identify the most effective activities for that organization. In particular, tracking outcome metrics typically requires that innovation organizations regularly follow up with their users. This communication helps ensure that innovation organizations are continuously aligned with users' missions.

Recommendation: Make Metrics Transparent

Innovation organizations should be transparent with their metrics, through application program interface, publications, or other open reporting. Metric transparency communicates organizational goals to the innovation community—including customers, users, and employees—and allows them to track progress. Transparency also helps end users understand their role in measurement and may encourage user organizations to be more willing to collect and provide the appropriate data.

Recommendation: Coordinate Across Innovation Organizations to Build and Maintain a Directory

As the government innovation ecosystem expands, organizations should make their roles and capabilities evident to the community. MITRE observed a lack of clarity regarding the services that innovation

organizations provide and how to engage them. The rapid growth in the number of innovation organizations exacerbates the challenge of maintaining awareness of players in the space. As such, future efforts should focus on a service for self-registry, advertising, and discovery of government innovation organizations by customers, peers, users, and potential partners. MITRE recommends that innovation organizations take the lead in building a directory, as they would be heavily invested in its success. The directory will also provide a platform for organizations to share metrics and best practices for measuring innovation.

Conclusions

MITRE assessed how government innovation organizations advance innovation and measure their effectiveness. This research found that individual government innovation organizations serve an average of three distinct roles, including (in order of frequency) networker, educator/advisor, acquisition facilitator, investor, incubator, accelerator, and developer. Organizations perform a variety of activities to fulfill those roles, and most collect metrics on their operations and results. However, most innovation organizations also view their metrics as insufficient, particularly with respect to measuring their contributions to government missions.

The findings from this research inform the categorizations of government innovation organization characteristics, roles, activities, and metrics provided in this report. This report recommends appropriate metrics for organizations based on their roles and activities, and areas for future research and efforts in the government innovation community. These recommendations and actions will help improve the effectiveness and impact of government efforts to foster innovation.

Acknowledgements

The MITRE team would like to thank Sanith Wijesinghe, the Innovation Area Lead responsible for funding this effort and helping shape the project. The team also thanks MITRE's innovation domain experts Dorcas Lasalle, Pete Modigliani, and Dan Ward for their review, contributions, and assistance with this effort. Anthony LaCour, Dean Worley, and Charles Havasy were instrumental in the data collection, as well. The team thanks DI2O and the Rockwood Company for assisting with the augmentation of the MITRE data set. This research would not have been possible without the guidance and support of Special Operations Forces Acquisition, Technology, and Logistics, and Kelly Stratton-Feix. Finally, the team thanks the participants in our research effort; without the time they provided, this effort would not have succeeded.

Author Note

Appendix

MITRE Survey for Innovation Organizations

Figures A-1 and A-2 depict the survey sent to government innovation organizations as part of the data collection phase of the research. The survey is described in more detail in Survey Design.

FIGURE A-1. FIRST PAGE OF THE WORD DOCUMENT SURVEY SENT TO GOVERNMENT INNOVATION ORGANIZATIONS FOR DATA COLLECTION BY THE MITRE TEAM

Questionnaire
Measuring Impact for Innovation Organizations

The purpose of this questionnaire is to understand how government innovation organizations measure their impact and align metrics with their organizational goals. This questionnaire is part of a MITRE internal research project. Please fill out and return to the below POCs.

(POCs: Justin Brunelle jbrunelle@mitre.org, Paula Randall pfaherty@mitre.org, Daniel Frisk dfrisk@mitre.org)

Mission

1) What is the purpose and/or mission of your organization?

   E.g. Encouraging collaboration, developing new technologies, fielding commercial products, etc.

2) What problem spaces does your organization emphasize?

   E.g. Technologies, domains, capabilities, etc.

3) Who are your organization's direct beneficiaries?

   E.g. Agencies, program offices, warfighters, communities of interest, etc.

4) How does your organization define innovation?

   Provide definition here.

Process

1) Describe the activities that your organization performs to promote innovation.

   E.g. Provide funding, hold conferences, execute challenges, conduct prototyping, etc.

2) Who participates in the innovation activities?

   E.g. Industries, program offices, universities, etc.

3) How often and by whom are projects evaluated and selected to participate in your program, if applicable?

   E.g. Annual competitions judged by panel, ongoing application process evaluated by single person, etc.

4) What support, guidance, oversight, or other engagement do participants receive?

   E.g. Funding, access to equipment, expertise, networking, quarterly check-ins, etc.

5) Describe how end-users are involved in the innovation process.

   E.g. Identify requirements, select participants, commit resources, etc.

6) Does your organization interact with other innovation organizations? Which ones and how?

   E.g. Industry partners, Partnership Intermediary Agreement organizations, government organizations, etc.

FIGURE A-2. FIRST PAGE OF THE WORD DOCUMENT SURVEY SENT TO GOVERNMENT INNOVATION ORGANIZATIONS FOR DATA COLLECTION BY THE MITRE TEAM

Metrics

1) How does your organization define success?

   Provide definition here.

2) What measures are collected, if any? Please note if any of these measures are required by leadership or parent organizations.

   E.g. number of projects, number of transitions, number of events, etc.

3) Are the current metrics sufficient? If not, what measures should be collected and over what timeframes?

   Provide response here.

4) What characteristics do successful or unsuccessful projects have in common?

   E.g. End-users identified early on, technology readiness, funding levels, etc.

Additional Information

1) What innovation best-practices or lessons learned have you observed and would like to emulate or avoid?

   Enter response here.

2) How could your innovation organization be improved and more successful?

   Enter response here.

3) What additional topics should this questionnaire have addressed and why?

   Enter response here.

Organization Details

Organization Name	*Enter your organization's name here.*	
Program Name	*Enter your program name here.*	
Year Founded	*E.g. 2004.*	
Parent Organization	*Enter your organization's parent agency/organization here.*	
Relation to Parent Org	*E.g. Subordinate, partnership, independent, etc.*	
Location(s)	*Enter locations where your organization has a presence.*	
Funding Source(s)	*Enter sources of funding.*	
Annual Budget	*Enter annual budget.*	
Staffing Level	*Enter military, civilian, and contractor staff years.*	
Type of Innovation Activities Performed (Select all that apply)	☐Investor ☐Incubator ☐Accelerator ☐Networker	☐Acquisition Facilitator ☐In-House Developer ☐Other (please describe)

References

Australian Government. (2018). *Innovation.* Commonwealth of Australia. https://www.business.gov.au/Change-and-growth/Innovation

Baregheh, A., Rowley, J., & Sambrook, S. (2009). Towards a multidisciplinary definition of innovation. *Manager Decision, 47*(8), 1323–1339. https://www.researchgate.net/publication/41104662_Towards_a_Multidisciplinary_Definition_of_Innovation

Blackburn, D. (2018). *Response of The MITRE Corporation to the NIST RFI regarding federal technology transfer authorities and processes* (Report No. MP180463). McLean, VA: The MITRE Corporation.

Blackburn, D. M., Cook, J., Maybury, M. T., Sciambi, R. K., Wood, B. J., Coury, R. A., Case, R. A., Holland, R. J., Knowles, R. A., Lacher, A. R., Landry, R. J., Orlans, N. M., Rudell, M. E., & Swarup, V. (2017). *The innovation landscape and government's future role.* The MITRE Corporation. https://www.mitre.org/publications/project-stories/mitre-fosters-agency-collaboration-in-the-brave-new-world-of-technologyLean+Impact:+How+to+Innovate+for+Radically+Greater+Social+Good-p-9781119506645

Bozeman, B. (2000). Technology transfer and public policy: A review of research and theory. *Research Policy, 29*(4), 627–655. http://calitc.pbworks.com/f/TechTransferStudy.pdf

Chang, A. M., & Ries, E. (2018). *Lean impact.* Wiley. https://www.wiley.com/en-us/+Impact:+How+to+Innovate+for+Radically+Greater+Social+Good-p-9781119506645

Chappellet-Lanier, T. (2018, July 12). *Defense Innovaton Board proposes new metrics for assessing DOD software development* [Online forum post]. FEDSCOOP. https://www.fedscoop.com/defense-innovation-board-software-development-metrics/

Defense Innovation Board. (2018). *Defense Innovation Board metrics for software development* [Draft working document]. Department of Defense. https://media.defense.gov/2018/Jul/10/2001940937/-1/-1/0/DIB_METRICS_FOR_SOFTWARE_DEVELOPMENT_V0.9_2018.07.10.PDF

Department of Defense. (2017). *Report to Congress restructuring the Department of Defense acquisition, technology and logistics organization and chief management officer organization* (Section 901, FY 2017 NDAA Report). Office of the Secretary of Defense. https://dod.defense.gov/Portals/1/Documents/pubs/Section-901-FY-2017-NDAA-Report.pdf

Forsgren, N., & Kersten, M. (2018). DevOps metrics. *Communications of the ACM, 61*(4), 44–48. https://doi.org/10.1145/3159169

Gagnon, K. J., & Van Remmen, P. M. (2018). *Hacking the defense innovation ecosystem enterprise: A comparative analysis* [Master's thesis]. Naval Postgraduate School. https://apps.dtic.mil/dtic/tr/fulltext/u2/1069574.pdf

Glor, E. D. (2019). Factors and factor clusters most influential in introduction and global (survive/terminate) fate of innovations and their organizations – IV. *The Innovation Journal, 24*(2), 1–34. https://www.innovation.cc/scholarly-style/2019_24_2_1_glor_factors-clusters-iv.pdf

Government Accountability Office. (2014). *Office of Personnel Management: Agency needs to improve outcome measures to demonstrate the value of its innovation lab* (Report No. GAO-14-306). https://www.gao.gov/assets/670/662137.pdf

Green, E. (2013). Innovation: The history of a buzzword [Online forum post]. *The Atlantic.* https://www.theatlantic.com/business/archive/2013/06/innovation-the-history-of-a-buzzword/277067/

Ibrahim, N. (2015). *A project, a pilot and a plan: Promoting a culture of innovation* [Online forum post]. IDEA Lab Blog. https://www.hhs.gov/cto/blog/authors/nadia-ibrahim/index.html

Kane, J. F. (2019). *Enhancing the impact of research at federal research organizations* [Doctoral dissertation]. Robert Morris University. https://search.proquest.com/openview/063acc265260cd3fe22ddd4ed6f23beb/1?pq-origsite=gscholar&cbl=18750&diss=y

Kostoff, R. N. (1997). Use and misuse of metrics in research evaluation. *Science and Engineering Ethics, 3*(2), 109–120. http://ethics.iit.edu/eelibrary/biblio/use-and-misuse-metrics-research-evaluation

Lacity, M., & Willcocks, L. (2016, February). Business process outsourcing and dynamic innovation. *Strategic Outsourcing: An International Journal, 7*(1), 66–92. https://www.researchgate.net/publication/263371422_Business_process_outsourcing_and_dynamic_innovation

Liedtka, J., Sheikh, A., Gilmer, C., Kupetz, M., & Wilcox, L. (2018, July). The use of design thinking in the U.S. Federal Government. *Academy of Management Proceedings, 2018*(1). https://journals.aom.org/doi/abs/10.5465/AMBPP.2018.74

Machi, V. (2018, April 27). Air Force accelerating acquisition with AFWERX. *National Defense.* http://www.nationaldefensemagazine.org/articles/2018/4/27/air-force-accelerating--acquisition-with-afwerx

Minor, D. (2019). *Quantifying a culture of innovation* [White paper]. Spigit®. https://info.planview.com/rs/456-QCH-520/images/Quantifying-a-Culture-of-Innovation-Spigit.pdf

Mortensen, P., & Bloch, C. (Eds.) (2005). *Oslo manual: Guidelines for collecting and interpreting innovation data* (3rd ed.). OECD and Eurostat. https://ec.europa.eu/eurostat/documents/3859598/5889925/OSLO-EN.PDF/60a5a2f5-577a-4091-9e09-9fa9e741dcf1

Nader, R. (2001). Shopping for innovation: Government as smart consumer [Online magazine]. *The American Prospect.* http://prospect.org/article/shopping-innovation-government-smart-consumer

National Defense Authorization Act for Fiscal Year 2017, Pub. L. 114-328 § 901 (2016). https://www.congress.gov/bill/114th-congress/senate-bill/2943/text

Observatory of Public Sector Innovation. (2018). *Embracing innovation in government: Global trends 2018.* Organisation for Economic Co-operation and Development. https://www.oecd.org/gov/innovative-government/embracing-innovation-in-government-2018.pdf

Ries, E. (2017). *The startup way.* https://www.amazon.com/Startup-Way-Companies-Entrepreneurial-Management/dp/1101903201

Rung, A. (2016). *Fostering a culture of innovation across government through acquisition innovation labs* [Online forum post]. The White House. https://obamawhitehouse.archives.gov/blog/2016/03/09/fostering-culture-innovation-across-government-through-acquisition-innovation-labs

Smith, K. M., Crookes, E., & Crookes, P. A. (2013). Measuring research 'impact' for academic promotion: Issues from the literature. *Journal of Higher Education Policy and Management, 35*(4), 410–420. https://www.tandfonline.com/doi/abs/10.1080/1360080X.2013.812173

Endnotes

[1] For example, the Department of Defense (DoD) recently created the position of Under Secretary of Defense for Research and Engineering, or USD(R&E) in response to organizational changes stipulated by Section 901 of the National Defense Authorization Act for Fiscal Year 2017. That role is designed to focus on innovation within DoD (DoD, 2017).

[2] https://www.h4di.org/

[3]https://presidentialinnovationfellows.gov/

[4] https://www.afwerx.af.mil/

[5] The MITRE team's research explicitly excludes the types of research and organizations covered in Kane's dissertation; however, his work may inspire improved metrics for more traditional research and development organizations. The work covered in this article explores innovation rather than "basic" research and development.

[6] For succinctness, this article references all of these types of organizations as "government innovation organizations" although some of them are not part of the government.

[7] To encourage candid responses and maintain anonymity, MITRE is not publicly releasing the names of organizations that were contacted or participated.

[8] The similarity in the MITRE and Rockwood Company surveys exemplifies the reason for survey fatigue among government innovation organizations. Many researchers are using surveys to collect data and study various aspects of government innovation, often soliciting feedback from the same organizations.

[9] MITRE excluded data from the Rockwood Company survey on topics that Rockwood did not explicitly address with participating organizations. For example, the Rockwood survey did not collect information on external partnerships, so MITRE excluded those organizations from its findings on that topic. This article identifies all sample sizes that change due to partial or complete exclusions of the Rockwood study data.

[10] For example, MITRE considered adding a category for technology scouting, but concluded that activity would be performed by an organization falling into other categories such as advisor, investor, or incubator.

[11] Note that organizations were not limited to executing events aligned to their innovation type.

[12] In the data provided by the Rockwood Company, some organizations may have provided their measures of success but had not yet collected the appropriate metrics.

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Delivering Capability Through COMPETITION IN DEFENSE CONTRACTING: DOES POLICY DRIVE RESULTS?

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Competition in Defense contracting is a vital component of the acquisition system. Competition encourages research, innovation, and the production of new products and services, while motivating a robust industrial base. Accordingly, legislation, DoD directives, and policy guidance have sought to encourage competition in DoD contracting and enhance methods of tracking competition progress. This article presents the results of a study against the background of previous U.S. Government Accountability Office competition examinations to identify trends in competition, particularly in terms of DoD agencies and purchase categories. Data retrieved from the Federal Procurement Database System–Next Generation, and a sample of Justification and Approvals, retrieved from beta.sam.gov, provide a basis to forecast trends and a foundation for recommendations.

DOI: *https://doi.org/10.22594/dau.20-855.27.04*
Keywords: *Competition, Contracting, Contract Award, Other Transaction Authority (OTA), Federal Procurement Database System–Next Generation*

Image designed by Michael Bubar-Krukowski

> Competition is at the very heart of our American economic system. In many ways, it is to economic freedom what free expression is to political freedom. Our economy was built on competition. Our economic system presumes that anyone will have the opportunity to compete in the marketplace, and that consumers will obtain the best products at the fairest price as a result of such competition. (Competition in Contracting Act, 1983a, p. 42)
>
> —Senator John Tower
> Chairman of the Senate Armed Services Committee

Defense Pricing and Contracting (DPC) in the Office of the Secretary of Defense (OSD), which has responsibility for all pricing, contracting, and procurement policy matters in the Department of Defense (DoD), agrees with Congress and the U.S. Government Accountability Office (GAO) that "competition is the cornerstone of a robust acquisition system" (GAO, 2013). The DoD budget for Fiscal Year 2019 (FY19) was $733 billion, representing approximately 50% of the discretionary spending budget and 15% of the total FY19 federal budget (U.S. Congressional Budget Office, 2020). This amount of spending requires accountability and has been heavily scrutinized. To foster accountability, competition has been a key DoD focus area, and is a "powerful tool for achieving cost effective acquisition" (Chandler, 2014, p. 1). Competition encourages research, innovation, and the production of new products and services, while motivating a robust industrial base. Accordingly, legislation, DoD directives, and policy guidance have sought to encourage competition in DoD contracting and enhance methods of tracking competition rates.

This article presents the results of a study against the background of previous GAO competition examinations. Specifically, the authors were guided by a series of GAO reports (2013, 2014, 2015), directed by the conference report for the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2012 (H.R. Rep. No. 112-329, 2011). The original methodology applied

in the GAO reports was repeated to investigate the same variables and extended to include competition data from FY14–19, the most recently completed fiscal years.

A comprehensive assessment of competition was performed to

- provide an overview of prior legislation aimed to encourage competition,
- identify trends in competition, particularly in terms of DoD agencies and purchase categories,
- examine Justification and Approval (J&A) documents from a sampling of product service code (PSC) categories in the data analysis to identify themes in program office rationales as an exception to pursuing competition, and
- review Other Transaction (OT) agreements to assess the competition impact from the significantly increased use of this contractual business instrument.

This focused review provides a basis to forecast trends and the foundation for recommendations.

Competition History

Competition in defense acquisition has been historically encouraged. The first Superintendent of Finance, Department of Treasury, Robert Morris, introduced invitations to bid in 1781, and the first law to require competition specified formal advertising in 1809 (Keeney, 2007). While statutory requirements for competition have varied over the years, the Competition in Contracting Act of 1984 (CICA, 1983a) serves as the foundation for the present-day Federal Acquisition Regulation (FAR) to govern competition (FAR, 2020; Manuel, 2009).

Contracting officers are directed by statute to promote full and open competition with limited exceptions (Policy, 2002). The requirement for full and open competition can be met by applying any of the following "competitive procedures" recognized in Competitive Procedures (2015), Full and Open Competition (2010), and Public Contracts (2020).

1. Procurement of architectural or engineering services conducted in accordance with Selection of Architects and Engineers (2011). The Brooks Act, enacted in 1972, directed procedures for selecting architects and engineers for federal

design and construction services. The qualification-based selection process considers applicant competency and qualifications applicable to the type of service desired and does not consider price. The highest ranked offeror enters negotiation for contract award. If a fair and reasonable price cannot be agreed to, the Government will pursue the next highest ranked offeror (The Brooks Act of 1972).

2. Competitive selection of basic research proposals resulting from a general solicitation and the peer review or scientific review of proposals, or from a small business solicitation in accordance with Research and Development (2012).

3. Procedures established by the Administrator of General Services for the multiple awards schedule program of the General Services Administration (GSA) if (a) participation in the program has been open to all responsible sources, and (b) orders and contracts under those procedures result in the lowest overall cost alternative to meet the needs of the Federal Government.

4. Procurements conducted in furtherance of the Small Business Act (Awards or Contracts, 2012) as long as all responsible business concerns that are entitled to submit offers for those procurements are permitted to compete.

5. Sealed bids. An agency shall solicit sealed bids if the four conditions are applicable: (a) time permits the solicitation, submission, and evaluation of sealed bids, (b) the award will be made on the basis of price and other price-related factors, (c) it is not necessary to conduct discussions with the responding sources about their bids, and (d) there is a reasonable expectation of receiving more than one sealed bid (Contracts: Competition Requirements, 2011a).

6. Competitive procedures when sealed bids are not appropriate given the prior four conditions (Contracts: Competition Requirements, 2011b).

7. Competitive procedures or combination of competitive procedures that is best suited under the circumstance of the procurement (Full and Open Competition, 2020).

Competition may be impractical or unadvisable for a variety of situations. When the head of the contracting agency determines that full and open competition is not viable, noncompetitive procedures may be applied under certain conditions (Task and Delivery Order Contracts: Orders, 2020a). Seven conditions exist that provide procedures for noncompetitive, other than full and open, contract award (CICA, 1983b; Contracts: Competition Requirements, 2011d; Task and Delivery Order Contracts: Orders, 2020b):

1. The property or services needed by the executive agency are available from only one responsible source.

2. The need is of such an unusual and compelling urgency that the United States would be seriously injured unless permitted to limit the number of sources.

3. It is necessary to award the contract to a particular source in order to maintain a facility, producer, manufacturer, or other supplier or achieve industrial mobilization.

4. The terms of an international agreement or a treaty between the United States and a foreign government or international organization require the use of procedures other than competitive procedures.

5. A statute expressly authorizes or requires that the procurement be made through another agency or from a specified source.

6. The disclosure of the agency's need would compromise the national security unless the agency is permitted to limit the number of sources.

7. The head of the agency determines that it is necessary in the public interest to use procedures other than competitive and notifies Congress in writing no less than 30 days before the award of the contract.

In an effort to encourage competitive contract awards, the executive branch, Congress, and the DoD have all issued directions to inform actions taken by the defense acquisition community. The increase in government spending on contracts caused dollar value to double to $500 billion between 2001 and 2008; this included an increase in the value of dollars awarded through noncompetitive procedures and an increase in the value of dollars obligated through cost-reimbursement. In 2009, President Obama issued a memorandum to federal contracting agencies directing the development of Government-wide guidance to maximize effective use of competitive acquisition strategies and minimize the use of sole-source and noncompetitive contract award.

Congress has specifically tasked major weapon systems program offices to develop acquisition strategies that include opportunities for competition and mitigate barriers to competition. The NDAA for FY 2007, Section 802(a) required major weapon systems and subsystems to assess the long-term requirements for technical data, computer software, and license rights to support system sustainment (NDAA, 2006). In 2009, Congress unanimously

passed the Weapon Systems Acquisition Reform Act, addressing "many of the problematic issues facing the defense acquisition process" (Berteau et al., 2010, p. 3). Specific to increasing competition in defense contracting, DoD required all major defense acquisition programs (MDAP Defined, 2006) to ensure competition at the prime and subcontractor level over the life cycle of the program (Weapon Systems Acquisition Reform Act of 2009). All opportunities for competition and cost-effective measures are to be considered in strategy development. System or program reviews are an opportunity to revisit program decisions and assess their effect on long-term impact on competition.

Additionally, DoD, which accounts for the vast majority of federal procurement spending every year, published Better Buying Power (BBP) guidance in 2010 to promote greater efficiency and productivity through internal improvement (Carter, 2010a). Competition in contracting remained a principal initiative for the duration of the 7-year program and was included in each of the two separate updates, BBP 2.0 and BBP 3.0. As Under Secretary of Defense for Acquisition, Technology, and Logistics, Dr. Ash Carter (2010b) identified real competition as being the single most powerful tool available to drive productivity.

Furthermore, BBP policy included initiatives to reduce the occurrence of "ineffective competition," which occurred when a full and open competition was facilitated and only one offer to a solicitation was received (Carter, 2010b). The Defense Federal Acquisition Regulation Supplement (DFARS) was amended in 2012 to implement the BBP initiatives: guidance for contracting officers regarding circumstances when additional cost or pricing data are necessary and whether such data must be certified; reporting requirements for agency-level competition advocates; resolicit requirement if fewer than 30 days were allowed for receipt of proposal; revaluate requirement definition for revision; solicit and document feedback from offerors that were previously interested regarding failure to submit a proposal (Acquisition Planning, 1991; Publicizing Contract Actions, 2020).

One significant example of "ineffective competition" is the Air Force solicitation for the Ground Based Strategic Deterrent. Although two contractors (Boeing and Northrop Grumman) were carried through the Technology Maturation and Risk Reduction (TMRR) phase, ultimately Boeing dropped out of the competition for engineering, manufacturing, and development (EMD), leaving Northrop Grumman as the sole bidder. The Air Force had previously eliminated Lockheed Martin from the TMRR contract (Insinna, 2017). Boeing's reasoning for withdrawing cited "...concerns with

the procurement process... and determined that the current acquisition approach does not provide a level playing field for fair competition" (Insinna, 2019). At the heart of Boeing's concern was Northrop Grumman's recent acquisition of Orbital ATK and whether it would provide an unfair competitive advantage, as the purchase positioned Northrop Grumman as one of only two producers of solid rocket motors in the United States. Boeing feared having to turn over proprietary data to Orbital (now a part of Northrop Grumman) if they were forced to use them as a subcontractor, thus giving Northrop Grumman a competitive edge.

Identifying causal factors behind ineffective competition requires detailed research into the background of a wide array of DoD acquisition programs. Through this research, trends may emerge that can influence future U.S. Government acquisition policy development and implementation. These updated policies would be structured to create an environment that would result in increasing levels of effective competition. This article will explore those causal factors using extensive information from existing, available sources.

Competition Data, FY14-19

Data for this article were collected from the Federal Procurement Database System–Next Generation (commonly referred to as FPDS) in December 2019 (GSA, 2020a). The system contains data on federal contracts with estimated values of $10,000 or more and any size modifications to those contracts. These reflect all prime contracts—contracts where the Federal Government has a direct relationship with the vendor. It does not contain information on subcontracting or subcontractors—situations where a vendor with a federal contract in turn hires another vendor to perform a portion of the work. Specifically, the authors examined data from FY14–19.

Although FPDS is the official system for reporting federal contracts, it is a dynamic system and is subject to error. FPDS relies on contracting office personnel reporting contractual data that are accurate and timely. Data are occasionally reported incorrectly and corrected at a later time. Funds obligated in one fiscal year, may be de-obligated in a later fiscal year, thereby affecting data captured by fiscal year.

Data on overall DoD competition rates and rates by agency were acquired using the FPDS standard competition report, which summarizes the number of contracting actions, the dollars spent on contracting actions, and the percentage of actions and dollars competed. (Note that actions reported in FPDS are defined by Reporting Data [2020]: definitive contracts over the micropurchase threshold, task and delivery order contracts, GSA orders,

and calls and orders awarded under the indefinite delivery vehicles.) This report enables drill-down to specific contracting agency, thereby allowing comparisons between numbers reported by the military departments—Army, Navy (including the Marines), and Air Force—and other DoD agencies.

To collect PSC data, the authors generated custom queries within FPDS that returned amounts obligated per PSC, and further subdivided by the use of competitive practices and any cited competition exceptions. The cited competition exception data in turn informed an analysis of rationales for noncompeted contracts, and guided searches on https://beta.sam.gov/ (the successor to FedBizOps.gov and the official Federal Government website for federal contract opportunities) for sample J&A documents (GSA, 2020b).

Competition rates for OTs are not specifically identified in the standard competition report; therefore, data for the OT analysis involved further custom queries specifically identifying OT status and reported competition extent as reported on individual OTs. The examination of competitively awarded OTs is reported following the analysis of FAR-based contracts.

Overall DoD Competition

For the initial DoD-wide view, the authors analyzed three number categories. The first category, dollars contracted, is the amount obligated by any part of the DoD on any contract regardless of the presence or absence of competition. The second category, dollars contracted on competitive contracts, is a subset of the first category; it includes only amounts obligated on contracts that reported using competitive procedures. The third category, percentage of dollars contracted on competitively awarded contracts, divides the first category by the second to calculate the competition rate (Table 1).

TABLE 1. DOD CONTRACTING AND COMPETITION SUMMARY

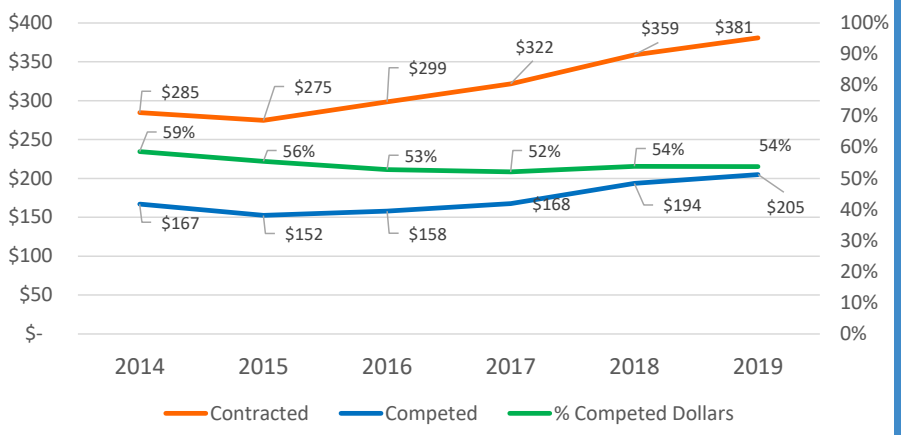
FY	Category	Army	Navy / Marines	Air Force	DLA	All Others	Total
2014	Total ($B)	$75	$84	$56	$32	$37	$284
	Competed ($B)	$49	$37	$24	$27	$29	$166
	% Competed $	65.4%	44.4%	43.5%	84.1%	77.6%	58.5%
2015	Total ($B)	$73	$85	$53	$31	$33	$275
	Competed ($B)	$43	$37	$21	$26	$26	$153
	% Competed $	59.4%	43.7%	39.0%	83.3%	77.7%	55.6%
2016	Total ($B)	$74	$93	$65	$30	$36	$298
	Competed ($B)	$43	$38	$26	$24	$27	$158
	% Competed $	58.3%	40.9%	39.3%	79.3%	74.7%	53.0%
2017	Total ($B)	$78	$110	$61	$36	$37	$322
	Competed ($B)	$45	$40	$26	$28	$29	$168
	% Competed $	57.6%	36.2%	43.1%	78.0%	77.4%	52.2%
2018	Total ($B)	$92	$108	$71	$45	$43	$359
	Competed ($B)	$54	$44	$30	$35	$32	$195
	% Competed $	58.9%	40.3%	41.8%	75.9%	74.4%	54.3%
2019	Total ($B)	$95	$120	$76	$44	$47	$382
	Competed ($B)	$58	$48	$34	$31	$34	$205
	% Competed $	60.8%	40.1%	44.6%	71.1%	73.5%	53.7%

The number of dollars contracted by DoD from FY14 to FY19 increased by approximately 33%, from $285 billion to $381 billion. Growth occurred every year except FY15, which dipped to $275 billion, $10 billion below the previous year. The amount of competed contract dollars grew at a slightly lower rate, increasing from $167 billion to $205 billion—a 23% increase. Mirroring overall contracted dollars, FY15 reported the lowest amount and the only year-over-year decline within the study period, falling to $152 billion, or $15 billion lower than the previous year. While FY16 grew $6 billion over its predecessor, its $158 billion was below FY14, and overall growth within this study period did not occur until FY17, with $168 billion. Percentage of competed dollars declined over the study period, from 59% to 54%. Values declined annually from FY14 to FY17, bottoming out at 52%. Rates increased to 54% in FY18 but remained flat into FY19.

Combining the data, the authors investigated linkage between the dollars contracted and competition percentage. During most of the study years, dollars contracted increased as the percentage of dollars contracted declined; however, this was not the case every year. While both competition

rate and contract dollars declined between FY14 and FY15, competition rates varied between declining, growing, and flatlining between FY15 and FY19, during which time contracted dollars saw uninterrupted growth. Counter to the overall inverse trend, competition rate grew the most (2%) during the largest dollars contracted year (FY18) (Figure 1).

FIGURE 1. CONTRACTED & COMPETED CONTRACT DOLLARS ($B) & COMPETITION RATE



A different picture emerges when considering the number of contracting actions (regardless of dollar amount). The percentage of competed actions over the same period grew from 97% to 99%, with a dip to 96% in FY16. In all years studied, the percentage of competed actions exceeded the percentage of dollars competed by at least 38%. Simultaneously, the number of contract actions reported by DoD skyrocketed from 13 to 14 million annually between FY14 and FY17, reaching over 70 million in FY19. This jump appears to be influenced by reporting changes at U.S. Transportation Command (USTRANSCOM) that resulted in the number of reported actions growing between 10 and 11 million per year from FY14 to FY17, to 30 million in FY18 and 66 million in FY19. A vast majority of contract actions are low dollar value (for example, USTRANSCOM accomplished more than 60 million contract actions for an average of $70 per action) and were awarded using competitive procedures.

Excluding all of USTRANSCOM's contract actions reduces the rate of competition by contract action and depicts a less dramatic overall increase in the number of contracting actions. Instead of exceeding 96% in FY14, the percentage of contracted actions, without USTRANSCOM, grew from

80% in FY14 to 89% in FY18, followed by a slight decline to 88% in FY19. Excluding USTRANSCOM, the difference between the percentages of competed actions and competed dollars decreased by approximately 21% (Figure 2). Non-USTRANSCOM contract actions jumped from 1.6 million in FY14 to 3.3 million in FY15 and grew annually through FY18. The only declining year was FY19, which saw a decrease from 4.6 to 4.4 million contract actions (Figure 3).

FIGURE 2. PERCENTAGE OF COMPETED ACTIONS

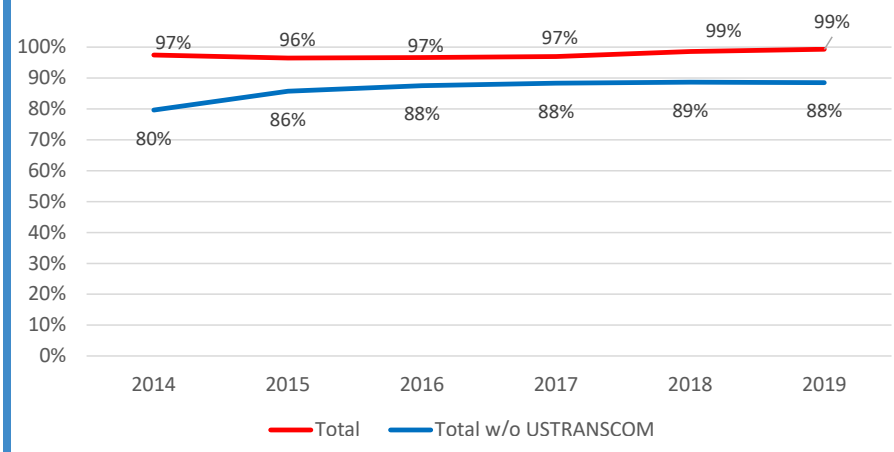
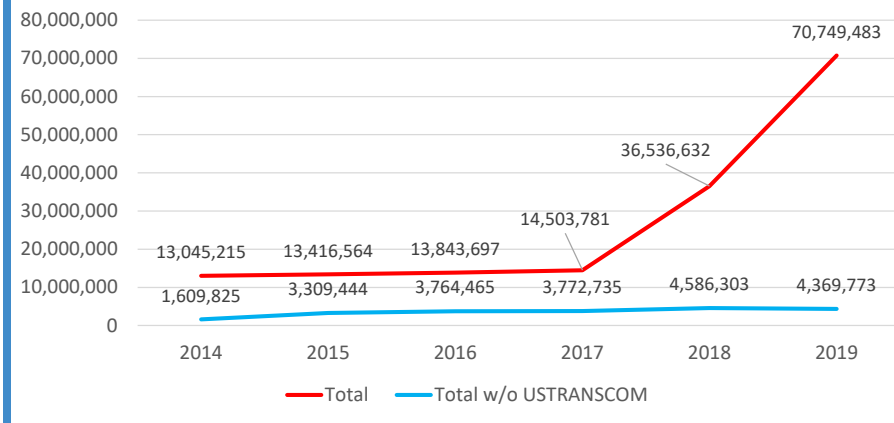


FIGURE 3. CONTRACT ACTIONS

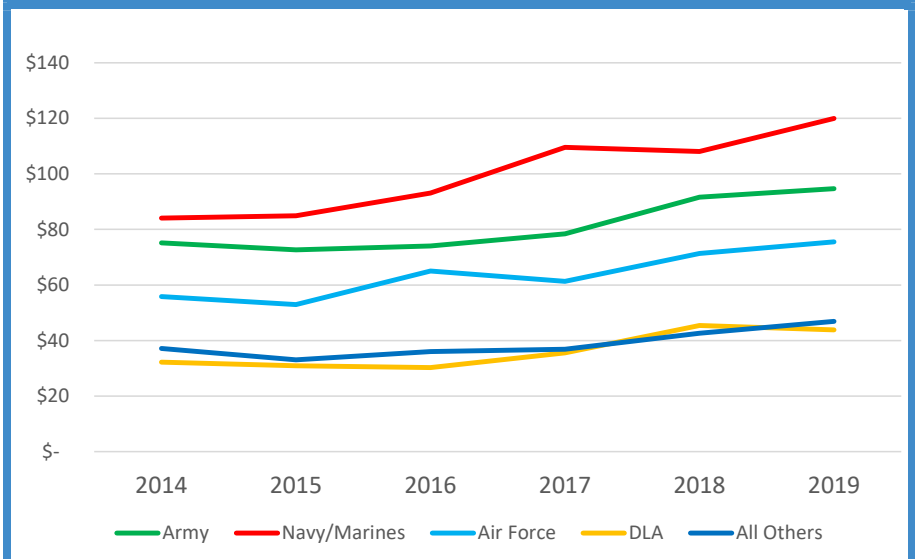


From the above, the research team notes that while a high percentage (80 to 99%) of contract actions are competed, the dollar values of these actions are not equivalent, and the rate of competed dollars is skewed by a relatively small number of high-dollar-value contracts.

Competition by DoD Agency

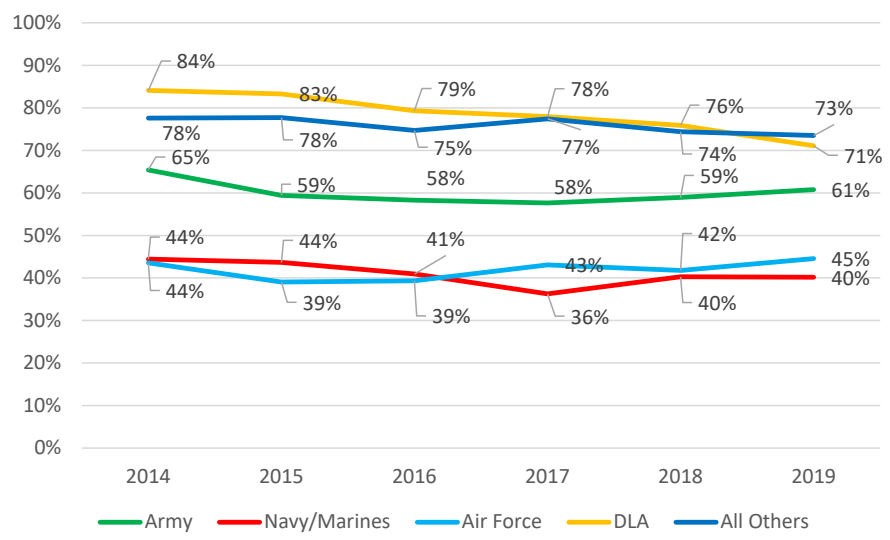
Competition rates vary across DoD agencies. The military departments—Army, Navy (including the Marines), and Air Force—account for an average of 75% of all of DoD's contracted dollars, individually ranging from 13 to 28%. The Navy led DoD agencies in contract dollars in every year of this study, growing annually, aside from a $1.5 billion dip between FY17 and FY18. In FY19 alone, the Navy contracted nearly $120 billion. The Navy was trailed by the Army and Air Force, respectively. Army contracts grew overall, from $75 billion to nearly $95 billion, with a downturn to $73 billion in FY15. Air Force contracts also increased, from $56 billion to nearly $76 billion, but their growth was interrupted twice: in FY15 and FY17. Outside of the military departments, the next highest obligating organization was the Defense Logistics Agency (DLA), which accounted for 13 to 18% of contracted dollars in the survey years, and close to $44 billion in FY19 alone. All other agencies combined (e.g., Missile Defense Agency, Defense Contract Management Agency, U.S. Special Operations Command) account for the remainder—approximately $47 billion in FY19 (Figure 4).

FIGURE 4. CONTRACTED DOLLARS ($B) BY DEPARTMENT/AGENCY



In terms of percentage of dollars awarded using competitive procedures, the military departments consistently lagged the rest of the DoD and, aside from the Army, the DoD as a whole. The Navy and Air Force reported the lowest competition rates among military departments, ranging between 36 and 45%. The two departments shared or swapped competition rates between FY14 and FY17, though the Air Force has maintained a higher competition rate than the Navy since that year. The Army reported the highest competition rates among the military departments, ranging from 57 to 65%, and consistently beat the overall DoD competition rate (Figure 1). Although DLA consistently reported competition rates more than 16% higher than the overall DoD rate, its rates declined annually over the study period from 84% to 71%. Remaining DoD agencies also reported rates above 70%, but also saw a general decline, moving from 78% to 73% (Figure 5).

FIGURE 5. CONTRACT COMPETITION RATES BY DEPARTMENT/AGENCY



In sum, from an agency-level perspective, the military departments obligate the majority of DoD's contracted dollars and award contracts using competitive procedures at the lowest rates. To investigate reasons for the competition rates between the military departments and the rest of DoD, the authors turned their attention to the categories of products and services the agencies acquired.

Competition by PSC

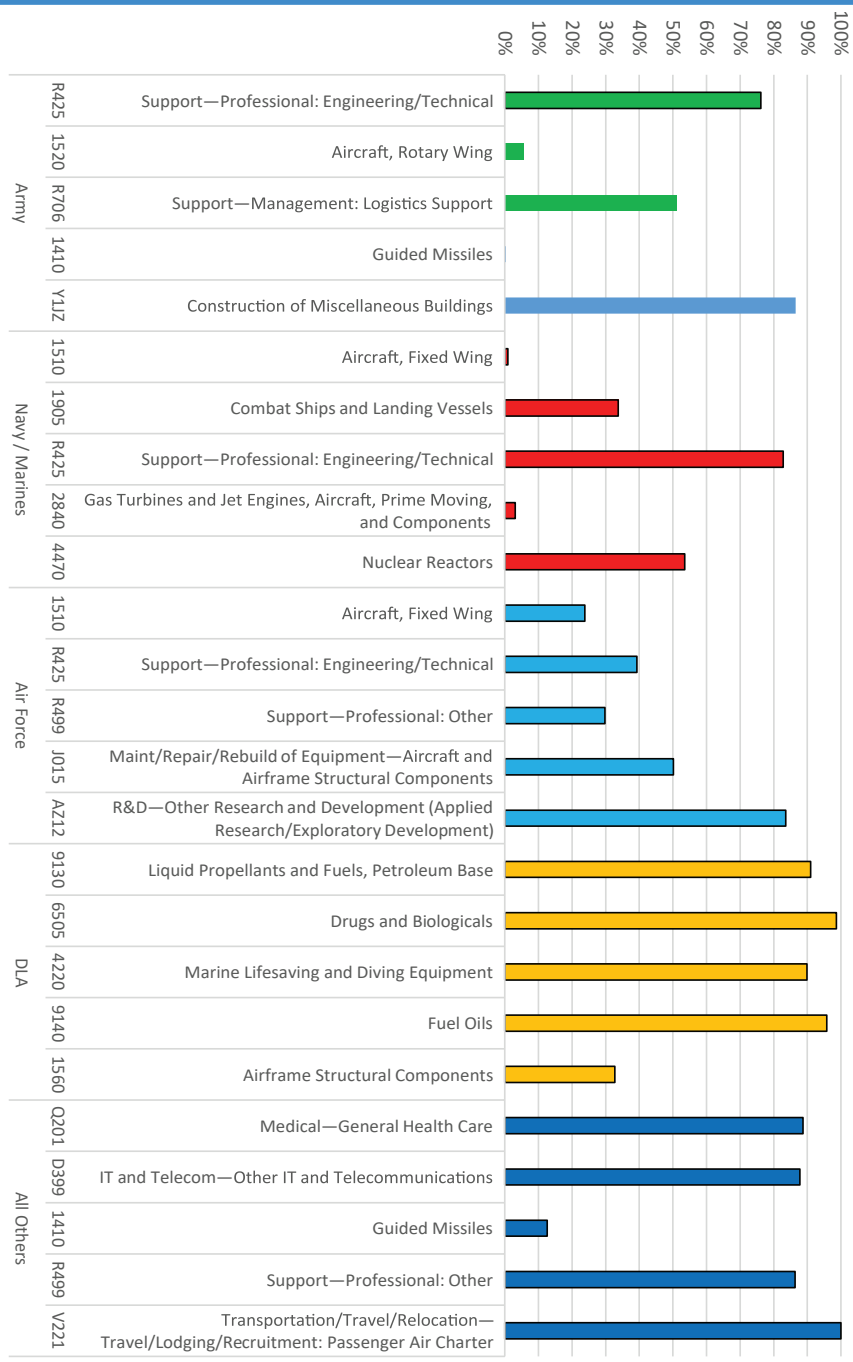
A useful method for grouping acquisitions is by using the PSCs. The codes categorize the predominant item or service purchased through a contracting action. GSA maintains a list of more than 5,000 PSCs covering a wide variety of categories including weapon systems; ship and marine equipment; mechanical power transmission equipment; and maintenance, repair, and alteration. PSCs give insight into the types of items purchased by different DoD agencies and provide correlations between the types of items purchased and competition rates.

According to FPDS, between FY14 and FY19, the DoD used more than 2,600 different PSCs. Table 2 depicts the top five PSCs in terms of dollars obligated for the military departments, DLA, and all other DoD agencies during the study years. These PSCs represent significant portions of each agency's obligation, ranging from 19% for the Army, to 45% for other DoD agencies. Plotting these PSCs on a graph (Figure 6) visually depicts differences in competition. In general, the military departments' top PSCs reported lower rates of contract award using competitive procedures. Four out of the top five Air Force PSCs have competition rates at or below 50%. Three of the Navy's top PSCs do not reach 50%. The Army has only two PSCs below 50%, but one—R706, Support-Management: Logistics Support—is only 51%; and PSC 1410, Guided Missiles, rounds down to 0%. DLA and other DoD agencies show the inverse of the military departments, with four of the five PSCs in both cases weighing in between 80 to 90%. This chart suggests competition is influenced by the type of product or service contracted by an organization.

TABLE 2. TOP PSC'S BY DEPARTMENT/AGENCY

Agency	Product Service Code		% Competed	Total ($B)
Army	R425	Support—Professional: Engineering/ Technical	76%	$28.62
	1520	Aircraft, Rotary Wing	6%	$21.81
	R706	Support—Management: Logistics Support	51%	$16.48
	1410	Guided Missiles	0%	$16.06
	Y1JZ	Construction of Miscellaneous Buildings	86%	$11.17
Navy / Marines	1510	Aircraft, Fixed Wing	1%	$110.54
	1905	Combat Ships and Landing Vessels	34%	$71.70
	R425	Support—Professional: Engineering/ Technical	83%	$24.75
	2840	Gas Turbines and Jet Engines, Aircraft, Prime Moving, and Components	3%	$21.73
	4470	Nuclear Reactors	54%	$16.71
Air Force	1510	Aircraft, Fixed Wing	24%	$57.55
	R425	Support—Professional: Engineering/ Technical	39%	$29.35
	R499	Support—Professional: Other	30%	$16.24
	J015	Maint/Repair/Rebuild of Equipment—Aircraft and Airframe Structural Components	50%	$13.93
	AZ12	R&D—Other Research and Development (Applied Research/Exploratory Development)	84%	$11.63
DLA	9130	Liquid Propellants and Fuels, Petroleum Base	91%	$40.15
	6505	Drugs and Biologicals	99%	$28.90
	4220	Marine Lifesaving and Diving Equipment	90%	$11.73
	9140	Fuel Oils	96%	$9.98
	1560	Airframe Structural Components	33%	$6.46
All Others	Q201	Medical—General Health Care	89%	$67.17
	D399	IT and Telecom—Other IT and Telecommunications	88%	$12.28
	1410	Guided Missiles	13%	$11.08
	R499	Support—Professional: Other	86%	$8.04
	V221	Transportation/Travel/Relocation—Travel/ Lodging/Recruitment: Passenger Air Charter	100%	$7.21

FIGURE 6. COMPETITION RATE FOR TOP PSC'S BY DEPARTMENT/AGENCY

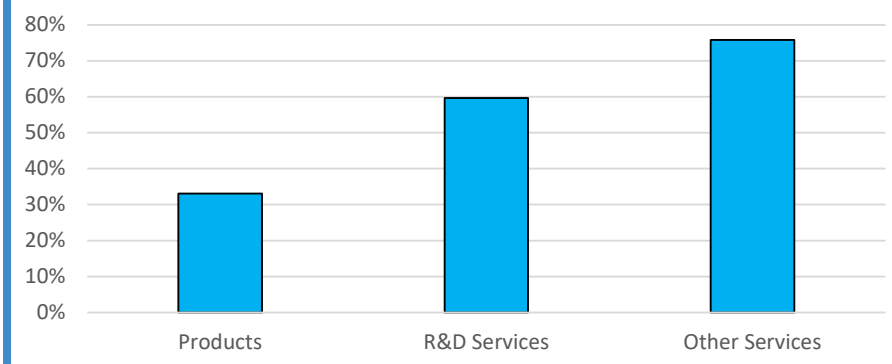


The most prominent low-competition PSCs in military departments are hardware-based, major weapon systems—aircraft (fixed and rotary wing), missiles, and engines. Contracts awarded using other than competitive procedures were driven by legacy systems and additional lot purchases. For example, in FY19 the Navy obligated more than $15 billion (around 12.5% of its entire annual obligation of $120 billion) on contracts for F-35 aircraft and engines that were not competed. Although the contract that led to the initial development of the F-35 was competitively awarded, subsequent awards were made through noncompetitive procedures and justification identified only one responsible source. Similar circumstances applied to the Air Force on recent F-15 and C-130 aircraft purchases, and for the Army on Patriot Missile purchases. This is a natural result of the DoD acquisition framework, where the Government competes and funds initial development, intending to purchase production quantities later, primarily from the original equipment manufacturer.

Conversely, the PSCs with the highest rates of competition—construction, professional engineering support, and research and development (R&D)—are based more on expertise and labor hours. This pattern holds true for non-DLA agencies, where the only hardware-related PSC in the top five—guided missiles—is also the lowest competed PSC. DLA's situation varies slightly as it reports high competition rates for hardware categories. DLA's situation is attributable to the nature of its mission, which is mainly focused on spare parts, equipment, and consumable items rather than the military departments' full weapon system responsibility. Note how DLA's top four PSCs can be categorized as equipment or consumable.

The hardware versus support difference is observed further with the macro view of grouping PSCs as "product" or "services." "Product" indicates purchase of a specific end item (e.g., an airplane, ship, or tank). "Services" indicate purchases for labor or expertise (e.g., engineering subject matter expertise, facilities maintenance, or dining services). Product PSCs are four-digit numeric codes, while services PSCs are denoted by a letter followed by three numbers. Figure 7 shows competition rates in groups of products, R&D services, and non-R&D services. Confirming the trend seen with the top PSCs, as an overall group, product PSCs compete at a much lower rate (33%) than either R&D (60%) or non-R&D services (76%). Competition occurs less frequently for end items than when purchasing labor or expertise. To determine the reason for this difference, the authors next examined the rationale cited by program offices as justification for other than competitive procedures.

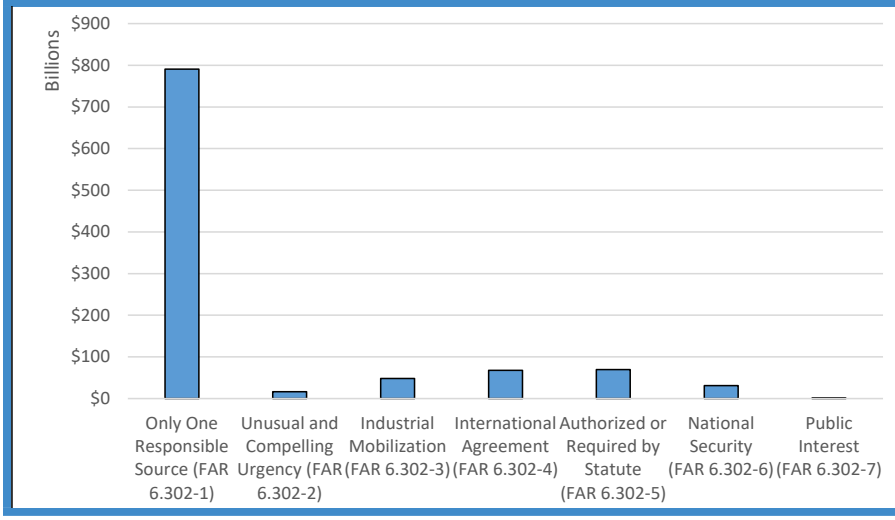
FIGURE 7. COMPETITION RATES FOR PRODUCTS & SERVICES



Exploring Reasons for Noncompetition

Exceptions may apply to full and open competition, and CICA allows for other than competitive procedures to procure property and services (Contracts: Competition Requirements, 2012). By far the most heavily cited exception over the study period (associated with more than $791 billion compared to $234 billion for all six other exceptions combined) was "only one responsible source." This exception to competitive procedures pertains to situations where only one responsible source is assessed as capable of reasonably meeting the contractual requirements, and no other type of property or service will satisfy the needs of the agency (Contracts: Competition Requirements, 2011c). Figure 8 lists the allowed exceptions and contractual dollars associated with each exception during the study period.

FIGURE 8. FAR EXCEPTIONS BY DOLLARS OBLIGATED



To explore factors leading to program justification of "only one responsible source," the authors examined 23 J&A documents (Table 3). A J&A is a document prepared by a program office to document the rationale of a contract award using other than competitive procedures. J&As are approved by senior DoD leadership based on the estimated dollar value of the expected associated contracts. Content includes background on the program, exception citation, rationale for that citation, a summary of research that led to that rationale, and a description of planned efforts to encourage future competition. The examined J&As, which were posted on beta.sam.gov, drew from the three military departments and include a cross-section of the PSCs with the lowest competition rates. A statically rigorous sample would require examination of a much larger number of the more than 5,000 J&As listed on beta.sam.gov during the study period. However, even with the smaller number of J&As examined, multiple consistent themes emerged. Notable themes include an established source developed with a high start-up cost, insufficient Government data rights, and unacceptable performance gaps.

Many of the examined J&As describe extensive investments made by their incumbent source and the high cost and schedule requirements of starting a new source, which would outweigh any perceived benefit gained from competition. For complicated hardware purchases, the additional costs and time investments necessary to establish a new source may not justify potential savings from a competition. For example, in a J&A that cited only one responsible source for a low-rate production contract for the F-35, the program office noted: "the establishment of a competitive production line for part or all of the JSF [Joint Strike Fighter] would require a front-end investment, together with increases in recurring costs, that would probably not be recovered through price reductions that might result from competitive forces." Furthermore, "developing and qualifying an alternative manufacturer would take roughly seven to nine years [at added cost] for nonrecurring engineering, tooling, nonrecurring equipment, testing, support, and training" (U.S. Navy [USN], 2017a, p. 7). Shipbuilding presents a stark example given the limited number of shipyards available in the United States. In a J&A for aircraft carriers, the Navy notes: "Huntington Ingalls, Inc., Newport News Shipbuilding is the nation's only designer and builder of nuclear powered aircraft carriers... [and is] the only private shipbuilder with adequate facilities to accommodate construction of the large deck carrier" (USN, 2016b, p. 3).

TABLE 3. SUMMARY OF REFERENCED J&A'S

PSC	Description	Program	Agency	Key Rationale
13	Ammunition and Explosives	RESET	DLA	Urgent and compelling need to repair equipment returning from deployment. Government does not have rights to technical data (DLA, 2017a).
42	Fire/Rescue/ Safety; Environmental Protection	DLA Maritime	DLA	Hood assembly used on existing respirator system; replacement from OEM required to maintain National Institute for Occupational Safety and Health (NIOSH) approval (DLA, 2017c).
61	Electric Wire, Power Distribution Equipment	Direct Support Electrical Test Sets	DLA	Only one responsible source. Government does not have Technical Data Package (TDP). Time to obtain technical data and compete a new contract deemed unacceptably long (DLA, 2017b).
1410	Guided Missiles	High-Speed Anti-Radiation Missile (HARM)	USN	Only source with technical knowledge, experience, highly skilled personnel, and resources. Government is reliant on contractor's proprietary knowledge. Unacceptable delays from other sources due to set-up and relocation (USN, 2016c).
1410	Guided Missiles	Harpoon	USN	Experienced contractor. Government does not have TDP; contractor not willing to sell. Estimate 4-7 years to stand up new supplier (USN, 2016d).
1410	Guided Missiles	Javelin	USA	Only source with knowledge and facilities. Other sources would duplicate development & test. Minimum 5-year delay. Planned assets insufficient for dual sources (USA, 2012).
1510	Aircraft, Fixed Wing	C-12	USN	Contract initially competed; subsequent buys were sole-source; estimated 24-month delay and nonrecurring engineering to recompete (USN, 2016a).
1510	Aircraft, Fixed Wing	F-22	USAF	Experienced contractor; established public-private partnerships. Highly innovative & specialized system. Government does not have TDP. Reverse engineering inefficient (USAF, 2016a).
1510	Aircraft, Fixed Wing	F-35	USN	Only source with the requisite knowledge, experience, technical expertise, and facilities required. Government does not have the TDP (USN, 2017a).
1520	Aircraft, Rotary Wing	AH-64E	USA	Only one responsible source. Government does not have technical data. Time to obtain technical data and compete a new contract deemed unacceptably long (USA, 2017a).
1520	Aircraft, Rotary Wing	AH-1Z	USN	Only source with the necessary propriety data, test facilities, tooling, equipment, and knowledge. Government does not own or have the TDP (USN, 2013).
1520	Aircraft, Rotary Wing	Liberty Project Aircraft	USA	Contractor is the only source with the technical data, proprietary manufacturing processes, technical expertise, and infrastructure required to meet timeline. Government does not have TDP (USA, 2015).
1680	Miscellaneous Aircraft Accessories and Components	Common Missile Warning System	USA	OEM has unique knowledge, skills, and understanding of the design. Government does not own TDP. TDP purchase not considered viable due to the program's expected life. Without TDP, other sources would need to duplicate OEM and receive qualification (USA, 2017b).
1680	Miscellaneous Aircraft Accessories and Components	Oxygen Canisters	USAF	Only known FDA-approved product available that meets requirements (USAF, 2014).
1901	Aircraft Carriers	Aircraft Carriers	USN	Complicated and specialized system. Contractor is the nation's only designer and builder of nuclear aircraft carriers. Only private shipbuilder with adequate facilities. Experience with the specific ship class (USN, 2018).
1905	Combat Ships and Landing Vessels	Decatur Rust	USN	Similar in scope to ongoing work; adding a contractor would result in duplication and interfere with the incumbent's ongoing work (USN, 2017b).

TABLE 3. SUMMARY OF REFERENCED J&A'S (CONTINUED)

2840	Gas Turbines and Jet Engines, Aircraft, Prime Moving; and Components	F107 Engine	USAF	Contractor uniquely possesses the facilities and equipment necessary. Specialty design. Duplication of costs. Government does not have TDP. Reverse engineering is technical risk (USAF, 2016b).
2840	Gas Turbines and Jet Engines, Aircraft, Prime Moving; and Components	F404 Engine	USN	Qualified source required. Contractor with manufacturing knowledge, or technical data. Government does not have TDP. Alternate sources would have to go through a qualifying approval (USN, 2014).
J019	Maintenance, Repair, and Rebuilding of Equipment—Ships, Small Craft, Pontoons, and Floating Docks	CVN Nuclear Touch Labor	USN	Requires detailed knowledge and familiarity. Only one builder of nuclear vessels (USN, 2016b).
R425	Support—Professional: Engineering/ Technical	Air Defense Planning Tool	USAF	Contractor owns intellectual property and data rights for key software used, and is only company that can make dynamic software changes in response to user needs. Government does not have TDP (USAF, 2017). Note: Sole Source Synopsis.
R425	Support—Professional: Engineering/ Technical	B61 Support	USAF	Contractor is uniquely qualified. Short-term effort to prevent break in service (USAF, 2015).
R499	Support—Professional: Other	U.S. Forces-Afghanistan/ Resolute Support, Intelligence Support Service—Afghanistan, and Combat Intelligence Augmentation Teams	USA	Uniquely experienced source. Break in service or vendor transition during middle of fighting season is unacceptable (USA, 2017d).
R706	Support—Management: Logistics Support	63 Regional Support Command	USA	Previous competitive efforts sidelined by protest. Current contractor in place and ready. This is an interim action (USA, 2017c).

Data rights were cited as a factor in 11 of the 23 examined J&As. Ten of those J&As specifically framed their data rights situation in terms of owning and/or controlling the technical data package (TDP). The DoD Standard Practice for Technical Data Packages, MIL STD 3100B, states, "the purpose of the TDP is to provide a technical description of an item which is clear, complete and accurate, and in a form and format adequate for its intended use" (DoD, 2018, p. 11). A complete TDP may include, but is not limited to, "models, drawings, associated lists, specifications, standards, patterns, performance requirements, quality assurance provisions, software documentation and packaging details" (DoD, 2009, pp. 7–8). Data rights refer to the ability of the Government to share or not share data (including the TDP) on a spectrum from unlimited to restricted distribution. Leveraging competition requires

both sufficient TDP and sufficient data rights. The programs that cite not owning complete TDP may also have data rights restrictions. In other words, even if the program did have a complete TDP, it may not necessarily have the data rights to share that TDP with potential new bidders.

Although the sampled J&As did not specifically identify how the data rights were insufficient, multiple factors may influence a program's level of data rights or amount of TDP owned or controlled. Data rights are tied to how a system's development was funded—whether it was completely government-funded or it was developed at a company's private expense. In practice, the division is not always clear. For example, a government-funded development may use a propriety component or process, thus limiting data rights.

Program offices may choose not to purchase, or may be unable to purchase, the TDP. A system may have limited projected quantities or be close enough to end of life that TDP purchase is unwarranted. The latter was noted by the Common Missile Warning System program's J&A when, upon receiving an estimate from the contractor for the purchase of the TDP, the program office concluded "it is not in the best interest of the Government to acquire the TDP because this is the final contract for these items and services" (U.S. Army [USA], 2017b, p. 5). Contractors may also be reticent to sell the TDP. The J&A for the Harpoon missile noted that the program office sent a request to purchase the entire data package, but the contractor was not willing to sell (USN, 2016d, pp. 1–2). Retaining data rights allows industry to maintain a competitive advantage that may guarantee continued business through a system's life cycle.

While data rights have long played a pivotal role in defense acquisition, a recent and renewed emphasis has emerged. The FY16 and FY17 NDAAs directed a Government and industry advisor panel to review Title 10 sections regarding rights in technical data, proprietary data restrictions, and implementing regulations (Government-Industry Advisory Panel, 2018; NDAA, 2015; NDAA, 2016). The Panel identified tension points for resolution and since then, Title 10 has been amended and DoDI 5010.44, Intellectual Property (IP) Acquisition and Licensing, was published by Office of the Under Secretary of Defense for Acquisition and Sustainment, or OUSD A&S (2019).The instruction underlines coordination and consistency across DoD, aims to ensure that all program managers are informed and aware of rights and obligations of the Federal Government, and encourages customized and robust program strategies for IP. All programs are tasked to manage the balance of innovation and "avoid sustainment and modernization vendor lock" while maintaining flexibility (Deptula, 2018).

As an example, Sikorsky filed a pre-award protest with the Air Force on the UH-1N helicopter replacement program over the issue of data rights. Sikorsky objected to the Government Request for Proposal (RFP) requirements they felt required the winning bidder to turn over too much intellectual property. Specifically, Sikorsky was concerned that the contract would "give the service unlimited rights to its computer software and technical data" (Selinger, 2018). The company requested the Air Force to revise its RFPs to address this concern. The GAO later rejected the protest, but the industry challenge to Government requests for IP remains.

While the Government's desire to obtain the maximum data rights for a program may facilitate sustainment, it may also serve to dis-incentivize companies that want to retain or protect their IP from bidding, fearing a loss of their completive advantage. More intensive research would be necessary to confirm the impact of Government IP requirements on industries' desire to submit proposals.

Unacceptable performance gaps were also used as a rationale by several examined J&As. In these J&As, the procuring agencies stated that resources were currently in place, and the nature of the work would not allow for a smooth handover without a lapse in performance. For example, a services contract that provided intelligence service to United States Forces–Afghanistan (USFOR-A) noted that awarding a sole source contract would avoid operational disruption during the Afghanistan fighting season (USA, 2017d, p. 6).

A myriad of compelling reasons may be posited to justify why program offices cannot or do not compete their contracts. For purposes of this article, we highlighted many of them to demonstrate the diverse nature of defense acquisition. The DoD continues to pursue other innovative strategies to foster competition. One that has received considerable attention is OT authority.

Impact of Other Transaction Agreements on Competition

The authors also attempted to assess the impact of OT agreements on DoD competition. As described by the *DoD Other Transactions Guide* (OUSD A&S, 2018), OTs give DoD the flexibility to adapt commercial business practices and tailor contractual arrangements to gain access to innovative and nontraditional vendors who may not be interested in, or familiar with,

entering into a FAR-based contract. Initially, OTs were used for research, experimentation, or concept exploration; their use has now expanded to include prototype development and even follow-on production. This expansion should also open the door for increased competition as companies seek to recoup investment funding through follow-on production arrangements. Although exempt from CICA requirements, the OT process encourages competition to the maximum extent possible, as tailored to the agreement's specific circumstances. Due to its flexible nature, the OT process has the potential to increase the DoD's vendor pool and range of technologies and solutions, thereby positively impacting competition (OUSD A&S, 2018, pp. 4–5, 31–32). DoD's use of OTs grew sharply over the study period, rising from just over $500 million in FY14 to over $7 billion in FY19 (Figure 9). This is consistent with multiple NDAA directions on OTs during this time, such as the FY16 NDAA (2015), which permanently codified OTs in Authority of the Department of Defense to Carry Out Certain Prototype Projects (2016) in place of previous temporary authorizations. A majority of the growth came from the Army, with nearly $5 billion obligated in FY19, followed distantly by the Air Force and Defense Advanced Research Projects Agency, with $1.4 billion and $0.4 billion respectively in FY19 (Table 4). In keeping with the OT process's innovation focus, a majority of OT dollars were obligated to R&D-related services PSCs, with eight of the top ten, including the top four reported PSCs, designated as R&D (Figure 10). Competition rate for all DoD OTs has also grown, rising from 11% in FY14 and 15 to 77% in FY19 (Figure 11).

FIGURE 9. DOD OT OBLIGATIONS

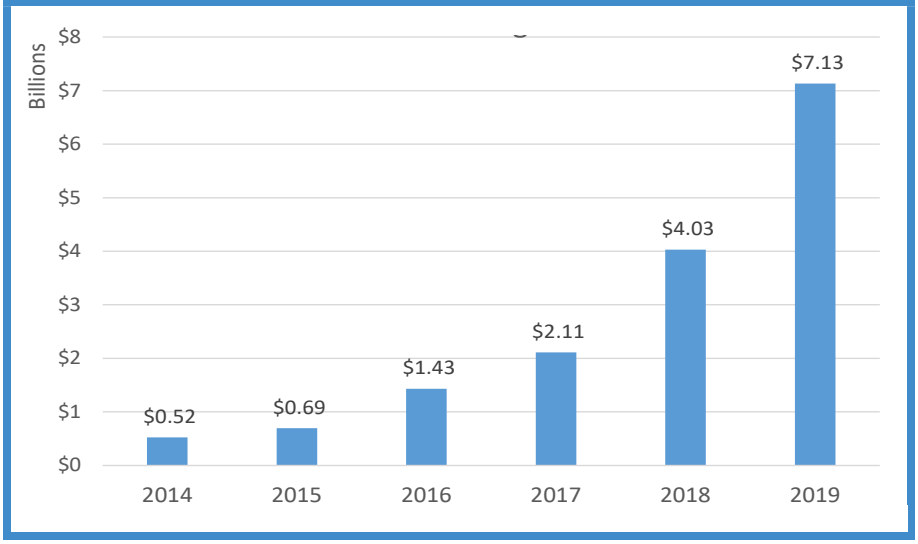


TABLE 4. OT OBLIGATIONS BY DEPARTMENT/AGENCY		
FY	**Department/Agency**	**Obligation $M**
2014	Army	$467.1
	Defense Advanced Research Projects Agency (DARPA)	$40.8
	Defense Threat Reduction Agency (DTRA)	$7.8
	Air Force	$4.6
	Navy/Marines	$2.7
	U.S. Special Operations Command (USSOCOM)	$0.5
	Total	$523.6
2015	Army	$623.3
	Defense Advanced Research Projects Agency (DARPA)	$62.9
	Air Force	$5.0
	Navy/Marines	$2.3
	U.S. Special Operations Command (USSOCOM)	$0.9
	Defense Threat Reduction Agency (DTRA)	$0.5
	Total	$694.9
2016	Army	$902.2
	Air Force	$250.0
	Defense Advanced Research Projects Agency (DARPA)	$214.8
	Defense Threat Reduction Agency (DTRA)	$61.0
	Navy/Marines	$4.9
	U.S. Special Operations Command (USSOCOM)	$0.3
	Total	$1,433.2
2017	Army	$1,541.0
	Defense Advanced Research Projects Agency (DARPA)	$379.7
	Air Force	$187.7
	Defense Threat Reduction Agency (DTRA)	$2.6
	Navy/Marines	$0.1
	Total	$2,111.1
2018	Army	$2,995.0
	Air Force	$526.1
	Defense Advanced Research Projects Agency (DARPA)	$376.8
	Washington Headquarters Services (WHS)	$74.8
	Navy/Marines	$32.0
	U.S. Transportation Command (USTRANSCOM)	$24.5
	U.S. Special Operations Command (USSOCOM)	$1.3
	Defense Threat Reduction Agency (DTRA)	$(0.0)
	Total	$4,030.4
2019	Army	$4,893.3
	Air Force	$1,395.2
	Defense Advanced Research Projects Agency (DARPA)	$419.9
	Washington Headquarters Services (WHS)	$173.6
	Navy/Marines	$172.6
	U.S. Transportation Command (USTRANSCOM)	$31.2
	Defense Counterintelligence and Security Agency	$19.2
	U.S. Special Operations Command (USSOCOM)	$14.8
	Defense Information Systems Agency (DISA)	$11.2
	U.S. Cyber Command (USCYBERCOM)	$2.2
	Defense Logistics Agency (DLA)	$0.6
	Defense Threat Reduction Agency (DTRA)	$0.2
	Defense Contract Management Agency (DCMA)	$(0.1)
	Total	$7,134.1

FIGURE 10. TOP 10 OT PSC'S

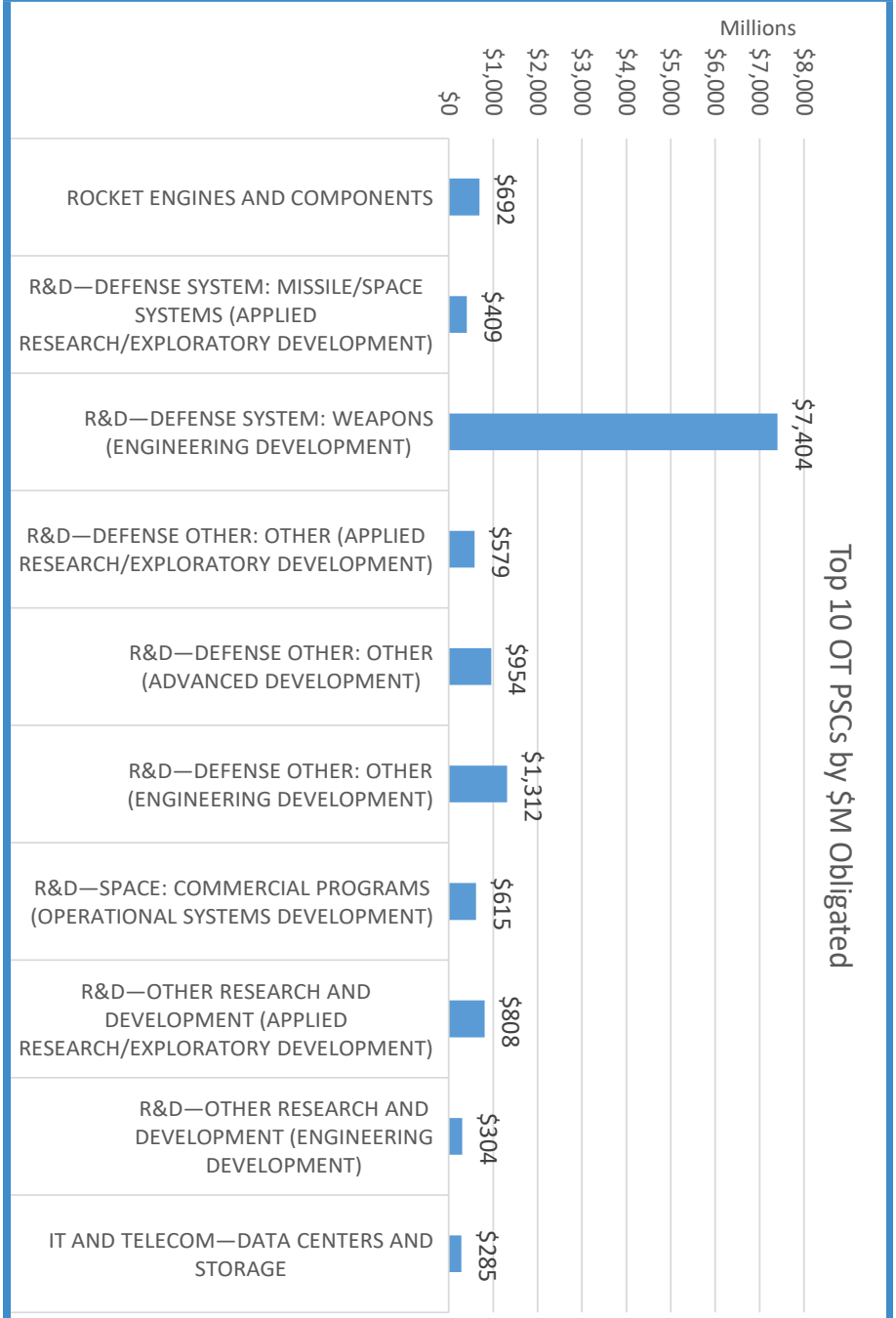
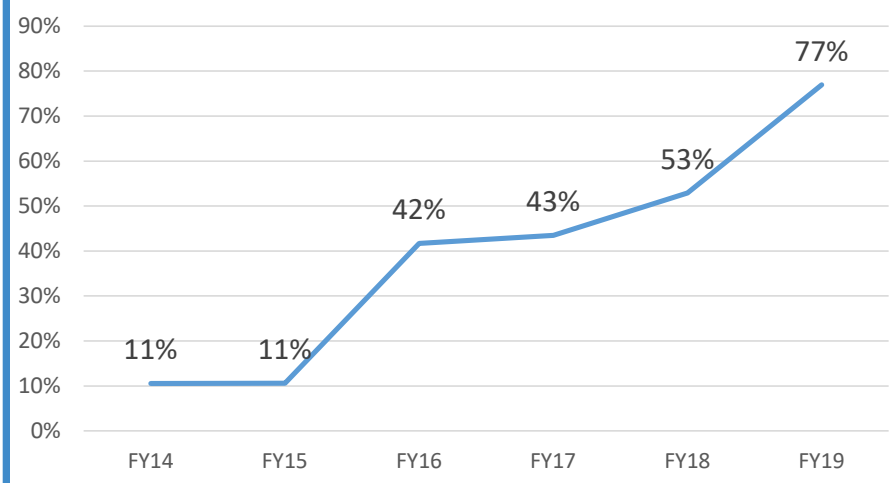


FIGURE 11. OT COMPETITION RATES (% COMPETED DOLLARS)



With the exception of FY19 (in which 77% of OT dollars were competed versus 54% for FAR-based DoD contracts), OT competition rates have lagged their FAR-based contract counterparts. Despite recent growth, OTs still represent a small percentage of overall contracted DoD dollars. The $7 billion obligated on OTs in FY19 is approximately 2% of the $381 billion obligated on FAR-based contracts in the same year. Even within the Army—the military Service with both the highest value of OTs and the least amount obligated on FAR-based contracts—OT obligations are only 5% of FAR-based contract obligations ($5 billion versus $94.7 billion). Additionally, OTs are being used with companies that are considered traditional defense contractors. This departure from the original intent does not contribute to expanding competition. Thus far, OTs have not "moved the needle" significantly in the area of competition.

The long-term impacts of OTs are currently unknown and will materialize in the future. The recent significant growth in OT obligation may be driven by experimentation with recently acquired authorities—a perception that they are "faster" than using the traditional FAR-based contracting process, or it may be the start of lasting increased use of OTs. By actively courting nontraditional sources, OT usage may also help create new DoD vendors for future competitions. It is worth following the trends and application of OTs across the DoD to determine if their use increased competition or brought significant numbers of new companies into DoD acquisition. This is a recommended area for future research.

Whither Competition?

> While industry faces a number of barriers to entry into and exit from the federal market, companies' behavior in the buyer–seller relationship is not dictated solely by changes to federal acquisition policy. Other considerations also influence a company's response to a policy change, such as the need to demonstrate sustained shareholder value to institutional investors. Also, the federal sales of a commercial company may be quite small as a proportion of its total sales in the global marketplace, reducing its willingness to participate in a highly regulated federal marketplace. (National Defense Industrial Association [NDIA], 2014, p. 5)

This statement from the NDIA provides an insight into the industry outlook on competition and some of the other factors involved in whether a company decides to bid or not bid on a Government contract. An industry concern about entering into a highly regulated federal marketplace may argue for less federal acquisition policy, not more. If greater profits and business volume can be had from the commercial marketplace, little incentive exists for companies—particularly new commercial companies—to break into highly regulated, yet small volume, market segments.

As this article and other studies have shown, even with Better Buying Power initiatives, goals for competition, and the expanded use of OTs, DoD competition policy is not "moving the needle" very much on the overall percentage of competition (Serbu, 2017, p. 7). If not policy or more flexible business arrangements, like OTs, then what would drive competition? Industry goes through a formal, rigorous process of evaluating whether or not to propose to the Government, including what their probability of winning that work might be. A number of other factors influence their decision to compete for work, including concerns about protecting IP, insufficient return on investment, and unease with contract types or contracting arrangements (Chandler, 2014, pp. 2–8). This is borne out by a number of high-profile programs where competition—initially thought to be robust—ended up being limited. In these instances, the bottom line, at the end of the day, was "the bottom line."

> In 2009, Northrop Grumman withdrew from the Air Force tanker program, with CEO Wes Bush stating the program implied *[sic]* "financial burdens on the company that we simply cannot accept." In 2015, General Dynamics decided to no-bid the Army Rifleman Radio competition due to concerns over

> attainable profit margins on the program. Multiple firms have withdrawn from the Air Force T-X trainer competition, due in part to concerns over the financial business case. And, in 2015, United Launch Alliance withdrew from the Air Force GPS-3 Launch opportunity, citing multiple factors including concerns over its ability to be cost-competitive. All of these bids required major effort before withdrawal, and in an environment of increasing bid effort, companies must focus their limited resources on fewer, higher probability pursuits. (Brindley et al., 2017, pp. 2 –3)

While the concerns listed by these companies, were primarily financial, it is worth engaging industry to query them to specifically identify actions the DoD could have taken in that area to resolve these constraints.

Beyond the financial aspects, other considerations within the control of the Government may open the aperture for increased competition. According to industry, among these would be: better coordination between the requirements, budget, and acquisition communities; empowering the acquisition workforce to make use of all available options; adapting to new technologies and a changing national security environment; creating clear lines of authority and accountability in program management; and implementing performance-based acquisition incentives that truly shift the focus from acquisition inputs to acquisition outcomes (NDIA, 2014, p. 70).

Sustaining the Delivery of Capability

Whether through competitive procedures or noncompetitive procedures, the DoD acquisition workforce and U.S. industry consistently deliver high-quality and high-technology weaponry to the warfighters. As with any cutting-edge technology, problems are inevitable with military systems—but to the authors' knowledge, the United States has never lost a war due to inferior equipment. Vibrant competition is still a worthy goal with many benefits, and sustaining it requires the acquisition workforce to be savvy in the ways of industry and always vigilant for opportunities to improve its own processes and performance.

References

Acquisition Planning, 48 C.F.R. § 207 (1991). https://ecfr.io/Title-48/Part-207

Authority of the Department of Defense to Carry Out Certain Prototype Projects, 10 U.S.C. § 2371b (2016).

Awards or Contracts, 15 U.S.C. § 644 (2012). https://www.govinfo.gov/app/details/USCODE-2011-title15/USCODE-2011-title15-chap14A-sec644

Berteau D. J., Hofbauer, J., & Sanok, S. (2010). *Implementation of the Weapon Systems Acquisition Reform Act of 2009–A progress report.* Center for Strategic & International Studies. https://www.csis.org/analysis/implementation-weapon-systems-acquisition-reform-act-2009

Brindley, A., Wood, B., & Mullen, T. (2017, April 21). Facing new realities in the defense market. *National Defense Magazine.* https://www.nationaldefensemagazine.org/articles/2017/4/21/facing-new-realities-in-the-defense-market

Carter, A. (2010a). *Better buying power: Guidance for obtaining greater efficiency and productivity in defense spending.* Office of the Under Secretary of Defense for Acquisition, Technology & Logistics. https://www.acq.osd.mil/fo/docs/USD_ATL_Guidance_Memo_September_14_2010_FINAL.PDF

Carter, A. (2010b). *Better buying power: Mandate for restoring affordability and productivity in defense spending.* Office of the Under Secretary of Defense for Acquisition, Technology & Logistics. https://www.ustranscom.mil/dbw/docs/BBP_USD_Memo_Acquisition_Professionals.pdf

Chandler, S. (2014). *Rethinking competition in defense acquisition.* Lexington Institute. http://www.lexingtoninstitute.org/wp-content/uploads/2014/11/ Rethinking-Competition.pdf

Competition in Contracting Act (CICA) of 1984, 41 U.S.C § 253 (1983a). http://acqnotes.com/acqnote/careerfields/competition-contracting-act-cica#:~:text=The%20Competition%20in%20Contracting%20Act%20%28CICA%29%20of%201984,the%20award%20of%20all%20types%20of%-20government%20contracts.

Competition in Contracting Act (CICA) of 1984, 41 U.S.C. § 253(c)(1)–(7) (1983b). http://acqnotes.com/acqnote/careerfields/competition-contracting-act-cica#:~:text=The%20Competition%20in%20Contracting%20Act%20%28CICA%29%20of%201984,the%20award%20of%20all%20types%20of%-20government%20contracts.

Competition in Contracting Act, Hearings before the U.S. Senate Committee on Armed Services, 98th Cong. (1983) (testimony of Senator John Tower). https://books.google.com/s?id=XTxglyiBEFEC&pg=PA140&lpg=PA140&dq=competition+in+contracting+act+senate+tower&source=bl&ots=Wp0Qup4GvE&sig=ACfU3U3zOTwqee_4_853njpA&hl=e-9ZToAhVBs54KHehcDz4Q6AEwD3oECAsQAQ#v=onepage&q=competition%20in%20contracting%20act%20senate%20tower&f=false

Competitive Procedures, 41 U.S.C. § 152 (2015). https://www.govinfo.gov/app/details/USCODE-2015-title41/USCODE-2015-title41-subtitleI-divsnA-chap1-subchapIII-sec152

Contracts: Competition Requirements, 10 U.S.C. § 2304(a)(2)(A) (2011a). https://www.govinfo.gov/app/details/USCODE-2011-title10/USCODE-2011-title10-subtitleA-partIV-chap137-sec2304

Contracts: Competition Requirements, 10 U.S.C. § 2304(a)(2)(B) (2011b). https://www.govinfo.gov/app/details/USCODE-2011-title10/USCODE-2011-title10-subtitleA-partIV-chap137-sec2304

Contracts: Competition Requirements, 10 U.S.C. § 2304(c)(1) (2011c).

Contracts: Competition Requirements, 10 U.S.C. § 2304(c)(1)–(7) (2011d). https://www.govinfo.gov/app/details/USCODE-2011-title10/USCODE-2011-title10-subtitleA-partIV-chap137-sec2304

Contracts: Competition Requirements, 10 U.S.C. § 2304 (2012). https://www.govinfo.gov/app/details/USCODE-2011-title10/USCODE-2011-title10-subtitleA-partIV-chap137-sec2304

Defense Logistics Agency. (2017a). *Justification for other than full and open competition—collimator, infinity.* Defense Logistics Agency–Warren. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/c356c82d1ada1407f838a827748b8292/download?api_key=null&status=archived&token=

Defense Logistics Agency. (2017b). *Justification for other than full and open competition—Direct Support Electrical System Test Set (DSESTS).* Defense Logistics Agency–Warren. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/d70d0d2adbeb14d38550dc2f0faa9bf7/download?api_key=null&status=archived&token=

Defense Logistics Agency. (2017c). *Justification for sole source—respirator assembly.* Contracting Center Puget Sound, Defense Logistics Agency Maritime. https://www.neco.navy.mil/synopsis_file/SPMYM218Q0215_SS_JA_REDACTED.pdf

Department of Defense. (2009). *Military standard: Technical data packages (TDP)* (MIL-STD-31000) [EverySpec Online library]. http://everyspec.com/MIL-STD/MIL-STD-10000-and-Up/MIL-STD-31000_20516/

Department of Defense. (2018). *Military standard: Technical data package (TDP)* (MIL-STD-31000B) [EverySpec online library]. http://everyspec.com/MIL-STD/MIL-STD-10000-and-Up/MIL-STD-31000B_55788/

Deptula, D. (2018, October 16). The growing importance of data rights in defense acquisition. *Forbes.* https://www.forbes.com/sites/davedeptula/2018/10/16/the-growing-importance-of-data-rights-in-defense-acquisition/#260288862a04

Federal Acquisition Regulation, 48 C.F.R. § 4.606 (2020). https://www.govinfo.gov/content/pkg/CFR-2014-title48-vol1/pdf/CFR-2014-title48-vol1-sec4-606.pdf

Full and Open Competition, 41 U.S.C. § 3301 (2010). https://www.govinfo.gov/app/details/USCODE-2010-title41/USCODE-2010-title41-subtitleI-divsnC-chap33-sec3301

Full and Open Competition, 41 U.S.C. § 3301(a)(2), 2020). https://uscode.house.gov/view.xhtml?req=(title:41%20section:3301%20edition:prelim)

General Services Administration. (2020a). *Contract data reports for FPDS users* [Database]. https://beta.sam.gov/

General Services Administration. (2020b). *Federal Procurement Data System—Next generation* [Database]. https://www.fpds.gov/fpdsng_cms/index.php/en/

Government-Industry Advisory Panel (2018). *Government-industry advisory panel on technical data rights.* Section 813 Panel. https://sbtc.org/wp-content/uploads/2018/11/Final-Report_ExSum_TensionPapers_11132018.pdf

H.R. Rep. No. 112-329 § 676 (2011). https://www.congress.gov/congressional-report/112th-congress/house-report/329

Insinna, V. (2017, July 21). Boeing, Northrop move forward on next-gen ICBM program; Lockheed out. *Navy Times.* https://www.navytimes.com/air/2017/08/21/boeing-northrop-move-forward-on-next-gen-icbm-program-lockheed-out/

Insinna, V. (2019, July 25). Boeing drops from next generation ICBM competition. *Defense News.* https://www.defensenews.com/space/2019/07/25/boeing-drops-from-next-generation-icbm-competition/

Keeney, S. (2007, Summer). The foundations of government contacting. *Journal of Contract Management, 5*(1), 7–19. http://connection.ebscohost.com/c/articles/26598510/foundations-government contracting

Major Defense Acquisition Program Defined, 10 U.S.C. § 2430 (2006). https://www.govinfo.gov/app/details/USCODE-2006-title10/USCODE-2006-title10-subtitleA-partIV-chap144-sec2430

Manuel, K. M. (2009). *Competition in federal contracting: An overview of the legal requirements.* Congressional Research Service. https://apps.dtic.mil/dtic/tr/fulltext/u2/a497721.pdf

National Defense Authorization Act for Fiscal Year 2007, Pub. L. 109-364 § 802, 120 Stat. 2083 (2006). https://www.govinfo.gov/content/pkg/PLAW-109publ364/pdf/PLAW-109publ364.pdf

National Defense Authorization Act for Fiscal Year 2016, Pub. L. 114-92 (2015). https://www.congress.gov/114/plaws/publ92/PLAW-114publ92.pdf

National Defense Authorization Act for Fiscal Year 2017, Pub. L. 114-328 (2016). https://www.congress.gov/bill/114th-congress/senate-bill/2943/text

National Defense Industrial Association. (2014). *Pathway to transformation: NDIA acquisition reform recommendations*. https://www.ndia.org/-/media/sites/ndia/policy/documents/acquisition-reform/acquisition-reform-initiative/ndia-pathway-to-transformation-acquisition-report-1.ashx?la=en

Obama, B. (2009). *Government contracting* [Memorandum for the Heads of Executive Departments and Agencies]. The White House, Office of the Press Secretary. https://obamawhitehouse.archives.gov/the-press-office/memorandum-heads-executive-departments-and-agencies-subject-government-contracting

Office of the Under Secretary of Defense for Acquisition & Sustainment. (2018). *DoD other transactions guide.* Department of Defense. https://www.acq.osd.mil/dpap/cpic/cp/docs/OT_Guide_(Nov_2018)_Final.pdf

Office of the Under Secretary of Defense for Acquisition & Sustainment. (2019). *Intellectual property (IP) acquisition and licensing* (DoDI 5010.44). Department of Defense. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/501044p.PDF?ver=2019-10-16-144448-070

Only One Offer (Defense Federal Acquisition Regulation Supplement), 77 F.R. 39125 (proposed June 29, 2012) (to be codified at 48 C.F.R. pts. 205, 208, 212, 214, 215, 216, 252). https://www.federalregister.gov/documents/2019/07/16/2019-14991/defense-federal-acquisition-regulation-supplement-only-one-offer-dfars-case-2017-d009-correction

Policy, 48 C.F.R. § 6.101 (2002). https://www.govinfo.gov/app/details/CFR-2002-title48-vol1/CFR-2002-title48-vol1-sec6-101

Public Contracts, 41 U.S.C. § 3301 (2020). https://uscode.house.gov/view.xhtml?req=(title:41%20section:3301%20edition:prelim)

Publicizing Contract Actions, 48 C.F.R. § 205 (2020). https://www.ecfr.gov/cgi-bin/text-idx?SID=6b70be731802c2145aab441b87a2a923&mc=true&node=pt48.3.205&rgn=div5

Research and Development, 15 U.S.C. § 638 (2012). https://www.govinfo.gov/app/details/USCODE-2011-title15/USCODE-2011-title15-chap14A-sec638

Selection of Architects & Engineers, 40 U.S.C. § 11 (2011). https://www.govinfo.gov/app/details/USCODE-2011-title40/USCODE-2011-title40-subtitleI-chap11

Selinger, M. (2018, February 12). Sikorsky protests Air Force's Huey replacement program. *Defense Daily.* https://www.defensedaily.com/sikorsky-protests-air-forces-huey-replacement-program/air-force/

Serbu, J. (2017, February 28). The legacy of better buying power: DoD's gambit to reform acquisition 'from within.' *Federal News Radio Special Report.* https://federalnewsnetwork.com/defense/2017/02/bbpndaa-special-report-part-1/

Task and Delivery Order Contracts: Orders, 10 U.S.C. § 2304(c)(1) (2020a). https://uscode.house.gov/view.xhtml?req=%28title:10%20section:2304c%20edition:prelim%29

Task and Delivery Order Contracts: Orders, 10 U.S.C. § 2304(c)(1)–(7) (2020b). https://uscode.house.gov/view.xhtml?req=%28title:10%20section:2304c%20edition:prelim%29

The Brooks Act of 1972, Pub. L. 92-582 (1972).

U.S. Air Force. (2014). *Justification for other than full and open competition—Chemical Oxygen Generating System (COGS).* 1st Special Operations Contracting Squadron. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/9ce9b80db094a99b06bd5c74a17d428c/download?api_key=null&status=archived&token

U.S. Air Force. (2015). *Justification and approval for other than full and open competition—B61-12 Life Extension Program (LEP)*. U.S. Air Force Global Strike Command. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/e575e6f0be4fe439d6f5b5513e49dfb5/download?api_key=null&status=archived&token=

U.S. Air Force. (2016a). *Justification and approval (J&A) for other than full and open competition—F-22 follow-on agile sustainment for the Raptor.* Air Force Life Cycle Management Center, F-22 System Program Office. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/b84c61236e3ce8f719768ac3e2efa200/download?api_key=null&status=archived&token=

U.S. Air Force. (2016b). *Justification and approval (J&A) for other than full and open competition—engine component improvement program (CIP) for F-107.* Air Force Life Cycle Management Center, Propulsion Acquisition Division. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/347003ec59a3d5158e6f68a142b59b50/download?api_key=null&status=archived&token=

U.S. Air Force. (2017). *Sole source synopsis* [Memorandum]. Department of the Air Force, Headquarters Air Combat Command. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/2ee2b5a3a1bfa80c9d4d5fc3ab13ba78/download?api_key=null&status=archived&token=

U.S. Army. (2012). *Justification and approval (J&A) for other than full and open competition (FAOC) for Javelin weapon system production in fiscal year FY 2013–FY 2017.* U.S. Army Contracting Command-Redstone. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/a8097ca1e34470e3ea04ea92cb499aaa/download?api_key=null&status=archived&token=

U.S. Army. (2015). *Justification and approval (J&A) for other than full and open competition for the modification of one Quick Reaction Capability (QRC) Liberty Project Aircraft (LPA) to be compliant with the Enhanced Medium Altitude Reconnaissance and Surveillance System (EMARSS) capability production document (CPD).* U.S. Army Contracting Command-Redstone. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/5716d83fad1513a6172e16b0e72d40ed/download?api_key=null&status=archived&token=

U.S. Army. (2017a). *Apache multiyear AH-64E full rate production lots 7-11.* U.S. Army Aviation and Missile Command Contracting Center-Redstone. https://beta.sam.gov/opp/717a4b2f1794c2c89dbde05015775dfe/view?

U.S. Army. (2017b). *Justification review document: FAR Part 6 Justification and approval for other than full and open competition—Common Missile Warning System (CMWS).* U.S. Army Contracting Command-Aberdeen Proving Ground. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/38fdc425f430ebb428609839e6dfacd1/download?api_key=null&status=archived&token

U.S. Army. (2017c). J*ustification review document for other than full and open competition—logistics readiness support service.* U.S. Army Mission and Installation Contracting Command. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/7ab18549db436cd76da8680abcd380be/download?api_key=null&status=archived&token=

U.S. Army. (2017d). *Justification review document for other than full and open competition—US Forces-Afghanistan/Resolute Support (USFOR-A/RS)-Intelligence Support Service-Afghanistan (ISS-A) and Combat Intelligence Augmentation Teams (CIAT).* U.S. Army Contracting Command-Warren. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/d3a714b5a4406cf81bf0bacfc5204c8e/download?api_key=null&status=archived&token=

U.S. Congressional Budget Office. (2020). *The budget and economic outlook 2020 to 2030.* https://www.cbo.gov/publication/56020

U.S. Government Accountability Office. (2013). *Defense contracting: Actions needed to increase competition* (Report No. GAO-13-325). https://www.gao.gov/assets/660/653404.pdf

U.S. Government Accountability Office. (2014). *Defense contracting: Early attention in the acquisition process needed to enhance competition* (Report No. GAO-14-395). https://www.gao.gov/assets/680/678888.pdf

U.S. Government Accountability Office. (2015). *Defense contracting: DoD's use of competitive procedures* (Report No. GAO-15-484R). https://www.gao.gov/assets/670/669998.pdf

U.S. Navy. (2013). *Justification for other than full and open competition—H1 helicopter.* Naval Supply Systems Command Weapon Systems Support-Philadelphia. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/07a7965d10db03af795603e934c5cdcd/download?api_key=null&status=archived&token=

U.S. Navy. (2014). *Justification for other than full and open competition.* Naval Supply Systems Command Weapon Systems Support-Philadelphia. https://www.neco.navy.mil/synopsis_file/fa812214g0001gbm8_fa812214g0001gbm8_n0038314qm178.pdf

U.S. Navy. (2016a). *Class justification and approval for use of other than full and open competition—C12W aircraft.* Naval Air Systems Command. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/4df36af480f2840b0c55083603a0fa84/download?api_key=null&status=archived&token=

U.S. Navy. (2016b). *Justification and approval for use of other than full and open competition*—Puget Sound. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/1232c8bd2f64b51f07d7b7fbc60da7e4/download?api_key=null&status=archived&token=

U.S. Navy. (2016c). *Justification and approval for use of other than full and open competition—HARM.* Naval Air Warfare Center Weapons Division https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/6e1a49b34d249e228c9b5e339da19c97/download?api_key=null&token=

U.S. Navy. (2016d). *Justification and approval for use of other than full and open competition—Harpoon.* Naval Air Systems Command. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/ff1b1c5361012eb4aa5a36aac0309364/download?api_key=null&status=archived&token=

U.S. Navy. (2017a). *Class justification and approval for use of other than full and open competition—F-35.* Naval Air Systems Command, Joint Strike Fighter Contracts Division. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/1db00afd1e5f1cd92247afc8013214d1/download?api_key=null&status=archived&token=

U.S. Navy. (2017b). *Justification and approval for use of other than full and open competition—USS Decatur ship repair.* Naval Sea Systems Command. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/f5d93e9bfafef4071b235c002bf8c781/download?api_key=null&status=archived&token=

U.S. Navy. (2018). *Justification and approval for use of other than full and open competition—aircraft carriers.* Naval Sea Systems Command. https://beta.sam.gov/api/prod/opps/v3/opportunities/resources/files/af92bd5d280598dcb79724160ba31d5a/download?api_key=null&token=

Weapon Systems Acquisition Reform Act of 2009, Pub. L. 111-23 (2009). https://www.govinfo.gov/app/details/PLAW-111publ23

Author Biographies

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The Defense Acquisition Professional Reading List is intended to enrich the knowledge and understanding of the civilian, military, contractor, and industrial workforce who participate in the entire defense acquisition enterprise. These book recommendations are designed to complement the education and training vital to developing essential competencies and skills of the acquisition workforce. Each issue of the *Defense Acquisition Research Journal* will include one or more reviews of suggested books, with more available on our website at http://dau.edu/library.

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Featured Book

Call Sign Chaos: Learning to Lead

Authors: Jim Mattis and Bing West

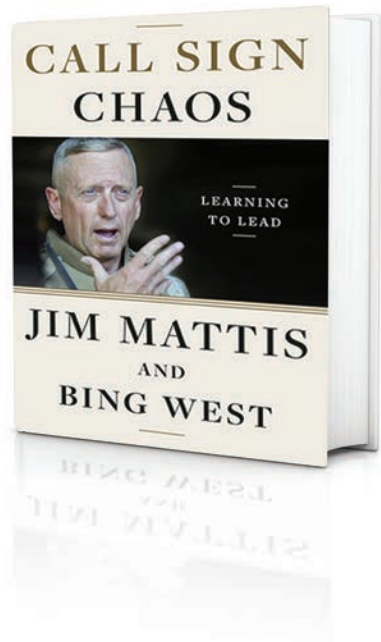
Publisher: Random House

Copyright Date: 2019

Hardcover: 320 pages

ISBN-13: 9780812996838

Reviewed by: : David Riel, Professor of Acquisition Management, Defense Acquisition University



Call Sign Chaos' central theme is the primary author's pursuit of leadership and his maturation as a leader. Unlike many leadership books where personal stories are used to reinforce foundational leadership principles, former Secretary of Defense James Mattis and his co-author, Bing West, write of Mattis' odyssey from "carefree youth" to the highest levels in the Department of Defense (DoD), while sharing nuggets of leadership wisdom along the way. The authors share Mattis' journey divided into three sections, from a young second lieutenant with direct platoon leadership to increasingly broader leadership positions in the U.S. Marine Corps (USMC) and DoD. Yet, while the stories are enlightening and leadership principles worthwhile, the reason this book should be on every acquisition professional's reading list is its link to the foundational changes we are experiencing in our DoD acquisition world, driven through the Adaptive Acquisition Framework (AAF).

Although the AAF was just published in January, its roots can be found in the 2018 National Defense Strategy (NDS), written by Mattis, and the acquisition reform legislation of the past several National Defense Authorization Acts, most notably FY16's Section 804, Middle Tier of Acquisition. In reading *Call Sign Chaos*, the acquisition professional can quickly grasp the leadership origins driving what Under Secretary of Defense for Acquisition and Sustainment Ellen Lord calls the "most transformational acquisition policy change we've seen in decades." Early in his command, Mattis cultivated a bias for action, referred to as "developing a culture of operating from commander's intent demand[ing] a higher level of unit discipline and self-discipline than issuing voluminous, detailed instructions" (p. 44). He further explains that personal initiative, aggressiveness, and risk-taking are instilled by a culture that has cultivated and inculcated these characteristics over years, where mistakes are tolerated and risk-takers rewarded, akin to what today's acquisition professionals are being told by DoD leadership.

As Mattis reached the highest levels of the USMC, he recognized that the essential asset of speed is "the least forgiving, least recoverable factor in any competitive situation" (p. 238), including inter-state strategic competition—the primary concern outlined in the NDS. To achieve speed, Mattis learned to "prize smooth execution by cohesive teams over deliberate, methodical, and synchronized efforts that … squelch[ed] subordinate initiative" (p. 238). That attitude permeates the current drive towards employing different acquisition pathways to give our Warfighters a sustained technological edge at the speed of relevance. Mattis establishes trust as the foundation of achieving that speed. Trust, that subordinates can sense, enhances their sense

ownership. This may include relying on strategic plans versus briefings of every detail for a fluid situation, such as one might readily find in the Urgent, Middle Tier, and Software Acquisition pathways.

Reading *Call Sign Chaos* is well worth the acquisition professional's time. It provides a better understanding of the roots of our culture shift towards speed, as well as insight into the AAF's maturation. It sets the stage to further the progression toward delivering weapon systems at "the speed of relevance" by providing "streamlined, rapid, iterative approaches from development to fielding" (National Defense Strategy, 2018).

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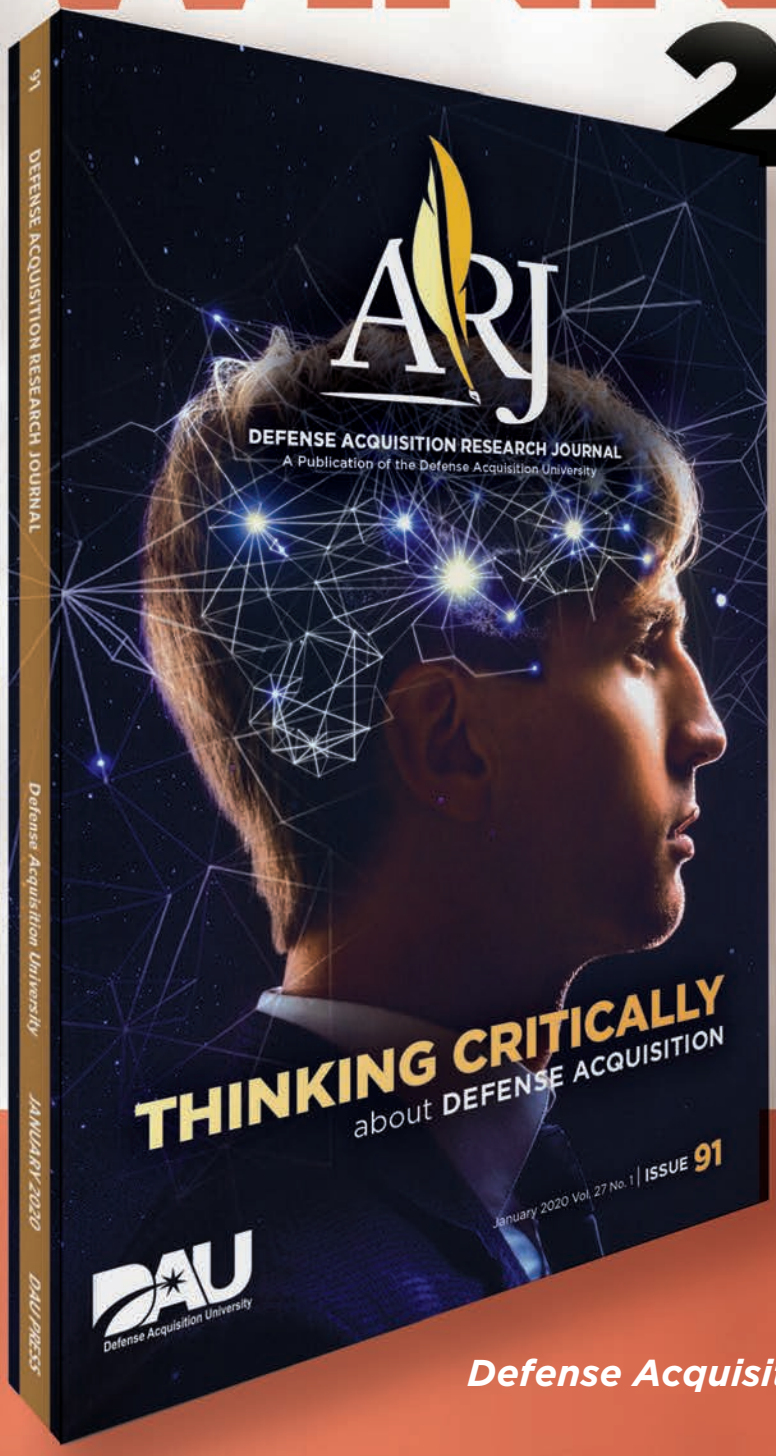

Norene Johnson, Emily Beliles,
and Michael Krukowski

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Current Research Resources in DEFENSE ACQUISITION

AGILE SOFTWARE DEVELOPMENT

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Kessel Run: An Analysis of the Air Force's Internal Software Development Organization

Jenny Aroune, Robert Hollister, and Nathan Taylor

Summary

The current method of acquiring custom, innovative software through traditional contracting methods is an outdated practice. These traditional methods are time-consuming, and could be improved with the Air Force's Kessel Run, an internal software development organization. With the Air Force's Kessel Run, the time from software inception to operation can go from years to days. Unfortunately, neither most of the Air Force nor the rest of the Department of Defense (DoD) has yet to catch up to the forward thinking of those involved in the creation of Kessel Run. Most of the Air Force and the DoD are still outsourcing for most of their innovative acquisitions, whether it be research and design or product (software) development. This case study offers insight to the new organization and identifies the potential to apply the concepts learned during its creation to benefit other DoD organizations when considering insourcing as opposed to the traditional outsourcing acquisition approach.

APA Citation

Aroune, J., Hollister, R., & Taylor, N. (2019). *Kessel run: An analysis of the Air Force's software development organization* (Master's thesis). https://calhoun.nps.edu/bitstream/handle/10945/63995/19Dec_Aroune_Hollister_Taylor.pdf?sequence=1&isAllowed=y

Agile Software Development: DHS Has Made Significant Progress in Implementing Leading Practices, but Needs to Take Additional Actions

Carol C. Harris

Summary

The article focuses on a study from the U.S. Government Accountability Office (GAO), which examines adoption of agile software development of the U.S. Department of Homeland Security (DHS). It mentions DHS has fully addressed one of three leading practice areas for organization change management and partially addressed the other two. It also mentions agile software development, which is focused on incremental and rapid delivery of working software in small segments.

APA Citation

U.S. Government Accountability Office. (2020). *Agile software development: DHS has made significant progress in implementing leading practices, but needs to take additional actions* (Report No. GAO-20-213). https://www.gao.gov/products/GAO-20-213

It's No Longer Enough to Simply Be Agile

Dr. Johnny D. Morgan

Summary

A tremendous amount of literature has been published about the merits of agile development practices. But in today's environment, agile development practices are quickly being supplemented with major technology breakthroughs that enhance software quality, improve enterprise performance, and provide business resiliency. This paper describes three major breakthroughs—services-based architectures, cloud computing, and DevOps practices. A brief overview of each technology is discussed and how the three technologies working together provide enterprise value. The paper concludes with a discussion on the skills and talents required to implement these technologies.

APA Citation

Morgan, J. D. (2019, July). It's no longer enough to simply be agile. *PM World Journal, 8*(6). http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip&db=bsu&AN=137630725&site=ehost-live&scope=site

Factors Limiting the Speed of Software Acquisition

Kevin Garrison, David M. Tate, and John W. Bailey

Summary

Improving the agility of defense acquisition is a high priority goal for both the Office of the Secretary of Defense and the military departments. Improving the speed at which the Department of Defense can develop, deploy, and update software-enabled capabilities would enable more general acquisition agility, given modern defense systems' critical dependence on software.

APA Citation

Garrison, K., Tate, D. M., & Bailey J. W. (2019, October). *Factors limiting the speed of software acquisition.* Institute for Defense Analyses. https://www.ida.org/-/media/feature/publications/f/fa/factors-limiting-the-speed-of-software-acquisition/d-10907.ashx

Software Is Never Done: Refactoring the Acquisition Code for Competitive Advantage

J. Michael McQuade, Richard M. Murray, Gilman Louie, Milo Medin, Jennifer Pahlka, and Trae Stephens

Summary

U.S. national security increasingly relies on software to execute missions, integrate and collaborate with allies, and manage the defense enterprise. The ability to develop, procure, assure, deploy, and continuously improve software is thus central to national defense. At the same time, the threats that the United States faces are changing at an ever-increasing pace, and the Department of Defense (DoD)'s ability to adapt and respond is now determined by its ability to develop and deploy software to the field rapidly. The current approach to software development is broken and is a leading source of risk to DoD: it takes too long, is too expensive, and exposes warfighters to unacceptable risk by delaying their access to tools they need to ensure mission success. Instead, software should enable a more effective joint force, strengthen our ability to work with allies, and improve the business processes of the DoD enterprise

APA Citation

McQuade, J. M., Murray, R. M., Louie, G., Medin, M., Pahlka, J., & Stephens, T. (2019). *Software is never done: Refactoring the acquisition code for competitive advantage*. Defense Innovation Board. https://media.defense.gov/2019/Apr/30/2002124828/-1/-1/0/SOFTWAREISNEVERDONE_REFACTORINGTHEACQUISITIONCODEFORCOMPETITIVEADVANTAGE_FINAL.SWAP.REPORT.PDF

Defense ARJ Guidelines
FOR CONTRIBUTORS

The *Defense Acquisition Research Journal (ARJ)* is a scholarly peer-reviewed journal published by the Defense Acquisition University (DAU). All submissions receive a double-blind review to ensure impartial evaluation.

IN GENERAL

We welcome submissions describing original research or case histories from anyone involved in the defense acquisition process. Defense acquisition is broadly defined as any actions, processes, or techniques relevant to the conceptualization, initiation, design, development, testing, contracting, production, deployment, logistics support, modification, and disposal of weapons and other systems, supplies, or services needed for a nation's defense and security, or intended for use to support military missions.

Research involves the creation of new knowledge. This generally requires either original analysis of material from primary sources, including program documents, policy papers, memoranda, surveys, interviews, etc.; or analysis of new data collected by the researcher. Articles are characterized by a systematic inquiry into a subject to establish facts or test theories that have implications for the development of acquisition policy and/or process.

The *Defense ARJ* also welcomes case history submissions from anyone involved in the defense acquisition process. Case histories differ from case studies, which are primarily intended for classroom and pedagogical use. Case histories must be based on defense acquisition programs or efforts. Cases from all acquisition career fields and/or phases of the acquisition life cycle will be considered. They may be decision-based, descriptive, or explanatory in nature. Cases must be sufficiently focused and complete (i.e., not open-ended like classroom case studies) with relevant analysis and conclusions. All cases must be factual and authentic. Fictional cases will not be considered.

We encourage prospective writers to coauthor, adding depth to manuscripts. We recommend that junior researchers select a mentor who has been previously published or has expertise in the manuscript's subject. Authors should be familiar with the style and format of previous *Defense ARJs* and adhere to the use of endnotes versus footnotes, formatting of reference lists, and the use of designated style guides. It is also the responsibility of the corresponding author to furnish any required government agency/employer clearances with each submission.

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Manuscripts should reflect research of empirically supported experience in one or more of the areas of acquisition discussed above. The *Defense ARJ* is a scholarly research journal and as such does not publish position papers, essays, or other writings not supported by research firmly based in empirical data. Authors should clearly state in their submission whether they are submitting a research article or a case history. The requirements for each are outlined below.

Research Articles

Empirical research findings are based on acquired knowledge and experience versus results founded on theory and belief. Critical characteristics of empirical research articles:

- clearly state the question,
- define the research methodology,

- describe the research instruments (e.g., program documentation, surveys, interviews),
- describe the limitations of the research (e.g., access to data, sample size),
- summarize protocols to protect human subjects (e.g., in surveys and interviews), if applicable,
- ensure results are clearly described, both quantitatively and qualitatively,
- determine if results are generalizable to the defense acquisition community,
- determine if the study can be replicated, and
- discuss suggestions for future research (if applicable).

Research articles may be published either in print and online, or as a Web-only version. Articles that are 5,000 words or fewer (excluding abstracts, references, and endnotes) will be considered for print as well as Web publication. Articles between 5,000 and 10,000 words will be considered for Web only publication, with a two-sentence summary included in the print version of the *Defense ARJ*. In no case should article submissions exceed 10,000 words.

Case Histories

Care should be taken not to disclose any personally identifiable information regarding research participants or organizations involved unless written consent has been obtained. If names of the involved organization and participants are changed for confidentiality, this should be highlighted in an endnote. Authors are required to state in writing that they have complied with APA ethical standards. A copy of the APA Ethical Principles may be obtained at http://www.apa.org/ethics/.

All case histories, if accepted, will receive a double-blind review as do all manuscripts submitted to the *Defense ARJ*.

Each case history should contain the following components:

- Introduction
- Background

- Characters
- Situation/problem
- Analysis
- Conclusions
- References

Book Reviews

Defense ARJ readers are encouraged to submit book reviews they believe should be required reading for the defense acquisition professional. The reviews should be 500 words or fewer describing the book and its major ideas, and explaining why it is relevant to defense acquisition. In general, book reviews should reflect specific in-depth knowledge and understanding that is uniquely applicable to the acquisition and life cycle of large complex defense systems and services. Please include the title, ISBN number, and all necessary identifying information for the book that you are reviewing as well as your current title or position for the byline.

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The readers of the *Defense ARJ* are primarily practitioners within the defense acquisition community. Authors should therefore strive to demonstrate, clearly and concisely, how their work affects this community. At the same time, do not take an overly scholarly approach in either content or language.

Format

Please submit your manuscript according to the submissions guidelines below, with references in APA format (author date-page number form of citation) as outlined in the latest edition of the *Publication Manual of the American Psychological Association.* References should include Digital Object Identifier (DOI) numbers when available. The author(s) should not use automatic reference/bibliography fields in text or references as they can be error-prone. Any fields should be converted to static text before submission, and the document should be stripped of any outline formatting. All headings should conform to APA style. For all other style questions, please refer to the latest edition of the *Chicago Manual of Style.*

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- Biographical sketch for each author (70 words or fewer)
- Headshot for each author saved as a 300 dpi (dots per inch) high resolution JPEG or Tiff file no smaller than 5x7 inches with a plain background in business dress for men (shirt, tie, and jacket) and business appropriate attire for women. All active duty military should submit headshots in Class A uniforms. Please note: low-resolution images from Web, PowerPoint, or Word will not be accepted due to low image quality.
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- Figures and tables saved as separate individual files and appropriately labeled

The manuscript should be submitted in Microsoft Word (please do not send PDFs), double-spaced Times New Roman, 12-point font size (5,000 words or fewer for the printed edition and 10,000 words or fewer for online-only content excluding abstracts, figures, tables, and references).

Figures or tables should not be inserted or embedded into the text, but submitted as separate files in the original software format in which they were created. For additional information on the preparation of figures or tables, refer to the Scientific Illustration Committee, 1988, Illustrating Science: Standards for Publication, Bethesda, MD: Council of Biology Editors, Inc. Restructure briefing charts and slides to look similar to those in previous issues of the *Defense ARJ*.

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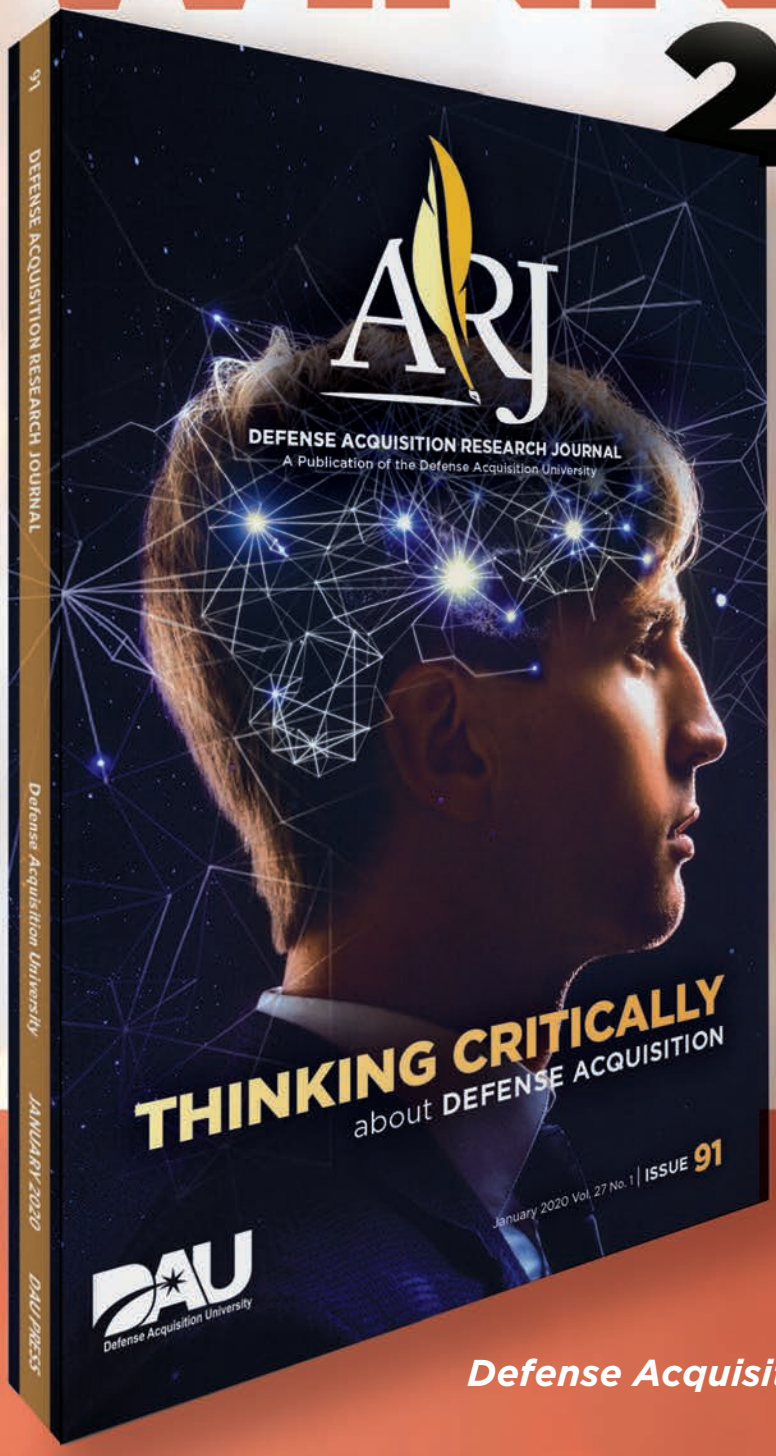

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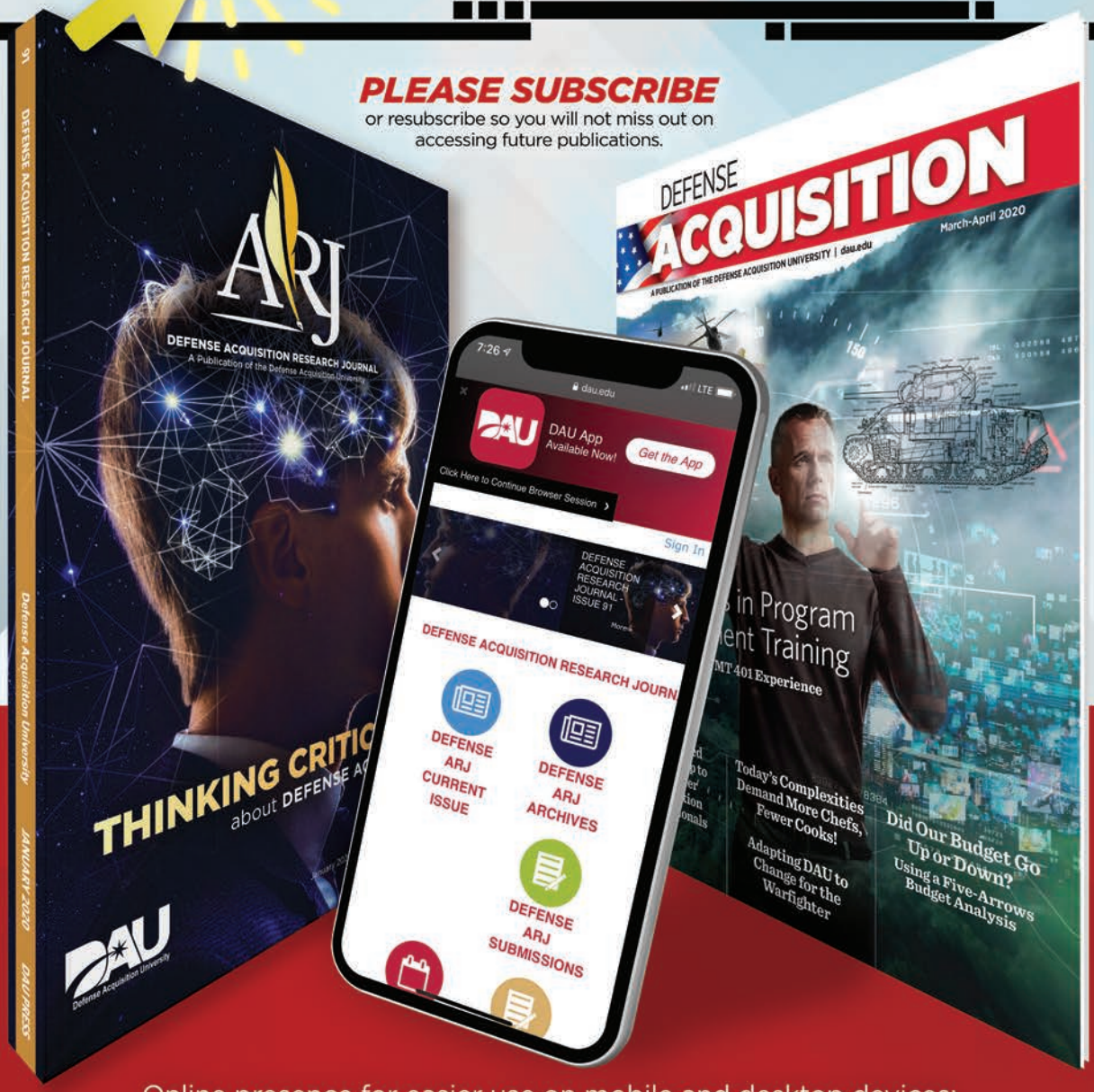

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