Making Every Dollar Count
- Improving Acquisition Outcomes -

2011 Annual DAU ASSOCIATION Research Paper Competition

1ST PLACE

Calculating Return on Investment for U.S. Department of Defense Modeling and Simulation

Ivar Oswalt, Tim Cooley, William Waite, Elliot Waite, Steve "Flash" Gordon, Richard Severinghaus, Jerry Feinberg, and Gary Lightner

2ND PLACE

Employing Risk Management to Control Military Construction Costs

LTC Steven M. F. Stuban, USA (Ret.), Thomas A. Mazzuchi, and Shahram Sarkani

3RD PLACE

Mitigating Spirals of Conflict in DoD Source Selections

Steven M. Maser and Fred Thompson

Maximizing Federal IT Dollars: A Connection Between IT Investments and Organizational Performance

BG Ennis C. "Jim" Whitehead, USAR (Ret.), Shahram Sarkani, and Thomas A. Mazzuchi

DAU

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DEFENSE AR JOURNAL

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A Publication of the Defense Acquisition University

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a blind review to ensure impartial evaluation.

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As budgets decrease, it becomes increasingly important to determine the most effective ways to invest in modeling and simulation (M&S). This article discusses an approach to comparing different M&S investment opportunities using a return on investment (ROI)-like measure. The authors describe methods to evaluate "benefit" (i.e., increased readiness, more effective training, etc.) received from an investment and then use those metrics in a decision analysis framework to evaluate each M&S expenditure. Finally, they conclude by discussing the importance of viewing M&S investments from a Department of Defense (DoD) Enterprise view, evaluating investment over multiple years, measuring well-structured metrics, and using those metrics in a systematic way to produce an ROI-like result that DoD can use to evaluate and prioritize M&S investments.

Systems acquisition inherently contains elements of uncertainty that must be effectively managed to meet project cost, schedule, and performance objectives. While the U.S. Department of Defense has a record of employing systems engineering technical management processes (including risk management) to address these uncertainties for major weapon systems acquisition, the application of risk management to Military Construction (MILCON) projects is a recent development. This research studies the use of a formal risk management program on a MILCON project and assesses whether such use influences the project's total cost growth relative to that of U.S. Army Corps of Engineers' historical data. A case study methodology is employed assessing the National Geospatial-Intelligence Agency (NGA)'s multibillion dollar NGA Campus East program.

Making Every Dollar Count
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Government contracting is rife with opportunities for miscommunication and misperception. This can undermine trust and fuel spirals of conflict. For this article, the authors interviewed participants and analyzed Government Accountability Office (GAO) bid protest decisions involving Department of Defense source selections. They found agency, vendor, and GAO practices that trigger and fuel these spirals. Contracting agencies and GAO can take steps to improve communication, reduce inconsistencies, and reduce perceptions of bias, thereby mitigating costly bid protests.

Evaluating how best to invest government information technology (IT) dollars means making choices. Should agencies strengthen infrastructure with energy-efficient servers and increased network bandwidth, purchase software to cut costs, increase collaboration, or invest more to meet stakeholders' future needs? Is there a connection between the way agencies invest IT dollars and successful mission accomplishment? In this article, the authors show a connection between IT investment allocations and organizational performance in federal government agencies, and demonstrate how higher performing agencies invest differently in IT than lower performing agencies. Federal managers can compare their organization's IT investment portfolio with high-performing agencies and compare their investment allocations with other federal organizations with similar missions to determine optimum IT investment allocations for their agencies.

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The impact of organizational culture, management leadership style, and employee commitment on organizational outcomes has long been studied, but no clear answer exists for which concepts most affect acquisition outcomes and increase organizational productivity. A key contribution of this study is the notion that they are interrelated and may work synergistically in improving acquisition outcomes. The author claims that the interaction of these elements, when combined, may produce a total effect that is greater than the sum of their individual elements. A conceptual model was identified and used as the foundation for building hypotheses. Structural Equation Modeling was used to analyze the data gathered, and a path diagram was developed for this study using Analysis of Moment Structures (AMOS).

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We are currently soliciting articles and subject matter experts for the 2011-2012 *Defense Acquisition Research Journal (ARJ)* print year.

DEFENSE **A R** JOURNAL

Defense Acquisition Research Journal
A Publication of the Defense Acquisition University

Making Every Dollar Count
- Improving Acquisition Outcomes -

Remarks

FROM THE CHAIRMAN AND EXECUTIVE EDITOR

In this issue, I am pleased to spotlight the winners of the DAU Alumni Association's 2011 Research Paper Competition. The theme for this year is "Making Every Dollar Count—Improving Acquisition Outcomes." The topic is directly relevant to one of the most important initiatives in recent years to come from Under Secretary of Defense for Acquisition, Technology and Logistics Dr. Ashton Carter: the mandate to deliver better value to the taxpayer and warfighter by improving the way the Department of Defense does business. Dr. Carter specifically tasked the acquisition community to search for means to achieve productivity growth; in other words, to do more without more.[1]

The winners of this year's competition have made significant contributions to our understanding of how defense acquisition can become more effective and more efficient. Ivar Oswalt and his colleagues garnered first prize with their paper "Calculating Return on Investment for U.S. Department of Defense Modeling and Simulation," which describes how modeling and simulation expenditures can be evaluated from an enterprise-wide point of view. Second prize is awarded to Steven Stuban and his co-authors for their article "Employing Risk Management to Control Military Construction Costs," which demonstrates how a formal risk management program was effective in controlling project cost growth.

Two papers tied for third prize. Steven Maser and Fred Thompson, in "Mitigating Spirals of Conflict in DoD Source Selections," explain how improved communications can mitigate costly bid protests that often plague government contracts. "Maximizing Federal IT Dollars: A Connection between IT Investments and Organizational Performance," by Jim Whitehead and colleagues, highlights the fact that organizations investing more in IT innovation often out-perform those in which innovation plays a lesser role in their investment portfolio.

Many other authors contributed noteworthy articles to this competition. However, space permits us to publish only one of those contributions in this issue: "Moving Toward Improved Acquisition Outcomes," by Everett Roper, which investigates the links between organizational culture and acquisition out-

comes. To all of the contributors, we give our heartfelt thanks for their efforts. We also thank those who reviewed the multitude of articles we received, and took on the task of selecting winning articles from a pantheon of excellent submissions.

In this issue, we add to the Defense Acquisition Professional Reading List with a review by Shannon Brown (National Defense University) of *Building the Trident Network* by Maggie Mort—an examination of how organizations, technologies, and communities all converged to create the United Kingdom's Trident submarine and missile system.

On a final note, I'm pleased to note that DAU has welcomed aboard its new President, Katharina McFarland, who brings to the position a wealth of knowledge and experience in defense acquisition.

Dr. Larrie D. Ferreiro
Executive Editor
Defense ARJ

ENDNOTE

1.   Carter, A. B. (2010). *Better buying power: Guidance for obtaining greater efficiency and productivity in defense spending* [Memorandum]. Washington, DC: Office of the Under Secretary of Defense for Acquisition, Technology and Logistics.

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2011 DAU

ACQUISITION COMMUNITY SYMPOSIUM

Fort Belvoir, Virginia | April 12, 2011

The Defense Acquisition University (DAU) will host its annual Acquisition Community Symposium Tuesday, April 12, 2011, at its Fort Belvoir Campus. The theme this year is:

Making Every Dollar Count
– Improving Acquisition Outcomes –

Through a series of speakers, panels, and breakout sessions, the symposium will provide congressional, federal-level, Office of the Secretary of Defense, Service-level, and industry perspectives on implementing affordability initiatives announced by the Under Secretary of Defense for Acquisition, Technology and Logistics in 2010. The 1-day symposium will conclude with a dinner in the evening honoring the winner of the 2011 Alumni Association's Acker Award; induction of new DAU Hall of Fame members; and presentation of the annual Hirsch Research Paper Competition prizes.

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Presented on behalf of DAU by:
The Defense Acquisition University Alumni Association

DEFENSE **ACQUISITION RESEARCH** JOURNAL

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CALCULATING RETURN ON INVESTMENT FOR U.S. DEPARTMENT OF DEFENSE MODELING AND SIMULATION

Ivar Oswalt, Tim Cooley, William Waite, Elliot Waite, Steve "Flash" Gordon, Richard Severinghaus, Jerry Feinberg, and Gary Lightner

As budgets decrease, it becomes increasingly important to determine the most effective ways to invest in modeling and simulation (M&S). This article discusses an approach to comparing different M&S investment opportunities using a return on investment (ROI)-like measure. The authors describe methods to evaluate "benefit" (i.e., increased readiness, more effective training, etc.) received from an investment and then use those metrics in a decision analysis framework to evaluate each M&S expenditure. Finally, they conclude by discussing the importance of viewing M&S investments from a Department of Defense (DoD) Enterprise view, evaluating investment over multiple years, measuring well-structured metrics, and using those metrics in a systematic way to produce an ROI-like result that DoD can use to evaluate and prioritize M&S investments.

image designed by Erica Kobren »

Successful Department of Defense (DoD) Enterprise modeling and simulation (M&S) investment requires structure, persistence, and common valuation for effective execution. The methodology summarized in this article provides a systematic process, based upon theoretical aspects of capital structure, by which DoD investments in M&S can be compared, evaluated, and directed to achieve the greatest return on investment (ROI) in this "national critical technology" (House Resolution [H. Res.] 487, 2007).

To effectively apply a technology like M&S to a DoD Enterprise, application, or program, it is critical to define and assess rigorous measures of merit and metrics that reflect the results of M&S application across the relevant spectra of management, mission, and system. Such assessments are especially critical as budgets are reduced, opportunities for live tests and exercises are curtailed, and acquisition time lines are shortened. Currently, most M&S value assessments use metrics that are uneven in scope, very case-specific, do not allow consistent aggregation, or are not well structured. Additionally, some measures that are used, like ROI, are actually incorrectly defined; others, however, are undefined, thus making the assertions of value at best vague, and at worst incorrect. Finally, all too often important distinctions are not made between and among terms critical to consistent ROI assessment, such as metrics, measure, scale, quantity, quality, cost, utility, and value.

Prior efforts to characterize the cost-benefits of M&S have included surveys, assessments, and methodological developments. Surveys summarize the results of efforts already conducted (Worley, Simpson, Moses, Aylward, Bailey, & Fish, 1996). Methodological development articles provide insights into how to improve M&S value calculation (Gordon, 2006). Assessments typically provide insights based on one of four approaches: nominal description, case-based, business-oriented, or multi-attribute examination. All four have advanced the state-of-the-art in M&S assessment, but have not yielded an overall, rigorous, and effective approach for placing metrics in a decision analysis framework to allow the evaluation of M&S investment. The methodology developed here (Figure 1) is distinctive insofar as it provides prescriptive guidance while allowing for the comparison of alternative M&S investments (M&S compared to other M&S or M&S compared to other alternatives [analysis, war games, etc.]) to support a mission or meet a goal.

It also facilitates an assessment of an M&S alternative over time (how the capabilities provided change from the initial application to subsequent use). Such time-considerate assessments are especially critical in today's environment of shrinking budgets. By viewing investments from a DoD Enterprise view, evaluating investment over a multiyear time line, measuring metrics developed from this view-

FIGURE 1. M&S INVESTMENT METHODOLOGY
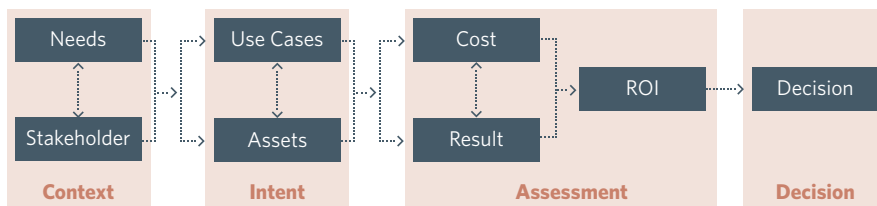
point, and using these metrics in a systematic way to produce an ROI-like result, the DoD can evaluate and prioritize M&S investment.

Market Context and Business Practice

> Stand-alone strategies don't work when your company's success depends on the collective health of the organizations that influence the creation and delivery of your product. Knowing what to do requires understanding the ecosystem and your organization's role in it. (Iansiti & Levien, 2004)

This quote from the *Harvard Business Review* addresses the fundamental premise that commercial businesses exist and thrive (or not) within the context of a business environment much larger than exists within the boundaries of an individual firm. To succeed, individual firms must learn to recognize and create value within "the ecosystem" in which they exist. Translated to the domain of DoD M&S Enterprise management, the quote, as interpreted by the authors, could read:

> Stand-alone M&S strategies don't work when DoD's success depends on the collective value created across the Enterprise, and its creation and delivery of value derived from its investment in M&S. Knowing what to do requires understanding DoD's ecosystem and leadership's role in it.

Within the DoD, many organizations influence the creation of value from M&S investment. On an Enterprise level, the key to maximizing value is understanding who shoulders the costs and who potentially derives value from the allocation of resources to M&S. DoD investment strategies need to address, at a minimum, these aspects of economic valuation:

- Government (DoD) being the (only) buyer in many parts of its M&S market does discriminate it from private-sector M&S investment.

- A lack of "marketplace" from which to gauge economic valuation often complicates DoD's efforts to make sound, credible valuation judgments.
- Government must account for intangible benefits as contrasted to monetized benefits or simple revenue.
- Unlike commercial practice (e.g., corporation- or company-based), when the DoD invests, a misalignment often occurs between the "cost bearer" (the resource sponsor) and the "benefit accruer" (the group that gains an advantage from the investment), especially when the investment creates and returns value to DoD components that exceeds the expected ROI.

The last bullet is particularly significant. In assessing a candidate investment, a practice or methodology does not exist in the DoD to capture and characterize the future and extended value accruing to users beyond the primary recipients of the investment. Having a methodology to capture such extended benefits could change the outcome of an investment decision from "not possible" to "approved," and provide a mechanism for assessing all beneficiaries for their fair share of investment costs. Additional difficulties arise in the fact that in many cases the DoD M&S investment cannot be monetized (translating elements of value to units of dollars) in a manner analogous to commercial business. Placing a monetary amount on lives saved, readiness improved, or warfighters better trained is difficult if not impossible. The DoD's characterization of value must often be in terms that are naturally qualitative, making the calculation of extended benefit (analogous to the time-value-of-money) very different than in the commercial sector.

Across the DoD, the present practice is to base investment in M&S on a number of methods; at an Enterprise level, however, the practice is neither systematic nor consistent. Writing in *Acquisition Review Quarterly*, the Army Developmental Test Command Director for Test and Technology C. David Brown and co-authors G. Grant, D. Kotchman, R. Reyenga, and T. Szanto wrote:

> Most program managers justified their M&S investment based on one or more of the following: reducing design cycle time; augmenting or replacing physical tests; helping resolve limitations of funds, assets, or schedules; or providing insight into issues that were impossible or impracticable to examine in other ways. (Brown et al., 2000)

Simply put, program managers (PMs) are under intense pressure to complete their programs on budget and within time lines. They

lack an institutional mandate to develop or use M&S tools that may have wider application to other programs, or that will be cheaper to operate and sustain in the long term (Brown et al., 2000). This focus on the program level, while potentially good for the PMs, can be detrimental to the Enterprise at large. When considering an allocation of resources, PMs must consider not only costs, but also explicitly definable benefits. Equally important at the Enterprise level are *values (economies of scope), which must be assigned by leadership* to complete the process of estimating ROI and other measures of value with respect to M&S assets. The methodology proposed here is a step in accounting for these competing, yet equally important value metrics.

Stakeholder and Community of Practice Specification

Understanding stakeholders and their role-dependent sensitivities within the M&S community of practice provides the context within which to determine M&S metrics. DoD stakeholders operate within a broad M&S market, where "market" includes the full economic landscape over which M&S products and services have impact. DoD M&S stakeholders fall into seven categories:

1. **Consumers/Users**—End users of M&S-powered products or of M&S services
2. **Buyers**—Expenders of funds for M&S-powered products or of M&S services
3. **Sellers**—Providers of M&S tools, data, or services
4. **Investors**—Providers/appropriators/deciders on expenditures of funds for M&S products or services
5. **Approvers/Raters**—Providers of a "seal of approval" for M&S tools, data, or services
6. **Reviewers**—Providers of "advice and consent" on M&S issues, including M&S products or services
7. **Promoters/Advocates**—Independent providers of "encouragement" to the development of the M&S market for M&S-powered products or services

Each stakeholder category comes to the M&S market with a role-dependent *perspective*. These perspectives are designated as: Program, Community, Enterprise, Federal, and/or Society. For DoD M&S investment, the first three perspectives—Program, Community, and Enterprise—are considered to be internal to the DoD. The final two—Federal and Society—are considered to be external to the DoD. Stakeholders provide another dimension that is useful

in characterizing DoD M&S investment considerations and elements of value.

1. *Program* stakeholders' concerns focus on applicability, availability, and affordability; credibility, analytic soundness, user friendliness, and entertainment delivered, as well as modularity, interoperability, and portability; and concentrate on systems-of-systems or system-level functionality.
2. *Community* stakeholders' focus is on managing M&S within specific areas such as acquisition, analysis, planning, testing, training, and experimentation, and is oriented toward application-level indicators of success or failure.
3. *Enterprise* stakeholders' concerns focus on M&S capabilities that apply across diverse activities of the Services, combatant commands, and DoD agencies.
4. *Federal* stakeholders' concerns focus on M&S developments across departments and agencies of the U.S. Government.
5. *Society* stakeholders' concerns focus on the role and impact of M&S on governments, cultures, academia, industries, and populations.

These concerns are broad and encompassing, and include standards, policies, management, tools, and people, along with reuse, interoperability, collaboration, interactiveness, and sharing of assets in a defense-wide manner.

Use Case

Developing and understanding use cases, including stakeholder needs and requirements, help determine, refine, and evaluate the process for defining M&S investment metrics. Use cases illustrate stakeholder issues and role-dependent sensitivities together with investment decision processes, and serve to support and guide the definition, explanation, and evaluation of processes and metric alternatives. We have developed a framework that encompasses a consistent and complete set of use-case descriptions for use in the analysis of M&S investment metrics. Table 1 lists the parameters of a framework that provides a consistent and complete set of use-case descriptions to help analyze M&S investment metrics. The full report of the study details three use cases from different perspectives (AEgis Technologies Group, 2008). The use cases examine exercise options, Live, Virtual, Constructive (LVC) middleware choices, as

TABLE 1. M&S USE CASE FRAMEWORK

Parameter	Selected Values
What/Where	Investment situation, investment goal, investment time line, asset types, asset numbers, other asset information, geographical constraints
Who	Stakeholder market category, stakeholder perspective, stakeholder office
Why	Concerns, issues, forcers, drivers, constraints
When	Near-term investments, mid-term investments, long-term investments, schedule constraints
How	Costs (near term, mid term, long term)
So What	Result, benefit, utility, cost savings
Data Support	Sources, pedigree, availability, timeliness

well as conceptual modeling alternatives for the Missile Defense Agency. In each of these, the steps in this process are delineated and discussed, sample data included, and a decision recommended based upon the given scenario. Due to space limitations, we were unable to include them in this article.

Assets

To fully understand DoD M&S investment, it is also critical to identify those items that DoD buys. We first define the difference between assets (items for DoD investment) and consumables (in accounting terms: expenses). Then we list the assets and categorize them depending upon the point of view (POV). For example, if one views assets from the DoD POV (Acquisition, Analysis, Planning, Training, Experimentation, and Testing), then the assets are categorized one way. Alternatively, if the POV is that of the DoD Enterprise Community (which from its M&S Vision Statement articulates the categories of Infrastructure, Policies, Management, Tools, and People), then the assets are characterized differently (AEgis Technologies Group, 2008).

From a DoD perspective, an asset is defined as: *"Something of monetary value, owned by DoD, that has future benefit."* A consumable, on the other hand, is: *"Something capable of being consumed; that may be destroyed, dissipated, wasted, or spent."* The primary difference is the concept of future benefit. "Future" in this sense is typically thought of as more than 12 months in the future. Examples of DoD M&S assets include: F-16 simulators, the Navy's Battle Stations 21 simulator, and the online game "America's Army." Consumables, on the other hand, are items such as paper, pencils, jet

TABLE 2. ASSETS LISTING

Hardware	Software	Networks	Facilities	People	Products & Procedures
Computers	Models	Communication Lines	Buildings	Expertise	Plans/Policies
Electronic Hardware	Simulation	Architecture	Labs	Experience	Standards
Hardware in the Loop	Tools (CAD/CAM)*	Transaction Protocols	Ranges	Skills/ Education	Analysis Results
Mock-ups	Data/ Databases		Physical Models	Operational Knowledge	Conceptual Models
Spares	Repositories				Management Processes

Computer-Aided Design/Computer-Aided Manufacturing

fuel, printer ink—all typically used and depleted within 12 months of purchase. In light of this, those types of items that constitute DoD investment assets, using the DoD M&S Vision Statement and the DoD Communities, are shown in Table 2.

By comparing this categorization with that developed by cross-mapping this list with the DoD Communities (from both mission and organizational views), and with the DoD M&S Vision Statement categories, we noted some interesting relationships. To start, every listed asset correlates to more than one major DoD Community. For example, every DoD M&S Community invests in the Asset Models. While this is not surprising, it shows that there may be efficiencies gained by studying the Enterprise view and how the DoD invests in models since that investment is widespread. Also, the assets are quite varied from the tangible items to the esoteric. This means that some assets are easy to value, making the determination of the cost of the investment relatively straightforward, and some extremely difficult. Finally, it is difficult to place assets neatly into bins. All assets cross functional, mission, organizational, M&S Community, and DoD M&S vision category lines, meaning an investment in any one of these assets affects multiple commands, agencies, and per-haps Services. All categories and sub-categories invest in multiple assets. Because of this, to be the most effective and get the highest ROI, investing in M&S needs to be viewed at the Enterprise level, not at an individual Community level. A true measure of investment effectiveness cannot be achieved unless one considers all the costs and benefits.

Asset Costs

A decision to purchase or modify an M&S asset should be based on the needs of the customer(s) and the cost of the purchase or modification. That cost and associated decisions are best understood within the context of multiyear fiscal calculations. In looking at costs and the ROI of those costs, it is important to again acknowledge that business and government operate differently. If a business were to purchase an asset, the business owner would likely evaluate the impact of the asset on the bottom line: profit. The owner would likely predict the changes in profit and the costs to purchase or modify the asset over the useful lifetime of the asset, and then compute ("discount") all those changes in profit and asset costs back to the current year (today's) decision point. Different options, such as "purchase asset A" or "modify asset B," can be compared in this way, even if these options have different payoff and cost streams over varying numbers of years. The comparison of the options in terms of current-year dollars at the time of the decision gives a standard metric that allows a fair evaluation of the alternatives.

Government and industry cost comparisons differ in that while government generally does not compute profit, it does compute changes in expenses. Additionally, in government the changes one stakeholder or one PM makes can have cost impacts on another PM, so one PM can show cost savings while others have the burden of increased costs because of a change in an asset. This shows once again that considering the Enterprise perspective across all impacted programs is essential to calculating an accurate and complete value of M&S investment.

Typically, cost elements for M&S assets can be grouped into useful classifications (Office of the Director, 2007) for evaluation of alternatives through the calculation of current-year metrics:

- Infrastructure: standards, architectures, networks, and environments
- Policies at the Enterprise level (including interoperability and reuse)
- Management processes for models, simulations, and data
- Tools in the form of models, simulations, and authoritative data
- People (including well-trained and experienced users)

The overall study illustrated how an increased level of granularity for these classifications could be tailored to the project and asset particulars, and could be used to facilitate the calculation of costs

by year (AEgis Technologies Group, 2008). The following example illustrates the type of M&S alternatives that could be evaluated using a cost element structure to characterize costs of several alternatives over several years.

Using the Cost Element Structure to Compare Alternative M&S Courses of Action

A simulation professional was directed to establish an annual experiment in Alaska to evaluate capabilities such as the combat benefits of a new system for position determination of friendly ground forces. The simulationist will need to evaluate alternative simulations for use in this annual experiment. Could a different simulation be used each year depending on what systems are being evaluated, or would it be acceptable and cheaper to use a standard core simulation over the next 5 years? The cadre of simulation operators is limited in Alaska, so the simulationist must also evaluate distribution of the simulation environment from other locations.

In this first year, the position determination system may need to be simulated or assumed. Databases for geography and other environmental factors may need to be purchased with requisite lead time. Connectivity and simulation architecture costs will have to be evaluated. The estimated cost of conducting the experiment, using all live forces, would be the most costly option, and could be used to estimate cost avoidance for the other LVC options.

Depending on the alternatives evaluated, some may be more costly in the current year and cheaper in the out-years; while others may be cheaper in the current year but with a high stream of out-year. Hence, the cost comparison of the alternatives is evaluated based on the sum of the discounted costs across the entire 5 years of the experiment.

Results

To understand ROI of M&S, it is necessary to accurately characterize the results of its application—the return in ROI. Such results

need to be rigorously described in a manner that accounts for both qualitative and monetary dimensions. The approach developed and detailed in this section describes the metrics required for such analyses, including types, variability, and application particularities. The development of such metrics is especially important in M&S, where the impact of investment and application is not exclusively monetary, naturally quantitative, or sometimes even intuitively obvious. Where the word "results" appears, its use reflects the outcome of M&S; includes both positive and negative; encompasses terms like value, utility, contribution, benefit, and return; and allows for both monetary and qualitative effects.

The results calculation methodology begins with a series of assumptions and definitions. It is assumed that decision makers in a governmental agency are rational actors who seek to optimize relevant outcomes. Also, outcomes can be characterized using terms that reflect the investment value of alternatives (meaning, no hidden agendas or overriding private concerns). The next assumption is that the metrics can be accurately quantified (whether inherently numeric [like money] or subjectively assessed). For this effort, we define three organizing principles or perspectives that can be consistently applied: Program, Community, and Enterprise. Next, it is important to understand the scope of the results determination. For instance, will they be used to compare alternatives in meeting a goal (M&S to M&S or M&S to other options), or to the evolution of an M&S capability over time? Next, in calculating results metrics, it is important to define the term "metric" in context (Table 3). The next step of results metric calculation is measurement or assessment.

TABLE 3. RESULTS METRICS CONTEXT

Relationships	Example
First are the classes/categories.	e.g., Technical
Associated with each group are characteristics/terms describing features.	Maintainability, Design
Associate these with more specific properties.	Mean Time Between Failures, Type
Decompose these into metrics, standards of measurement, like variables.	Hours, Days/Compiled, Interpreted
Metrics values are relative to a scale (a specified graduated reference used to measure) and may be nominal, ordinal, interval, or ratio in type.	1-2-3-4-5-6-7-8-9-10 / C-I
May range from 0 or no representation to X, which X represents a complete implementation of the areas.	Continuously for interval and ratio data
Metrics are assigned values, based on the features of the M&S (the act of measurement) or mission requirement.	e.g., 9, Compiled
Values can be combined into aggregate measures of merit.	C = 2*1, I = 1, Value = 18

The focus here is on qualitative or subjective judgments that can be numerically characterized and indices that are naturally quantitative. Finally, it is often very important to aggregate, calculate, or derive an overall measure from a decision theoretic approach.

Three perspectives apply within the DoD to the derivation of relevant M&S results metrics and the calculation of their ROI. They are the Program perspective, which includes both M&S programs and programs or activities that use M&S (Oswalt & Kasputis, 2006); the Community perspective, as described in the Application Area Descriptions (Oswalt, 2005) (i.e., the "Surfboard Chart"); and the Enterprise perspective, as articulated in the Strategic Vision for DoD M&S. Acknowledging these three perspectives is critical, since the results metrics applicable to each are different (Figure 2). However, due to space constraints and the desirability to view M&S investments from an Enterprise aspect, only Enterprise metrics are summarized here.

The Enterprise perspective focuses on M&S capabilities that apply "across the diverse activities of the Services, combatant commands, and agencies" and thus presents goals that are necessarily broad and encompassing. They include standards, policies, management, tools, and people that are collaborative, interactive,

FIGURE 2. RESULTS PERSPECTIVES

Enterprise (Brain)
Leadership, Implementation, Business, Infrastructure, System of Systems
Enterprise metrics reflect orchestration and management-type activities

Communities (Organs)
Design, Manufacturing, Sustainment, Time to Market Alternatives, Complexity, Sensitivity, Result Time Projection, Familiarity, Comprehensive, Decision Time, Test, Design, Augmentation, Extrapolation, Completion Time Availability, Scenario Variation, Experimental, Retention Time Discovery, Doctrine, Technology, Cycle Time
Community metrics reflect more specific uses and yet can include both enterprise-type and program-type metrics (when the program crosses boundaries within a community or between communities)

Programs (Blood)
Applicability, Availability, Affordability, Rigorousness, Engaging, Usability, Creditability, Technical
Program metrics reflect the key dimensions of individual M&S system developments or M&S use within platform development of programs

and sharing of assets in a defense-wide manner that includes other "governmental agencies, international partners, industry, and academia." Metric categories for each were derived previously (Oswalt & Tyler, 2008). A sample set of Leadership metrics is provided in Table 4.

ROI Methods

In financial analysis, the concept of return is critical and is principally used to measure the change in "value" over time. As such, return is used by the Financial Community to determine two important concepts: (a) whether or not the benefit of an investment (or similar action) was positive or negative—this is the "direction" of the change; and (b) how positive or negative the change was—this is the "magnitude." Financial analysts typically calculate only one value by which both direction and magnitude can be ascertained. The use of a single value is possible because analysts usually compare changes in a single, same quantity: U.S. dollars. The two most common ways to measure return are as a percentage increase in a holding's value between two time periods. Return consists of (a) the income and the capital gains relative to an investment. It is usu-

TABLE 4. ENTERPRISE METRIC SAMPLE

Enterprise Perspective		Sample Metrics	
Term *(characteristics)* **Definition**		**Quality**	**Monetary**
Leadership (class/category)			
Leadership	Statement of vision and associated advocacy/support of timely actions needed for an effective enterprise (*property*)	#/currency of vision and resulting/ supporting docs (*metric*) ° senior leaders adopt vision within their (other) areas	% alignment of funding to vision Savings from reduced unused sunk costs
Empowerment	Developers, managers, users that are engaged, asked, able to make significant contributions	# innovative ideas forwarded without solicitation % M&S decision makers attending key meetings	Reduction in costs to get new M&S concepts Savings from innovative M&S use
Situational Awareness	Decision maker's and users' understanding and awareness of M&S standards, tools, etc.	# meetings, conferences, repositories, Web portals % critical information exchanged among communities	Reduction in costs to finding good M&S information Cost savings from reduction of duplicative efforts
Management	Human Capital Management for recruiting, assigning, career development of M&S workforce	% M&S billets staffed with M&S qualified people % M&S qualified personnel promoted/ retained	Unnecessary training/retraining costs Cost-effective M&S decisions
Processes	Adoption of rigorous, timely, and relevant standardization and certification of M&S policy, tools, workforce, etc.	# promulgated processes consistently adopted Decreased product (policy, tool, etc.) generation time	Reduced labor, travel, and software reworks Savings from error-rate reduction

ally quoted as a percentage (INVESTOPEDIA®, 2010); and (b) as the amount of cash (or revenue) generated from a set, fixed asset base, expressed as a percentage of investment. Examples of this include Return on Equity, Return on Assets, Return on Common Equity, or

FIGURE 3. DIAGRAM OF MADM PROCESS FOR DoD M&S INVESTMENT ORGANIZED BY DoD COMMUNITIES
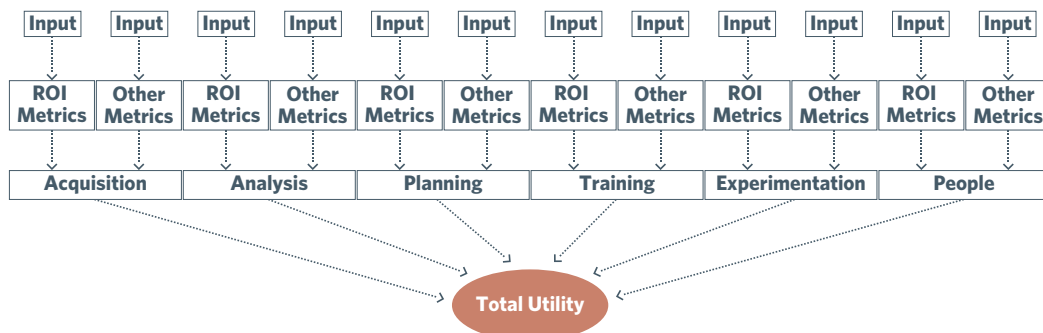
Return on Invested Capital. Both of these methods typically use dollars as the unit of measure.

So how *do* we apply the concepts of financial analysis to DoD M&S projects? The concepts of magnitude and directionality mentioned previously are essential to this endeavor. To make a decision between a finite set of options, a relative sense of order is needed; that is, to be able to distinguish which project is better than the others. Therefore, while we might not assign a specific dollar value to the benefit of one choice over another, by using directionality and magnitude, we can arrive at a "relative ranking" that will let us compare those options among which we are seeking to decide. Additionally, the notion of "internal consistency" in evaluating different options is vital. If we are not able to gain an absolute value (such as, say 83 percent), but are to rely on relative values (A is better than B, which is better than C), we must make sure that we are consistently applying the same evaluation criteria to all the potential choices. The methodology for evaluating DoD M&S investment described in the following discussion meets these criteria and is completely consistent with the manner in which financial analysis seeks to evaluate return.

Investment Decision Process

Having now determined metrics for the costs and results associated with an investment, we are in a position to decide whether or not to make the investment using these metrics and others. Our goal is to employ a decision process that takes into account the data gathered, does not rely upon chance, is fundamentally simple to explain and defend, and is consistent (would give the same answer each time with the same data).

Rational actors, when faced with a decision, will choose the option that maximizes their gain by some measure. In previous sections, we presented methods to evaluate the costs and results of an M&S investment; noted that monetization of these metrics may be difficult, if not impossible, to perform for the DoD; and discussed ROI methods, including key financial analysis elements. Given this environment with its constraints, we developed a decision process that produces an ROI-like quantitative result for use in M&S investment evaluation. We used assessed metrics as input to a Multi-Attribute Decision Making (MADM) network, which has the qualities of being robust, relatively explainable, objective, consistent, and once established, can be executed fairly simply. MADM (Figure 3) is not new and has been shown to work well in structuring complex decisions involving a multidimensional decision space. In its simplest form, MADM is a weighted sum. The total utility score is calculated by multiplying each attribute's normalized input score by its relative weighting (which would be assigned earlier) and summing all the products. This process is repeated at every layer. While other formulae can be employed to calculate a utility score, the weighted linear method is most often used due to its simplicity and transparency (Tompkins, 2003). In this case, multilayers are desirable for a few reasons.

First, it allows for the higher level DoD decision makers to put different emphasis on certain communities by assigning different weights to each community. Additionally, multilayers are desirable for transparency since grouping the metrics by community makes it easier to see how certain measures impact the overall utility score.

It should be noted that attributes measured should be mutually exclusive (no overlap) to prevent one attribute from influencing the final score by a higher amount than intended. Additionally, the weights are typically set by a team of subject matter experts, which should consist of experts from every area affected by the decision under consideration, and these weights should be reviewed regularly. Finally, risk for an investment can be incorporated in this process either as its own category or as a cost metric input to the framework.

Conclusions

By viewing investments from a DoD Enterprise perspective, evaluating investment over a multiyear time line, measuring metrics developed from this POV, and using these metrics in a systematic way to produce an ROI-like result, the DoD can evaluate and prioritize M&S investment. The process outlined in this article meets these criteria and is robust, consistent, and adaptable. If followed,

the prescribed methods and guidelines should allow the DoD, and similar types of organizations, to make M&S investment decisions that result in an increased ROI when compared to the current state. An important next step in the development and use of this methodology is its application. Whether as an assessment technique for a historical examination or an approach for future M&S investment analysis, the techniques described herein would provide rigorous and useful insights.

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EMPLOYING RISK MANAGEMENT TO CONTROL MILITARY CONSTRUCTION COSTS

❨ *LTC Steven M. F. Stuban, USA (Ret.), Thomas A. Mazzuchi, and Shahram Sarkani*

Systems acquisition inherently contains elements of uncertainty that must be effectively managed to meet project cost, schedule, and performance objectives. While the U.S. Department of Defense has a record of employing systems engineering technical management processes (including risk management) to address these uncertainties for major weapon systems acquisition, the application of risk management to Military Construction (MILCON) projects is a recent development. This research studies the use of a formal risk management program on a MILCON project and assesses whether such use influences the project's total cost growth relative to that of U.S. Army Corps of Engineers' historical data. A case study methodology is employed assessing the National Geospatial-Intelligence Agency (NGA)'s multibillion dollar NGA Campus East program.

image designed by Debbie Gonzalez/U.S. Army Corps of Engineers photo by Marc Barnes »

U.S. Army Corps of Engineers

Risk on a Military Construction (MILCON) project has generally been addressed through the use of contingencies/reserves, specified bonding and insurance requirements, and inclusion of appropriate contract clauses at the onset of a project (Khadka & Bolyard, 2010). The design, construction, and commissioning of a facility is, however, a dynamic process engaging numerous parties. Adhering solely to relatively static measures could adversely constrain the project team's ability to achieve overarching cost, schedule, and performance objectives.

While DoD has provided its acquisition professionals ample guidance on the need for implementing risk management throughout a project's life cycle, it does so in the context of major weapon and automated information systems (Bolles, 2003). As was noted by a former Director of Military Program, U.S. Army Corps of Engineer Joe Tyler, this guidance has only recently been adapted in the realm of facility acquisition accomplished through MILCON projects (J. J. Tyler, personal communication, July 13, 2009).

Additionally, a structured approach to risk management from a cost, schedule, and performance perspective has recently been incorporated into the Defense Acquisition University (DAU)'s Level III certification course for the Facilities Engineering career field (DAU, 2010).

A 2008 survey of construction industry professionals revealed that respondents are managing project risks roughly 61 percent of the time, and it may be interpreted to mean that the corner may have been turned regarding use of formal risk management processes (FMI Corporation, 2008). But with billions of dollars committed annually to MILCON projects, one must ask not only if DoD's current level of formal risk management processes is adequate, but also if it is relevant.

The authors of this research used a case study format in assessing the application of risk management processes on the National Geospatial-Intelligence Agency (NGA) Campus East program. In doing so, they sought to define the process that was employed and to assess whether it was effective in controlling the cost growth of the facility component of the NGA program.

Background

NGA is a combat support agency in the Department of Defense (DoD) and a member of the Intelligence Community. NGA's mission is to provide geospatial intelligence in support of U.S. national defense, homeland security, and safety of navigation. Presently headquartered in Bethesda, Maryland, with principal facilities based in the St. Louis, Missouri, and Washington, DC, metro areas, NGA

is in the process of consolidating its National Capital Region facilities to comply with a Base Realignment and Closure (BRAC) 2005 decision.

BRAC 2005 Recommendation 168, which was enacted into law in November 2005, directed the following activity:

> Close National Geospatial-Intelligence Agency (NGA) Dalecarlia and Sumner sites, Bethesda, MD; Reston 1, 2, and 3 leased installations in Reston, VA; Newington buildings 8510, 8520, and 8530, Newington, VA; and Building 213, a leased installation at the South East Federal Center, Washington, DC. Relocate all functions to a new facility at Fort Belvoir, VA. Realign the National Reconnaissance Office facility, Westfields, VA, by relocating all NGA functions to a new facility at Fort Belvoir, VA. Consolidate all NGA National Geospatial-Intelligence College functions on Fort Belvoir into the new facility at Fort Belvoir, VA. (DoD, 2005)

NGA responded by establishing an NGA Campus East (NCE) Program Management Office (PMO) early in 2006 and immediately developed a plan to meet this BRAC mandate (NGA, 2010). While these initial efforts were underway, Fort Belvoir updated its facility Master Plan and completed an Environmental Impact Statement to address how NGA- and other BRAC-impacted organizations would be accommodated at Fort Belvoir (U.S. Army Corps of Engineers [USACE], 2007). Both called for locating NGA at Fort Belvoir's Engineer Proving Ground (a site adjacent to I-95 in Springfield, that has since been renamed the Fort Belvoir North Area [FBNA]), and with the signing of the Record of Decision on Aug. 7, 2007, FBNA was officially designated as the future home for NGA.

Program Scope

The NCE effort included facility, information technology (IT), security, and deployment as primary executing elements. Focusing on the facility component, its scope called for the design, construction, and commissioning of a 2.4 million gross square foot (gsf) campus able to accommodate 8,500 personnel. As the initial design took shape, these requirements were satisfied with a Main Office Building (MOB), Central Utility Plant (CUP), Technology Center (TC), Garage (structured parking), Visitor Control Center (VCC), and Remote Inspection Facility (RIF) (NGA, 2009a). The MOB (indicated as structure "1" in Figure 1) consists of two 8-story office buildings, each roughly 900 feet long with 1 million gsf of capacity, and connected by an enclosed atrium structure. The CUP (structure "4")

FIGURE 1. NGA CONSOLIDATION

is approximately 89,000 gsf and houses the utility services that are distributed to the campus facilities. The TC (structure "2") is a 4-story structure roughly 140,000 gsf in size. The Garage (structure "3") is a 6-level pre-cast concrete structure providing 5,100 parking spaces (in compliance with the National Capital Planning Commission guidelines). The VCC (structure "5") is an 8,300 gsf facility located on the campus perimeter and allowing access control over visitors. The RIF (not depicted in Figure 1) is a separate 10,000 gsf structure located adjacent to a main access point to FBNA; it allows for security screenings of all inbound deliveries to the NCE.

Facility Acquisition Strategy

The NCE effort is an enormous undertaking, and due to the language of the BRAC directive, not only did the facility need to be designed, constructed, and commissioned by the mandated

FIGURE 2. FACILITY ACQUISITION STRATEGIES

Traditional D-B-B
- Design
- Procure Construction
- Construct

Conventional Design-Build
- Bridging Docs | Procure D-B | Design
- Construct

D-B "Fast-Track"
- Bridging Docs | Procure D-B | Design
- Construct Phase 1
- Construct Phase 2
- Construct Phase 3

"Fast-Track" using ECI
- Design 10%
- Design Packages
- Procure IDBB | "Integration"
- Construction Elements
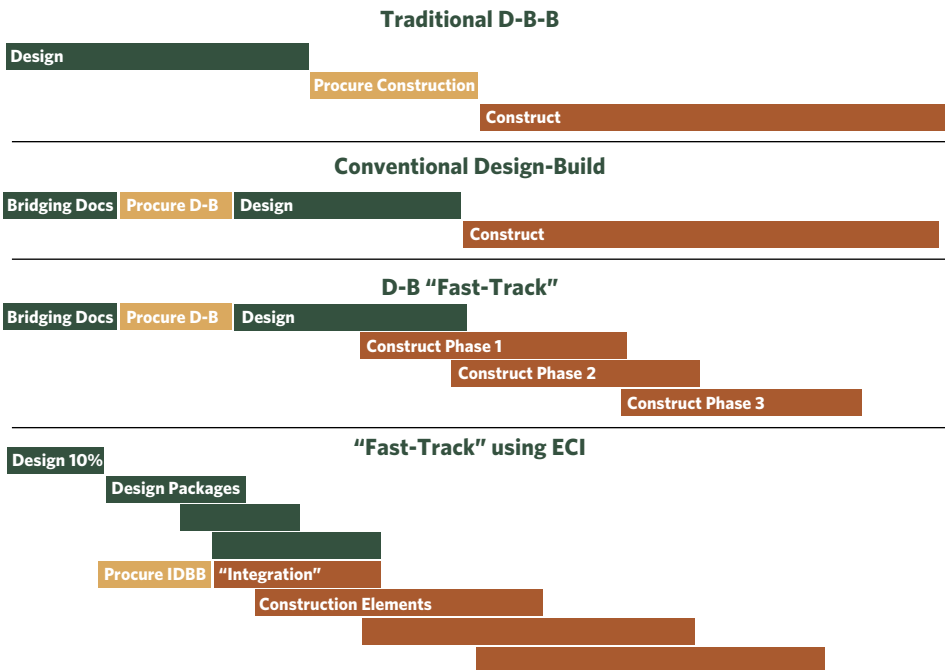
deadline, but the requisite enterprise IT architecture and security management systems had to be designed, installed, tested, and placed into operation; and NGA had to deploy 8,500 personnel and the missions they performed at the NGA legacy sites to the NCE by the September 15, 2011, suspense. Assessing early schedules of the program's activities revealed that the facility effort was on the critical path and key to the program's success. As the program's other efforts were dependent on the facility being in-place, an acquisition strategy had to be determined that would deliver the facility component as rapidly as possible.

When acquiring facilities through new construction, the acquisition strategy (Figure 2) typically follows one of two forms: a Design-Bid-Build (D-B-B), or a Design-Build (D-B). In the case of a D-B-B, a facility designer is contracted, a design is completed, and then a construction contract is awarded to build the facility. A D-B-B strategy employs sequential activities and usually represents the longest amount of time to deliver a usable facility. A D-B strategy calls for a single contract that awards both a design and construction scope. The project time (duration) savings occur not only from a single contract source selection (vice two in a D-B-B), but also potentially from the selected contractor's ability to integrate its design and construction efforts (this second variant is sometimes referred to as a D-B "Fast Track").

At the onset, the NCE PMO settled upon a D-B facility acquisition strategy. As the architect progressed toward a 35 percent level of design that would be used to secure a D-B contractor to complete the project, the NCE PMO recognized that if it were to maintain this course, the facility might be completed in time, but even with incremental acceptances of completed work, minimal time was allotted to complete the remaining scope of the program prior to the BRAC suspense. The NCE PMO and the Baltimore District of USACE agreed upon an alternate strategy—that of Early Contractor Involvement (ECI). Similar to the Construction Manager at Risk (CM @ Risk) strategy gaining usage in the private and commercial sectors, ECI calls for the awarding of separate design and construction contracts, with the construction contract award occurring very early in the design development (at a 10 to 15 percent development of the design). This strategy maximizes the construction contractor's ability to influence the design itself and the packaging of design elements to facilitate a rapid initiation of construction efforts (Peck, Stuban, Bagshaw, & Calloway, 2010).

As for the construction contract type, given the relative immaturity of the design and a need to control cost, a "Fixed Price Incentive with Successive Targets" format was chosen in accordance with Federal Acquisition Regulation 52.216-17. Doing so allowed for establishment of target and ceiling prices for the various elements of work and incentivizing cost containment (Peck et al., 2010).

Program Governance

The NCE PMO managed the totality of the program effort, but executing prime contractors were controlled by an assortment of contract management teams, many of which were external to NGA. The facility efforts were managed by the USACE Baltimore District; the security management system and construction surveillance technician contracts were managed by the U.S. Navy Space and Naval Warfare Systems Command; and the site security, IT, and deployment contracts were managed by NGA.

In addition to these efforts internal to the program, the program was also dependent on the substantial efforts of a number of elements external to NGA and the NCE PMO: the Virginia Department of Transportation for a number of roadway improvements adjacent to the FBNA; the Fort Belvoir Garrison staff for infrastructure improvements to the FBNA; commercial utility providers for gas and electric service improvements to the FBNA; and several telecommunications providers for wide area network connectivity.

To enhance communication and coordination between these various parties, the NCE PMO established a 3-tiered management

structure termed the "One Team" (NGA, 2009b). At the foundational level, the Project Leadership Teams (PLTs) are focused on efforts underway at their discrete project level (the MOB, CUP, TC, etc.). The PLT membership consists of representatives from all elements engaged in delivering a completed, occupied, and operational project, and includes facilities (design and construction), IT, security, deployment, Ft. Belvoir Garrison, and operations and maintenance staff. Mid-level governance is provided by an Executive Leadership Team (ELT), co-chaired by the PMO's Deputy Program Director—Site and Baltimore District's program manager for the NCE effort. ELT membership is comprised of the PMO's deputy and assistant program managers, and the program/project managers (both government and contractor) of each executing element. Top-level governance is provided by a Program Board (PB), co-chaired by the NCE PMO's program director and the Baltimore District commander. Like the ELT, membership consists of executives (both government and contractor) of each executing element (Figure 3).

FIGURE 3. NCE GOVERNANCE STRUCTURE

PLTs meet on a weekly basis (or more frequently depending on emergent issues), the ELT meets biweekly, and the PB meets once a month. Each PLT has its own decision space and authority. So long as the PLT's decisions do not adversely impact another program element, perturb a program-level milestone, or exceed their budget authority, they can directly manage their project's effort. Activities that may adversely impact other program elements, or are outside the PLT's decision space, are elevated to the ELT (or PB if necessary) for resolution (NGA, 2009b).

Risk Management

The PMO has from the onset of the program employed standard program management and systems engineering technical management processes to execute the program within established cost, schedule, and performance constraints. Many of the techniques

FIGURE 4. NCE RISK QUAD TEMPLATE

Risk Title:								
Risk Statement				**Risk Score with Analysis**				
• IF								
• THEN				**Score**				
Decision/Trigger Points (Key Dates or Events)				**Probability:**				
•				**Cost Impact:**				
				Schedule Impact:				
				Performance Impact:				
Closure Criteria								
•				**Probability Key:** Issue (100%); Near Certain (80-99%); Highly Likely (60-79%); Likely (40-59%); Unlikely (20-39%); Remote (1-19%) **Impact Key:** Catastrophic; Critical; Significant; Marginal; Negligible				
Mitigation Plan				**Context**				
				•				
				•				
Step	**Date**	**Action**	**Target Score**	**Status**	•			
1								
2								
3								
4				**Status/Sticking Point**				

employed (requirements management, schedule management, change management, etc.) were commonly understood by all members of the One Team and were summarily described in the NCE Program Management Plan (PMP). When the NCE program was initiated in 2006, risk management as a means to contain cost, maintain schedule, or ensure performance had only recently, however, been adapted on MILCON projects. Drawing upon NGA's enterprise risk management process and the DoD's *Risk Management Guide for DoD Acquisition*, the PMO crafted a Risk and Opportunity Management Plan (ROMP) and tool set, approved by the NCE program director (PD), which was incorporated into the NCE PMP and used across the One Team to facilitate the management of risk.

A Risk and Opportunity-focused Integrated Process Team (IPT) was established. Like the PLTs, its membership included representation from all of the program's executing elements and is facilitated by the PMO's government and contractor Program Integration staff. Employing standard Microsoft Office applications, the IPT formalized a "Risk Quad Chart" template (Figure 4) to capture the essential elements of information necessary to assess a potential risk, opportunity, or issue.

Starting with the upper left quadrant and moving counter-clockwise, an "If–Then" formatted statement is utilized to identify the root cause of a potential future situation, which, if mitigated, would preclude a potential adverse consequence. The "Decision/ Trigger Points" line notes when decisions may need to be made between alternative courses of action or in furtherance of the intended mitigation plan. The "Closure Criteria" define what constitutes successful mitigation of the potential risk. The "Mitigation Plan" section chronologically outlines the discrete steps to be taken in mitigating the potential risk. The "Context" line provides for further background information as to the development of the potential risk. The "Status" line allows for entry of relevant recent information. The "Risk Score with Analysis" allows for entering the assessed "probability" or likelihood of the risk occurring as well as the consequence or adverse impact assessments from a cost, schedule, and performance perspective.

The Risk Scoring is based on a standard 5x5 matrix and probability definitions/percentages (DoD, 2006). The consequence definitions are specific to the NCE program.

Similar quad charts and scoring rubrics were developed for assessing "opportunities" (potential future conditions that, if exploited, could result in positive consequences for the program) and "issues" (existing conditions that were having an adverse impact on the program).

With development of the ROMP and tool sets, and conduct of refresher training, the PLTs were allowed to manage risks, issues, and opportunities at their level. If the PLTs determine that additional resources may be required to successfully mitigate a risk or if mitigation is outside their defined decision space, the risk has to be coordinated via the Risk IPT and elevated within the program.

The Risk IPT meets on a biweekly basis and serves as the forum in which anyone associated with the program could suggest an NCE program-related risk, issue, or opportunity. The IPT considers suggested matters and aids in drafting an associated quad chart. Once drafted and coordinated across the IPT's membership, the IPT determines what recommendation should be made to the program's Risk and Opportunity Management Board (ROMB). The ROMB meets monthly and is chaired by the NCE PMO PD. The PD is briefed on the proposed risk and the IPT's recommendation, and then renders a decision as to whether the risk should be placed in a "watch" status (to allow for validation of the potential conditions that are suspected), "opened" and actively mitigated, elevated to NGA's enterprise-level risk management board, or returned to the IPT for further coordination. Risks that are opened, elevated, or placed on a watch status are then tracked in a Risk Register (a

FIGURE 5. COST GROWTH

NCE Facility Project	Baseline Contract Value (Base + Options)	Cost Growth Amount	Final Contract Amount	Cost Growth (%)
CUP	$99,961,243	$7,503,144	$107,464,387	7.51
TC	$77,996,108	($5,645,069)	$72,351,039	(7.24)
Garage	$76,729,943	($4,443,661)	$72,286,282	(5.79)
VCC	$5,880,734	$79,397	$5,960,131	1.35

spreadsheet chronologically detailing every mitigation step of every risk) and statused monthly at the ELT and PB sessions.

To date the NCE PMO has handled nearly 150 separate risks, issues, and opportunities above the PLT level.

Cost Growth Record

Have the NCE program's active risk management activities made any difference in the cost growth realized on the MILCON component of the program? To assess this possibility, a t-test for independent samples was performed (Salkind, 2009). In this test, a comparison was made between the cost growth realized on several of the NCE program's facility projects that were at or near a substantial completion point and the cost growth realized on a sample of USACE MILCON projects completed prior to FY06 (a timeframe when active risk management as employed on the NCE program was not practiced) (J. J. Tyler, personal communication, July 13, 2009).

MILCON projects completed by USACE in FY04 and FY05 were assessed (earliest complete fiscal year data available from USACE) (USACE, 2010). From this sample set, projects completed outside the continental United States (CONUS) were excluded due to external impacts that could influence the true cost growth (material shipping costs, material and labor availability, currency exchange rate fluctuations, construction in military theaters of operation, etc.). This yielded 15 projects completed in FY04 and 38 projects completed in FY05 (a total sample size of 53), ranging in value from roughly $1.4 million to nearly $45 million. Comparing each project's baseline contract and options amount to its final contract amount (determined after all construction was complete and the contract was financially closed-out) revealed the cost growth realized on the projects. Assessing the cost growth on all 53 projects revealed a sample mean cost growth equaling 7.493 percent, with a standard deviation of 9.728.

Four NCE facility projects were included in the comparison sample: the CUP, TC, Garage, and VCC. The financial details for these projects are shown in Figure 5.

Assessing the cost growth of the four projects listed in Figure 5 revealed a sample mean cost growth equaling –1.04 percent with a standard deviation of 6.824.

Translating this into cost totals, had the NCE program experienced the average cost growth of the historical sample, it would have incurred $22,234,270 in additional costs.

The NCE program unquestionably managed to better control costs relative to that of the historical sample. To assess whether it was statistically significant—that the NCE sample was indeed different from the historical sample and not simply an outlier—a t-test for independent samples was performed. The NCE sample's t_o was calculated as 1.715 (Walpole & Myers, 1978). This t_o value was plotted on a t-distribution of the historical sample. The distribution's $t_{0.05,55}$ value equals 1.673; this is the point at which 95 percent of the distribution with the appropriate 55 degrees of freedom lies to the left. Focusing on this point revealed that t_o in this case lies to the right (it is in the critical zone). This signifies that the mean cost growth realized on the NCE projects is statistically significant relative to that of the USACE sample of FY04 and FY05 (Salkind, 2009). As the NCE cost growth is lower than that of the USACE sample, it is preferred, and whatever characteristic(s) made the NCE sample distinct from the USACE sample would be preferred as well. It is suggested that an active risk management process is at least one of the characteristics that sets the NCE projects apart from the way historical MILCON projects have been managed, and is a process that should be employed on all MILCON projects (if not already underway) where controlling cost growth is an objective.

Conclusions

Risk, issues, and opportunities are ever-present and require proactive management approaches throughout an acquisition to ensure that a program's cost, schedule, and performance objectives are met. In that DoD acquisition takes many forms, including facility acquisition via MILCON projects, leveraging all the management tools and techniques that may be available appears to be the most prudent course of action. An active risk management program, particularly applied throughout the project's delivery phase (the design, construction, and commissioning of the facility), is one such tool.

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MITIGATING SPIRALS OF CONFLICT IN DoD SOURCE SELECTIONS

Steven M. Maser and Fred Thompson

Government contracting is rife with opportunities for miscommunication and misperception. This can undermine trust and fuel spirals of conflict. For this article, the authors interviewed participants and analyzed Government Accountability Office (GAO) bid protest decisions involving Department of Defense source selections. They found agency, vendor, and GAO practices that trigger and fuel these spirals. Contracting agencies and GAO can take steps to improve communication, reduce inconsistencies, and reduce perceptions of bias, thereby mitigating costly bid protests.

image designed by Tia Gray »

Conflict

Tornado

This way to
MITIGATING
SPIRALS

In 1984, Congress gave its investigatory arm, the General Accounting Office, or GAO (renamed the Government Accountability Office in July 2004), authority to decide protests of source selection decisions under the Competition in Contracting Act. Judicial forums for resolving protests, such as the Court of Federal Claims (COFC) or Circuit Courts, are adversarial by design. GAO is not. It is an alternative dispute resolution (ADR) mechanism, designed to be fast, inexpensive, and flexible.

How well does this process work? The response to this question evokes not one, but two answers. If the question means: Does it handle protests efficiently? the answer is clearly "yes." If it means: Does it fix the root causes of the conflicts that lead to protests? the answer is less clear. To answer the question, we apply concepts from the theory of dispute-systems design (Costantino & Merchant 1996; Slaikeu & Hasson, 1998; Stitt, 1998; Lynch, 2001; Conbere, 2001; Lipsky, Seeber, & Fincher, 2003; Shariff, 2003; Bordone, 2008).

During Fall 2009 and Winter 2010, we used a protocol designed to diagnose conflict (Ury, Brett, & Goldberg, 1988) to interview over 25 members of the acquisition community:

- Four attorneys at GAO
- Executives and in-house counsel at four prime contractors
- Four outside bid protest counsel
- Contract managers at two small subcontractors
- Current and former officials in the Office of the Secretary of Defense
- Officials and in-house attorneys at three military commands—Air Force Materiel Command, Naval Air Systems Command, and Defense Logistics Agency
- Senate Committee staff
- Executives—typically, former DoD contracting officers with industry trade or professional associations such as the Aerospace Industries Association, the National Contract Management Association, the Professional Services Council, and TechAmerica.

These are not a representative sample, but rather a network that expanded as respondents recommended others who could share their perspectives. Their insights are suggestive, not definitive.

We also analyzed GAO bid protest decisions related to DoD source selections between 2001 and 2009. Our interlocutors generally agree that source selection procedures, although often onerous for everyone involved, are basically fair and bid-protest processes

effective. They also expressed concern about insufficient information, inconsistency, and bias.

Insufficient Information

In the absence of information, innocuous matters can grow into spirals of conflict. Miscommunication and misperception trigger distrust and sometimes hostility even though the procedures for resolving disagreements seem clear (Carpenter & Kennedy, 2001). For example, an offeror, having made a significant investment in the process, seeks information or acknowledgement of a problem. The contracting agency, also having made a significant investment, resists. Negotiating does not resolve the problem. The offeror perceives the agency to be stonewalling. The agency perceives the offeror to be seeking a competitive advantage.

After protesting informally, an offeror might protest formally within the contracting agency or skip the formal, agency-level review and go directly to GAO. Other parties begin to take sides. Elected officials, for example, step in, perhaps directing affected constituents to pursue the protest at the GAO. The contract winner may step in to support the agency.

GAO procedures are fairly well defined and managed, often resolving the dispute. However, a company dissatisfied with GAO's decision can go to COFC or pursue the matter in Congress or with other decision makers at DoD or elsewhere in the Executive Branch—a relatively unmanaged process. As the conflict escalates, communication becomes fraught; misunderstandings multiply. Zealots replace moderates and invest resources to win rather than to resolve disagreements. Perceptions distort, parties lose objectivity, gray areas become black or white, or seemingly innocuous behaviors become meaningful as distrust and suspicion grow.

To generate more complete and accurate information, government establishes regulations, typically in the Federal Acquisition Regulation (FAR) and Defense Federal Acquisition Regulation Supplement (DFARS). In the Federal Acquisition Streamlining Act of 1994, Congress made agency debriefings mandatory upon request. Rejected offerors may request information from the agency about the basis for its selection decision and contract award. A potential benefit of conducting a debriefing is to prevent a bid protest by explaining the reason for agency decisions so the rejected offeror will see that the agency acted within the bounds of its discretion and consistent with its evaluation plan.

If an agency gears its standard of disclosure to surviving the protest at GAO, which can result in the agency sharing less information, the offeror, anticipating this, might start bringing attorneys

to debriefings to elicit more information. The engineers, attorneys, or head of a business unit want to explain to the team that spent time working on a proposal why the company lost. Executives to whom they report want to know, as well. The agency might perceive the presence of attorneys as a threat (Szeliga, 2008). In a classic illustration of a conflict spiral, the dissatisfied offeror files a protest and contracting agency executives have to explain to their team, who also invested time working on the source selection, why the company filed a protest, and, potentially, why GAO sustained it.

Where an agency discloses in a debriefing as much to rejected offerors as it would to the Source Selection Authority, some offerors will be grateful and satisfied. However, some rejected offerors will comb the information to find bases for challenges. A business consultant and contactor said, "Even if you give a contracting officer a script for the debriefing, written by an attorney, a rejected offeror can find a problem in a gesture or a phrase." A prime contractor executive said, "If the agencies are becoming paranoid because attorneys are involved earlier so agency people become more cautious in what they say, remember the old saying: 'Just because you're paranoid doesn't mean someone isn't out to get you.'"

Agencies fear rejected offerors will exploit their every word, so utter fewer of them. Businesses fear agencies will utter fewer words, so try to pry more out of them. In a spiral of conflict, perception matters more than substance. Reciprocating reactions create an adversarial tone.

Inconsistencies

Ironically, postaward debriefings can contribute to a climate of distrust because the FAR gives a contracting officer discretion in the content of debriefings. At one agency, a vendor might receive a 10-minute review, scripted by an agency attorney, with a contracting official showing one Powerpoint slide containing the minimal amount of information required by the FAR and minimal opportunity for the rejected offeror to ask questions. At a second, the vendor might receive an analysis of what the contractor did or did not do that was problematic. At a third, the vendor might receive a 2-day review by multiple members of the source selection team, including engineers and attorneys, presenting essentially the same information conveyed to the Source Selection Authority; the agency will ask the winner for permission to explain to rejected offerors why the agency selected the winner, albeit with competitive information redacted. The rejected offeror has ample opportunity to ask questions. Even within the same agency, people disagree on which debriefing approach to implement.

Not knowing what they will encounter, businesses prepare for the worst. Conversely, while some business executives maintain resolutely that they attend debriefings to find reasons not to protest, agencies cannot necessarily discriminate them from executives who attend to prepare to protest. Reflecting the cost of inconsistency, a protest attorney believes agencies build 3 months into their schedules for large contracts to account for bid protests, and companies build the expected cost of a protest into their overhead.

After companies file protests, disclosure practices also can be inconsistent across agencies. Anticipating a protest, one agency might have documented every step it took from the outset and prepared to reveal all. Another might not create a file, as in a legal discovery process, until the protest has been filed. If the bid protest targets a particular part of the selection process, an agency might focus its disclosure on only the protested part. If a rejected offeror is unable to distinguish an agency that will disclose more postprotest from one that will disclose less, it has an incentive to challenge multiple, interrelated parts and, prior to that, to mine debriefings for information that could provide the basis for protests, increasing the costs to the agency and irritating its decision makers.

A perception of inconsistency afflicts decision making at GAO, as well. GAO attorneys discriminate frivolous from legitimate protests—those that point out an error in a contracting agency's processes. They also differentiate among legitimate claims those that are material—meaning the outcome of the source selection might have been different but for the agency's error—from those that are immaterial. In that sense, GAO, in effect, applies a standard of reasonableness in its bid protest decisions and works to maintain that standard with consistency.

Members of the acquisition community on both the government and the business side believe GAO's standards of reasonableness and materiality have eroded, encouraging more protestors to file protests and more protests to involve frivolous and immaterial claims. GAO disagrees that its standard of reasonableness has declined. An independent legal analysis might confirm that it has not. What nourishes spirals of conflict, however, is the perception that it has.

Similarly, some agencies and legal practitioners expect GAO to follow precedent but perceive that it does not. Others believe GAO exercises discretion in the areas where it chooses to rule and on the direction of its rulings, by ignoring facts in one case that are the same as in another case and should be determinative in both. When a new area of dispute arises, such as organizational conflicts of interest in the early 2000s, GAO will choose to find merit in claims in the new area and begin sustaining them until the

acquisition community adapts to the likelihood of those claims prevailing. A protest attorney might argue less on precedent relevant to the main issue in a protest than on attracting GAO's attention to a minor issue that could set a new one. For good or ill, GAO's pursuit of its multiple missions—third-party intervener, educator, and promoter of competition—can contribute to a perception of its inconsistency.

Perceptions of Bias

The acquisition community's perception of bias takes several forms. For example, few of our business interviewees found agency-level reviews to be efficacious (Troff, 2005) because they believe agencies become defensive. A bid-protest attorney asks why an agency would correct its own mistake? "It's more likely to circle the wagons. An agency review is a single filing, no discovery, and you wait for an agency to decide." He recommends against it.

An informal agency review involving one-on-one conversations can make an agency nervous that a company will try to influence the definition of requirements or the evaluation scheme to favor the proposal it intends to submit. One trade association official described this as "a Kabuki dance." After agencies publish solicitations, businesses believe the agencies have vested interests in them and tend to be dismissive of inquiries from companies. Frustrated offerors do not see agencies as neutral venues.

Vendors hear agencies say that protests are part of the source selection process and they do not and legally may not treat a protestor with prejudice during a subsequent selection. But, as a consultant to many offerors put it: "The contracting community lives in fear of retribution for protesting." A vendor protests, then loses a subsequent contract and attributes the failure not to its unresponsive bid, but to the agency seeking retribution. Or, vendors experience retribution for poor performance in the business world and project it into the government world. Offerors believe that protests impact careers in the agency, leaving its decision makers with prejudice.

The business executives' fears are not necessarily misplaced. A former contracting official described the ease with which an agency can exact revenge. Suppose a contracting official wishes to punish a vendor who protested and subsequently plans to bid on a contract to be performed outside its geographical area in competition with vendors close to the location of performance. The contracting official specifies in the solicitation that expenses will not be reimbursed for travel in excess of 50 miles, effectively denying the target offeror an opportunity to bid.

Some members of the acquisition community perceive that Democratic administrations favor particular firms, Republicans others, that defense agencies have their pets, and that the GAO decisions reflect congressional preferences. A few cited specific examples that confirmed their suspicions, but most were based on little more than hearsay. What is remarkable about these responses is the distrust the participants expressed about the source selection process, despite the fact that, when queried about their own experiences, they often described the officials they had direct contact with as open, helpful, and informative.

Several factors bear on this. First, a rejected offeror, not having achieved its objectives, will blame the process. This is human nature, a "self-serving attribution" (Malhotra & Bazerman, 2007, p. 135). As a trade association official put it: "When you've lost, you distrust the system and believe the decision was wired for someone else."

Second, the inherent subjectivity of the decisions made by agencies induces distrust of the process by business participants. Evaluating "best value," for example, requires balancing price, performance, and other characteristics, which is problematic. A contracting agency official said: "Even big companies believe government looks only at lowest price, not at best value." Business executives concur (Schofield, 2009, p. 53).

Third, smaller companies, who comprise the majority of offerors and a disproportionate source of protests, are less sophisticated. They might not devote resources to obtaining contracting expertise or in-house or outside counsel. The company errs but believes the government did. A small company might protest because it believes an injustice has been done. Indeed, it might perceive a bias based solely on its size, a view expressed by a business executive at a smaller firm who said, "No one gets fired for hiring Raytheon, but someone can get fired for hiring [my company]." In contrast, a large company with multiple product lines makes a business decision to protest based on assessing the potential outcome versus the cost of pursuing the protest.

Given the high cost of understanding these processes, a visible, sustained protest on a high-value contract, like the KC-Tanker, sends a signal throughout the contracting community, triggering new spirals. According to a bid protest attorney: "Lots of contractors now think that if they work hard, turn in a good bid, and protest vigorously, they might win, as Boeing did. [My firm] has handled twice as many protests during the past two years as in the previous two." Decision makers assign outsized significance to low-probability events with significant impact, like a sustained protest on a high-value contract.

Fourth, companies create advantages for themselves, sometimes in ways that undermine confidence in the contracting process. For example, a company buys expertise about the contracting process by recruiting contracting officers from government agencies. Competitors believe that these contracting officers will trade not only on their expertise, but also on their relationships with decision makers in the contracting command.

Fifth, contracting commands need expertise from their suppliers to define requirements. Not all suppliers have the access, experience, and resources to respond. The result can be requirements that preclude some suppliers from qualifying. Regulations designed to create fairness can have the opposite effect because of their complexity. According to a business executive: People who know how to play the game will prevail.

Sixth, although GAO maintains that it operates on professional principles, immune from political influence by members of Congress, people in the business world do not believe it. A legal practitioner at a prime contractor said, "No matter what the issue, you can find GAO opinions on either side. GAO tries to keep the politics out of it. I don't know how they do it when their bosses in Congress are calling them in to testify at hearings."

Businesses seek congressional assistance in securing a contract or in protesting failure to win. GAO believes members of Congress like being able to direct their constituents to GAO for a neutral hearing, rather than having to do battle over the matter with another member (McCubbins & Schwartz, 1984). Nonetheless, as elected officials are wont to do, they will take credit for GAO decisions that favor their constituents, damaging perceptions of GAO's neutrality.

Recommendations

In general, agency officials agree with industry executives and attorneys: What an agency does to conduct a good source selection is also what will avoid a protest. However, given the root causes we found to be associated with spirals of conflict in source selections, we recommend changes that increase the flow of information, improve consistency, and reduce perceptions of bias. The recommendations implement principles of dispute-systems design (Ury et al., 1988).

Principle No. 1: Put the Focus on Interests

To short circuit a spiral of conflict, focus the parties on solving a mutual problem, face-to-face, in a relatively informal process that they help to shape (Carpenter & Kennedy, 2001, pp. 26–29). The parties at the lowest level will have the best information, be able to

respond most quickly, and be more likely to satisfy their underlying interests—the reasons why each party is participating in the source selection process—so they are less likely to perceive bias. That would be agency-level review.

At the Defense Logistics Agency (DLA), contracting officers respond when there are source selection problems. Sometimes, they educate offerors. Other times, if an offeror is correct, the contracting officer rectifies the situation. If an offeror formally protests to DLA, it can choose to go to either the contracting officer or to the

chief of the contracting officer, but not both. DLA's internal alternative dispute resolution (ADR) process employs trained mediators. No appeal within DLA is possible; the next step is GAO. Since 2004, DLA has had a lower rate of protests at GAO than the Army, Navy, Air Force, or DoD (Maser, Subbotin, & Thompson, 2010).

Procurement agencies have not been aggressive in implementing an executive order requiring agencies to create ADR systems (Nabatchi, 2007). First, it was a relatively new concept, so agencies were not convinced that it served their organizational interests. Second, few internal pressures existed to use it, and external actors were

not clamoring for it. Third, agencies had little empirical evidence of its merits. However, the concept is no longer new. The likelihood of increasing numbers of protests that forestall execution makes agency-level reviews more efficacious. The success of DLA's and GAO's processes testifies to the merits of ADR on principle. From an incentive perspective, requiring agency-level reviews would give agencies added incentives to document their decisions, and thereby improve disclosure, especially if their responses become part of the record before GAO. Whether it will work with source selections more complex than those at agencies like DLA merits testing.

Principle No. 2: Provide Loop-Backs to Interest-Based Negotiation

The bid protest system encourages parties to do this by allowing agencies to take corrective actions. At any time, including during GAO's proceedings, an agency can respond affirmatively to the claims made by an offeror, who then withdraws the protest. GAO has a specialized form of ADR nested within it—predictive-dispute resolution—where GAO predicts the outcome of its decision making based on a preliminary analysis.

This has resolved a high percentage of protests by parties who have participated in it.

Incentives for offerors to negotiate seriously could be implemented. If a rejected offeror lodges multiple protests with one or more agencies, who all conclude that the protests have no merit, and if GAO subsequently agrees, then after some number of protests, such as three in 3 years, GAO could be empowered to require the rejected offeror to begin compensating the agencies for their costs associated with responding to the protests. Failing Congress authorizing GAO to do that, GAO could begin documenting repeatedly frivolous protest behavior as part of past performance data that agencies consider in making awards. This merely makes transparent and systematic something contractors already believe transpires in obscurity and inconsistently.

Principle No. 3: Provide Law-Cost Rights and Power Backups

If interests-based negotiations do not yield a resolution acceptable to both parties, they require access to a determinative process. This, in effect, is what GAO's bid protest process represents relative to the COFC. The process looks more like nonbinding arbitration than mediation, although it does not fit neatly into any traditional model of ADR. Arbitration, chosen primarily for its finality and efficiency, is more about consistency—within limits. Something akin to a precedent can emerge, but not as rigorous a body of precedent

and law governing discovery and evidence as an Article 3 court (Metzger & Lyons, 2007).

GAO should monitor and be transparent about its standards of materiality and reasonableness and the processes by which they are assured. A higher standard might be appropriate for incumbents who protest, either in terms of agencies providing a rationale for changing suppliers or in terms of GAO's standard of the reason-ableness of an incumbent's claim. If an agency has had experience with an incumbent and still believes a new contractor is preferable, GAO could afford greater deference to the agency. This offsets, in part, the incumbent's informational advantage in the competition and its incentives to protest to extend its contract for the period of the protest review.

Principle No. 4: Build in Consultation Before, Feedback After

As a form of consultation between agencies and rejected offerors, debriefings remain key to improving trust and mitigating protests. To promote disclosure means, ironically, that agencies should assume rejected offerors will protest. Agencies should sup-ply them the same information provided to the Source Selection Authority, which is to say, the same level of detail that the agency should provide in responding to a protest. Agencies should be able to explain to the offeror why that offeror was not selected; if the agency cannot do that in a debriefing, then it will not be able to defend itself in a protest.

A Source Selection Joint Action Team in the Office of the Sec-retary of Defense is looking at the consistency of debriefings. This office or its designated agents should collect data continuously about the quality of the debriefings to compare performance with expectations and, thereby, to continue to improve them. A related recommendation is to mitigate the adversarial tone in debriefings. Rather than explaining how the rejected offeror erred and should change so as to help the agency, the debriefing ought to explain what the offeror should do better to help itself (Thompson, 2009, p. 165).

Another way to improve consistency is to record debriefings. This might obviate the need for attorneys to attend them. It also obviates the need for protestors to solicit affidavits from everyone at their companies who attends a debriefing. It also supports GAO's job as third-party intervener. A contracting official can say the same thing in debriefings to two different protestors; depending on the attitudes and interests of the protestors, one will find the contract-ing official unresponsive and the other will not. If a protest results, GAO can judge.

Finally, GAO reports to Congress annually on the number of bid protests and their resolution, including agency responses to GAO decisions and the number of corrective actions. To improve the efficacy of its bid protest system, GAO should track and report more fully to Congress on the outcomes of agency decisions. If, for example, an agency agrees to take corrective action—which is generally viewed as a positive outcome—by initiating a new solicitation but takes years to do so, devaluing the investment made by the contract winner and putting other offerors on hold, the result is not necessarily salutary. Congress should have better feedback on what works and what does not.

Principle No. 5: Provide Necessary Motivation, Skills, and Resources

To make agency-level reviews more credible, agencies should use staff trained in negotiation and mediation, preferably using parties different from those engaged in the initial decisions (Troff, 2005, pp. 145–149). The same idea applies to peer reviews of source selections, formally instituted in 2008. Peer reviewers should be trained to conduct a peer review, which is different than conducting a source selection; and their involvement should become part of their performance evaluation and tracked, which does not happen systematically. Finally, if certification becomes the coin of the realm in the government's Defense Acquisition Workforce (Fast, 2009), contractors could be required to have staff whose understanding of the source selection process is certified, as well.

Another skill to improve consistency in source selections would be for agencies to invest in managing risk in the way companies do. DoD has developed a methodology for risk management that lodges primary responsibility with the program manager, and explained it in *Risk Management Guide for DoD Acquisition* (DoD, 2006). It focuses on three risks: performance, cost, and schedule. The term "source selection" never appears. The term "contracting officer" appears twice. While it purports to apply to the entire acquisition process, it focuses on contracting and contract execution after source selection.

Yet source selection is all about managing risks. Technical risk concerns the ability of the product to perform to specifications. Financial risk concerns the ability to deliver the product or service on budget. Sustainment risk concerns the ability to maintain the product within budget. Congressional risk concerns political support for or interest in the product or service. Appropriation risk concerns the ability of Congress to continue funding the product or service. Reputational risk concerns the ability of the agency to execute a successful source selection. Bid protest risk concerns

the likelihood of drawing a protest. Some risks are internal to the agency; others are external (Rogerson, 1994). Some are tangible; others less so.

Companies face an analogous set of risks to their success in bidding, although they perceive risk differently (Frick, 2010). Many have a chief risk officer (CRO); agencies do not. Some believe the Source Selection Advisory Committee identifies risks for the Source Selection Authority, who plays the CRO. Other current and former contracting officials see no one responsible for identifying the complete range and extent of risks in source selections and apprising decision makers of their options and tradeoffs in managing them. While methods for adapting corporate risk management processes to acquisitions have been developed (Rice, 2010), systematically assigning responsibility and authority for using them has not. Adopting common methods and structural arrangements to manage risk could reduce perceptions of bias and inconsistency.

Conclusions

Given the inevitability of human error, good source selection processes will not eliminate protests. As an agency official put it: "The question is one of reasonableness. If one puts in place processes to 'perfect' the source selection so as to minimize protests, you'll create delays in producing the award that may exceed the delays caused by the protest process." Once an offeror decides to protest, in the words of a bid protest attorney: "Alternative dispute resolution works." It provides a valuable, inexpensive way of resolving disputes, especially compared to the judicial process. Another said, "It limits the time you are spending a client's money. GAO helps the sanity of the acquisitions community."

Principles of ADR and dispute systems design can prevent conflict spirals and mitigate those that begin. Strengthening agency-level review can reconcile the interests of disputants at low cost. Peer reviews and greater disclosure through thorough debriefings can increase the parties' satisfaction with the process and its outcomes. Treating risk management in source selection as systematically as it is treated in contract execution can improve consistency in decision making and, thereby, relationships among the parties, including not only agencies and contractors, but also Congress and other stakeholders. Greater transparency in GAO's standards can promote GAO's multiple missions, which in turn can produce more durable resolutions.

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MAXIMIZING FEDERAL IT DOLLARS:
A CONNECTION BETWEEN IT INVESTMENTS AND ORGANIZATIONAL PERFORMANCE

BG Ennis C. "Jim" Whitehead, USAR (Ret.), Shahram Sarkani, and Thomas A. Mazzuchi

Evaluating how best to invest government information technology (IT) dollars means making choices. Should agencies strengthen infrastructure with energy-efficient servers and increased network bandwidth, purchase software to cut costs, increase collaboration, or invest more to meet stakeholders' future needs? Is there a connection between the way agencies invest IT dollars and successful mission accomplishment? In this article, the authors show a connection between IT investment allocations and organizational performance in federal government agencies, and demonstrate how higher performing agencies invest differently in IT than lower performing agencies. Federal managers can compare their organization's IT investment portfolio with high-performing agencies and compare their investment allocations with other federal organizations with similar missions to determine optimum IT investment allocations for their agencies.

image designed by Miracle Riese »

IT Portfolio

Goals

Assets

Plan

Invest

"The federal government has largely missed out on the transformation in the use of IT due to poor management of its technology investments. Government IT projects all too often cost millions of dollars more than they should, take years longer than necessary to deploy, and deliver technologies that are obsolete by the time they are completed."

—Vivek Kundra
U.S. Chief Information Officers Council, July 1, 2010

So testified U.S. Chief Information Officer Vivek Kundra before the House Committee on Oversight and Government Reform, July 1, 2010. The federal information technology (IT) budget stands at $87.9 billion for 2010, with the Department of Defense (DoD) budget consuming $35.7 billion of this total (Office of Management and Budget [OMB], 2010). The government faces significant pressure to improve agency performance and reduce IT costs, but challenges and questions emerge. Is there a connection between IT investments and agency performance? If so, where should IT funds be spent to be most effective—on improved IT infrastructure with more energy-efficient servers and increased network bandwidth, or on new software to cut costs and increase productivity? Would IT dollars be most effectively used to increase collaboration and management control, or should agencies forecast their stakeholders' future needs and invest more to meet those requirements?

With each new administration, laws and programs are created to improve agency performance through improved IT productivity. In 1996, the Clinger-Cohen Act adopted a private sector IT investment approach of performance and results-based management; in 2002, e-Government initiatives were begun to bring government services online; and today, agencies are looking at Information and Communications Technologies (ICTs) to improve services to constituents. If we could find evidence that certain categories of IT investments were associated with higher organizational performance, perhaps we could spend IT budget resources more effectively.

Sinan Aral and Peter Weill at the Massachusetts Institute of Technology Center for Information Systems Research (MIT CISR) found that corporate performance was affected by IT asset allocation (Aral & Weill, 2007). Although federal government requirements and measures of performance differ significantly from those of the private sector, with agencies focusing on mission accomplishment and responding to political conditions more than market conditions (Holmes, 2001; Ostroff, 2006), this research examines a similar connection between federal IT investments and agency performance.

Studies of IT investments and organizational performance have been conducted in the private sector for two decades, but research

has not been applied to the federal sector. The authors of this study examined federal government agency IT portfolio investments for 30 agencies, as provided annually to the OMB on their Exhibit 53 data submissions, and divided federal agency IT investments into four categories: Innovation, Management Support, Process Automation, and Infrastructure. They statistically compared agency program performance, as determined from the OMB's Program Assessment Rating Tool (PART), with IT investment allocations and sought to answer the following question:

> Do higher performing federal government agencies invest IT assets differently than lower performing agencies?

Evidence pointed to a significant difference in how higher performing and lower performing agencies invest their IT budgets. A causal effect between IT investment and agency performance could not be statistically proven, but significant differences were found. This research provides a new perspective on IT investment allocation and suggests a technique by which IT investments in the federal government can be evaluated and adjusted to achieve agency goals.

Definitions

IT Assets and Investments
The U.S. Government Accountability Office, formerly the General Accounting Office (GAO), adopted a definition of IT assets in its 2000 report on *Information Technology Investment Management:* "computers, ancillary equipment, software, firmware and similar procedures, services (including support services), and related resources used by an organization to accomplish a function" (GAO, 2000). IT investments, the report cited, are "the actual expenditure of resources on selected information technology or IT-related initiatives *with the expectation that the benefits from the expenditure exceed the value of the resources"* (emphasis added) (GAO, 2000). IT investments are expected to create value for any organization, private or public sector, and at least for the long term, to return more than their costs.

Organizational Performance
Organizational achievement for federal government agencies includes continuous improvement on mission goals (Popovich, 1998); cost-effective program delivery, accountability to taxpayers, improved productivity, and human resources strength, including quality of the workforce and employee satisfaction (Kaplan & Norton, 2005; Keyes, 2005); and the approval of political stakeholders

TABLE 1. PRIVATE SECTOR VS. FEDERAL AGENCY ORGANIZATIONAL PERFORMANCE

	Private Sector	**Federal Agencies**
Strategic Goal	Competitiveness	Mission effectiveness
Financial Goal	Profit, growth, market share	Cost reduction, efficiency
Values	Innovation, creativity, good will, recognition	Accountability to public, integrity, fairness
Desired Outcomes	Customer satisfaction (customer pays for product/service)	Stakeholder satisfaction (stakeholder may not pay proportionally for service)
Stakeholders	Stockholders, owners, market	Taxpayers; legislative, executive, and judicial branches
Budget Priorities Defined by:	Customer demand	Leadership, legislators, planners
Justification for Secrecy	Protection of intellectual capital, proprietary knowledge	National security
Key Success Factors	Growth rate, earnings, market share	Best management practices, legislative compliance
	Uniqueness	Sameness, economies of scale
	Advanced technology	Standardized technology

Note. Adapted from "Differing Measures for Private Sector and Federal Agency Organizational Performance," by P. Arveson, 1999.

and the public perception that they are "doing the right thing" (Holmes, 2001). Since the Clinger-Cohen Act attempted to replicate IT investment portfolio success in the private sector (Van Over, 2009), and earlier IT investment portfolio research is based on the private sector, it is instructive to examine some of the differences between public and private sector performance measures. Table 1 is an adaptation of a chart by Paul Arveson (1999), customized for federal government agencies.

Background

IT portfolio management is rooted in Markowitz' Modern Portfolio Theory for investments, where diversification of financial assets (stocks, bonds, and cash) is balanced by expected returns and risk (Markowitz, 1952). Warren McFarlan (1981) used the work of Markowitz to apply the principles of investment and risk to information systems investment, noting that IT project and portfolio risk alone

was neither positive or negative, but must be seen in context to the degree of risk and potential reward. IT portfolio risk requires examining current and future projects, constantly evaluating projects to determine effectiveness, and investing and divesting as necessary (Van Over, 2009).

Several IT investment portfolio allocation methods have been proposed over the years. Glen Peters (1988) and John Ward (1990) both divided IT investments into functional categories. Bryan Maizlish (2005) furthered this concept with an IT asset portfolio system, which allocated investments into Infrastructure, Process, Information/Data, and Human Capital investments. He noted that in the federal government extra challenges are inherent to successfully designing an IT asset portfolio: Few common standards or historical bases are available for evaluating IT investments; IT investments are difficult to retire without other agency systems and databases being affected; investments and their component interdependencies must be monitored, adjusted, and disposed of for their full life cycle; and IT projects must be evaluated not only for performance goals, risk management, and life-cycle cost formulation, but also for security and privacy, and support of the President's management agenda.

G. David Garson (2003) noted that, traditionally IT investments were made on a project basis—a conservative policy with riskier projects often not funded. Portfolio management allows higher risk/higher payoff projects to be balanced with less risky/lower payoff projects, justifying some large nontraditional systems, including e-Government initiatives. An awareness of the IT investment process must be built into the agency so that formal processes of IT evaluation are adopted, and the agency moves from a project-centric base to a portfolio approach, evaluating investments according to their support of the agency's overall mission. High-risk, low-value, or obsolete IT investments are evaluated and may be de-selected from the portfolio, and through benchmarking IT investments to successful organizational investments, better technologies can be chosen.

Researchers from the MIT CISR have done extensive research on private company and industry IT investment portfolios. Using survey data from chief information officers or their representatives from 1,508 companies in 60 countries over a 10-year period, and statistically controlling for industry, firm size, advertising expense, and research and development, they divided IT expenditures into four asset classes: Infrastructure, Transactional, Informational, and Strategic. From this data, they established patterns within industries, evaluated business strategies, and defined measures companies could take to evaluate their current IT expenditures and improve organizational performance.

Weill and Aral (2003), Weill and Ross (2004), Aral and Weill (2007), and Weill and Aral (2008) found that:

1. Strategic investments, which are designed to gain competitive advantage in the marketplace and to develop new business products and services, on average consumed 13 percent of private sector IT investments in 2007. These investments are higher risk, have a longer lead-time, and often involve very new technologies. The failure rate for strategic IT investments can be as high as 50 percent, but their successes could put a company several years ahead of competitors. Weill noted that strategic investments in the small sample of public sector organizations (charities, private schools, local government) he studied led to greater innovation, increased interaction with customers, enabled major changes, and easier facilitation within the organization.

2. Informational investments, which provide internal information (e.g., for accounting, and communication) are designed to reduce costs and add potential profitability improvements in the future. In 2007, they consumed on average 13 percent of annual firm IT investment.

3. Transactional investments, which often automate existing operations, may result in immediate cost reductions. In 2007, the average private sector organization studied by Weill apportioned 27 percent of annual IT investment to transactional investments. Private sector companies that invest more heavily in transactional systems than their competitors had higher productivity (sales per dollar of assets) and lower costs. They estimate transactional investments return 25–40 percent per IT dollar invested.

4. For Infrastructure costs, the objective is to either reduce IT costs via consolidation or to establish a flexible, reusable base for future business needs. Infrastructure investments typically have high initial costs and lower short-term profitability, but higher operational performance and profitability over the long run. In 2007, the average firm in the CISR study allocated 47 percent of IT investment to infrastructure.

One important consideration for government organizations is their high legacy system costs. When Weill, Woerner, and Rubin (2008) looked at *sustaining* IT investments, which maintain and update current systems, and new investments, which encompass

major initiatives and changes to systems, they found that in 2007 the average firm spent 66 percent of IT investments on sustaining investments, and one-third of the firms studied by the MIT CISR spent over 75 percent of their IT dollars to run existing systems. With so much of IT assets spent supporting existing complex and often redundant systems, portfolio assets are not freed up to support new IT systems. Weill found that organizations allocating more to new investments rather than sustaining investments had greater revenue growth, and by that measure, were higher performing in their industry. Top performers in each industry spent 4 percent more on IT, but had similar portfolios (Weill & Aral, 2004).

Research Data and Methods

Our study adapted private sector research methods relating organizational performance and IT investment portfolios to U.S. Government agencies. Much of our comparative resource information came from studies by the MIT CISR, but because of differences between the public and private sector, we adapted our categories to public sector requirements.

Agency Selection

Federal government agencies in this study were selected for comparative purposes if both publicly available performance data and IT investment data were available. Thirty agencies were evaluated, as shown in Table 2. The 10 highest performing agencies were compared to the 10 lowest performing agencies in terms of their IT investment allocations. Agencies with similar mission focus were also disaggregated and compared within each focus area to develop trends.

Data for Agency Performance

To determine agency performance, we looked for publicly available, objective measures by which federal government agency performance could be ranked. Comparative data are limited, and agencies are reluctant to be compared with one another: They perceive themselves as unique in mission and resources—both of which are dictated by Congress—with changing political environments and politically determined budgets. Comparisons could only be found for employee satisfaction (Brewer, 2000), management excellence (Office of Personnel Management, 2008), and website technology effectiveness (West & Lu, 2009).

The Government Performance and Results Act of 1993 established a framework for department and agency performance reporting, designed to assist federal organizations in improving

TABLE 2. AGENCIES EVALUATED FOR THIS STUDY

Thirty Agencies Evaluated in this Study

Department of Agriculture	Department of Transportation
Department of the Air Force	Department of Veterans Affairs
Department of the Army	Environmental Protection Agency
Department of Commerce	General Services Administration
Department of Defense — Other	National Aeronautics and
Department of Education	Space Administration
Department of Energy	National Archives and
Department of Health and	Records Administration
Human Services	National Science Foundation
Department of Homeland Security	Nuclear Regulatory Commission
Department of Housing and Urban	Office of Personnel Management
Development	Small Business Administration
Department of the Interior	Smithsonian Institution
Department of Justice	Social Security Administration
Department of Labor	US Agency for International
Department of the Navy	Development
Department of State	U.S. Army Corps of Engineers —
Department of the Treasury	Civil Works

program performance. Through 2008, the OMB had assessed the performance of 1,017 federal government programs, representing 98 percent of the federal budget, using the Program Assessment Rating Tool (PART) (OMB, 2009a).

The PART is an annual agency report that evaluates each agency's key programs in four key areas: purpose, performance, measurement, and results across a common matrix. The PART questionnaire asks 25 questions specific to the category of each program, and must be documented with data. Agencies have some flexibility in choosing methods of evaluation, which must be approved by the OMB. Four areas are assessed: purpose and design, strategic planning, management and results, and accountability. A numeric score is derived from each of the four areas of assessment, ranging from 0–100, with 100 being the best. These numbers determine one of four qualitative ratings: Effective (85–100), Moderately Effective (70–84), Adequate (50–69), or Ineffective (0–49). If a program is not measured by acceptable performance measures or does not yet have performance data, a rating of Results Not Demonstrated is given. Programs may be reassessed after corrective actions are completed to improve their ratings (OMB, 2009a; OMB, 2009b).

By design, the PART has historic agency data on listed programs that reflect the latest evaluations, including any reassessments. It was initiated in 2004 with approximately one-fifth of agency pro-

grams rated each year until the PART reflected all 1,017 programs in 2008. The 2008 reporting year was selected to evaluate the maximum number of programs, and the 2-year mean was used to establish weighted scores for program size in each agency. With these numbers, agencies could be ranked as to the effectiveness of the programs they self-described as most important to their agency mission, using cluster analysis in performance categories of "highest performing" (top third of grouped agencies) and "lowest perform-ing" (bottom third of grouped agencies).

Only agency information that was publicly available at the time of this study was used. Intelligence agencies participate in these evaluations, but their results are not publicly available and not included in this report. The methods and results appear to be con-sistent throughout different organizations, however, and should be internally applicable to these agencies as well.

Data for IT Investment Allocations

The Clinger-Cohen Act of 1996 put the OMB in charge of improv-ing the productivity, efficiency, and effectiveness of federal agencies by linking planning and investment strategies and IT portfolio man-agement to the federal budget process. Each agency is required to create capital IT asset portfolios and review them to determine if a project is still attainable and has a high benefit/cost ratio compared with other investments in the portfolio. The agency annual IT invest-ment portfolio, known as OMB Exhibit 53, is a reporting mechanism for agencies to evaluate all IT projects and ensure that they are well-planned and meet cost, schedule, and performance goals planned for the investment. It has six major categories of IT invest-ments: Mission Area Support; Infrastructure, Office Automation, and Telecommunications; Enterprise Architecture and Planning; Grants Management Systems; Grants to State and Local IT Investments; and National Security Systems. Exhibit 53 is used by each agency to report the information in its annual IT investment portfolio for both major and nonmajor programs to the OMB, and is published as part of the federal budget. It is designed to assist agencies in selecting investments to improve the management of IT programs, understand the amount spent on IT modernization and support of legacy systems, and encourage interagency cooperation to elimi-nate redundant and nonproductive IT investments. The purpose of Exhibit 53 is to encourage agencies to focus IT spending on high-priority modernization initiatives; to manage major IT investments within 10 percent of cost, schedule, and performance objectives; and to protect the security of information systems (OMB, 2008).

Data for this research were taken from the 2008 Exhibit 53. Over 7,200 IT investments were listed for the 2008–2009 bud-

FIGURE 1. AGENCY IT INVESTMENT DISAGGREGATION PROCESS

get years for the 30 departments and agencies used in the study (OMB, 2009c). Again, the study used the mean of 2 reporting years to better accommodate any spikes in one type of investment in a given year. This study allocated over 7,200 17-digit coded investments in a total of 30 federal government agencies, based on project descriptions and codes, according to the four investment allocation categories of Innovation, Management Support, Process Automation, and Infrastructure. These categories are similar to the four categories described in Weill and Aral (2003): Strategic, Informational, Transactional, and Infrastructure, but adapted to better describe Exhibit 53 categories. Total IT investments were disaggregated into these four IT investment categories, as shown in Figure 1.

1. *Innovation investments* include those investments that provide a new service or major innovation that impacts external stakeholders. Examples include the e-Grants portal, giving citizens one central location from which to access federal government grant information; the Veterans Administration e-Gov Benefits program, providing a single point of access for citizens to locate and determine potential eligibility for government benefits; and the Army's Force XXI Battle Command, Brigade and Below information system, a new graphical information system significantly improving battlefield awareness for commanders.

2. *Management Support investments* are designed to provide information to employees to improve accounting, management, reporting, communication, collaboration, or analysis. This would include the DoD's Defense Enterprise Accounting and Management System, a financial management system designed to modernize internal accounting systems, and the Department of State's Treaty Information Management System, which makes treaty data more accessible to department employees.

3. *Process Automation investments* are used to cut costs or increase throughput for the same cost in organizational operations, often through automating existing operations. Examples include the National Institutes of Health

Electronic Research Administration System, which automates formerly paper-based functions in grant administration; the Department of Labor PeoplePower system, which integrates all human resources processes into one system; and the Defense Travel System, which automates travel authorization and vouchering—previously a manual, labor-intensive process.

4. *Infrastructure investments* are shared resources used by multiple applications (e.g., servers, networks, desktop computers, and customer databases), and comprise a substantial proportion of IT investments.

In reality, individual investments often span two or more of these categories, and can change over time as Infrastructure investments are retired and Innovation investments become accepted as mainstream.

Figure 2 illustrates these investment categories as interdependent Building Blocks of IT. Infrastructure is at the base and provides support for all other IT investments. At the next level, Process Automation investments, which often automate existing procedures for cost-cutting purposes, rely on a solid base of Infrastructure, but also symbiotically relate to both Management Support and Innovation investments. Management Support investments improve communications and operations within an agency, and rely both on a solid Infrastructure base and Process Automation investments. Innovation investments—the high-risk/high-potential investments providing new, strategic services for stakeholders—rely both on Infrastructure as a shared base and Process Automation investments to improve cost effectiveness.

FIGURE 2. BUILDING BLOCKS OF IT INVESTMENTS
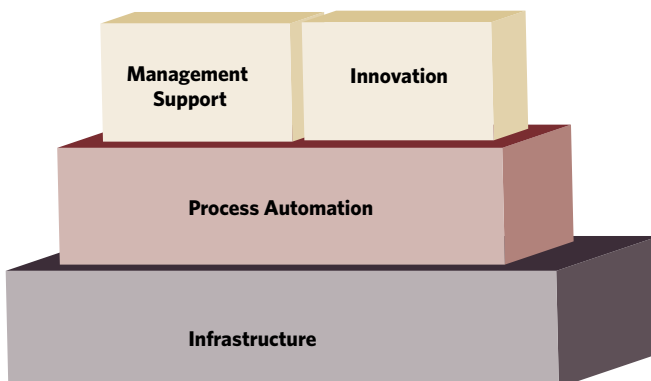
Reliability and Limits of the Data

Data from both the PART and Exhibit 53 were obtained from official public U.S. Government reports. Each agency's report is required by law annually and must be verified by agency leadership. Our statistical results were limited to 30 federal agencies, and expanded research in the future could be pursued with the addition of agency subgroups. We did, however, find trends that were consistent throughout each of the federal government agency categorical comparisons we studied, and were similar to trends Weill and Aral (2004) found in the private sector.

It can be argued that 2 years of Exhibit 53 data is not enough, since the effects of IT investments may lag behind implementation and therefore need a longer time frame. We agree that further research should examine the Exhibit 53 and PART data over different time frames. Rai, Patnayakuni, and Patnayakuni (1997) note that IT investments may have less of a lag effect than capital investments, however, due to the accelerated rate of IT obsolescence. They further note that more than 80 percent of an organization's IT expenditures are for current operations, and the depreciation of new hardware further dilutes any investments, which would impact any lag time for current performance.

Recurring complaints are that the PART does not accurately measure the focus of the programs, allow flexibility as to the program's mandates, or give credit for any programs that cannot be currently quantified, and are therefore awarded a "Results Not Demonstrated" classification (Gueorguieva et al., 2009). The PART is not a perfect interagency program evaluation tool, but it has advantages for this study in its public availability, verified data, consistent criteria among agencies, multiyear time frame, allowance for rescoring and updating of programs, and coverage of 98 percent of the federal budget (OMB, 2009d).

Results

Do higher performing agencies, based on program performance, invest in IT differently than lower performing agencies?

We first examined the data to determine normality of distributions. Using Minitab 15, we could only show normality within a 95 percent confidence interval for Management Support investments in both the 10 highest performing agencies and 10 lowest performing agencies. As a result, we chose to use nonparametric tools in an attempt to prove the null hypothesis—that higher performing federal agencies have the same IT investment strategies as lower performing agencies. Using the Mann-Whitney test, which assesses whether

two independent samples of observations have equally large values, we showed that within a 95 percent confidence interval, Innovation investments are different for the highest and lowest performing agencies. Since the Innovation investments are different, the overall portfolios of investments are different. The null hypothesis is not supported, and therefore, the 10 highest performing agencies invest their IT assets differently than the 10 lowest performing agencies.

We could not prove causal statistical correlations, but we can see relationships between aggregate performance and IT investment categories. We first looked at the IT investment breakdown for the average of the 10 highest performing and 10 lowest performing agencies, and the average of all agencies (Table 3). We then classified Cost-focused and Agility-focused agencies according to agency mission statements and evaluated their IT investment allocations (Table 4).

Higher performing agencies spent twice as much as the average agencies and more than five times that of lower performing agencies for Innovation investments and less than average agencies for Management Support and Process Automation systems. Infrastructure investments were consistent across all performance categories. Higher performing agencies invested 41 percent more on IT than the agency average and 71 percent more than lower performing agencies (Table 3).

TABLE 3. IT INVESTMENT AVERAGES FOR AGENCIES BY RANKING[a]

Four Categories of IT Investments[b]	Lower Performing Agencies	Average of All Agencies	Higher Performing Agencies
Innovation	3%	8%	16%
Management Support	16%	13%	10%
Process Automation	24%	23%	18%
Infrastructure	57%	56%	56%
IT Spending as a Percentage of Overall Agency Budget[c]	1.68%	2.04%	2.87%

[a]Performance determined by ranking of PART scores over a 2-year period.

[b]Agency category distribution determined by Exhibit 53 data.

[c]Total Agency Budget information for 2008-2009 retrieved from Government Printing Office (GPO) Access database: http://www.gpoaccess.gov/usbudget/

TABLE 4. IT INVESTMENT STRATEGY BENCHMARKS FOR AGENCIES BY COST-FOCUSED AND AGILITY-FOCUSED MISSION[a]

Four Categories of IT Investments[b]	Average Agency	Cost-Focused	Agility-Focused
Innovation	8%	5%	17%
Management Support	13%	16%	5%
Process Automation	23%	30%	21%
Infrastructure	56%	49%	57%
IT Dollars as a Percentage of Overall Agency Budget[c]	2.04%	0.62%	5.89%

[a]*Mission determined from agency websites.*

[b]*Agency category distribution determined by Exhibit 53 data.*

[c]*Total Agency Budget information for 2008–2009 retrieved from Government Printing Office (GPO)*
Access database: http://www.gpoaccess.gov/usbudget/

DoD agencies—which include the Department of the Air Force, Department of the Army, Department of the Navy, and Department of Defense–Other—each independently ranked high in the PART evaluation. Their IT investment portfolio spending showed the following investment allocations: Innovation (30 percent), Management Support (3 percent), Process Automation (12 percent), Infrastructure (55 percent), and an overall IT spending percentage of 5.29 percent, as compared to their budget. These results are consistent with other top-performing agencies.

We next divided the agencies into Cost-focused and Agility-focused, according to the missions stated on their agency websites. Cost-focused agencies (e.g., the General Services Administration and Social Security Administration) are committed to providing optimum value for taxpayers, and Agility-focused agencies (e.g., the Department of Defense and Homeland Security) have a primary objective to protect the nation and react promptly to mission changes.

Cost-focused agencies spent less than average agencies on Innovation and Infrastructure, and more than average on Management Support and Process Automation. Agility-focused agencies spent twice as much as average agencies on Innovation, less on Management Support and Process Automation, and the same on Infrastructure (Table 4).

These results are consistent with those found in private sector studies. Weill and Aral (2003) noted that cost-focused firms spent less than average on Strategic (similar to Innovation) investments, Informational (similar to Management Support) and Infrastructure, and significantly more on Transactional (Process Automation) investments.

Agility-focused firms spent more on Strategic, less on Informational and Transactional, and slightly more on Infrastructure investments.

Discussion

This research proves that federal government agencies that are most successful in program performance have a different IT portfolio of investments than those of less successful agencies. Higher performing agencies invest more in Innovation and less in Management Support and Process Automation as a percentage of their total portfolios. This result may be because Innovation investments can set the stage for new services or major agency improvements, or signal that improved IT governance has allowed more of an agency focus on modernization. Higher performing agencies may not place top priorities on reducing costs, and therefore not channel their resources into Management Support and Process Automation. Higher performing agencies also invest more in IT as a percentage of their budgets than lower performing or average agencies, possibly indicating a greater management focus on IT as a way to improve agency performance.

Our study also found that Cost-focused agencies invest higher than average in Process Automation, lower than average in Innovation and Infrastructure, and lower in IT as a percentage of their overall budget. This is completely consistent with private sector results found in the research of Weill and Aral (2003). Process Automation investments bring immediate cost savings while Innovation and Infrastructure investments increase costs in the short term and may never lead to lower costs in the long term.

Finally, this study also showed that Agility-focused agencies, like DoD and all the Services, have higher than average investments in Innovation, lower than average investments in Management Support, and higher than average IT investments as a percentage of their overall budget. Again, these results are very consistent with the private sector results found in the MIT CISR research (Weill & Aral, 2003). Agility-focused federal agencies and private firms will invest more in Innovation IT that brings new services to stakeholders and less on Management Support that brings them future cost savings and future profitability. For DoD agencies, it may simply be that the high spending (30 percent) on Innovation in the IT portfolio crowds out dollars available for "lower priority" IT, such as Management Support.

To apply the results of our study, DoD managers can disaggregate an organization's IT spending allocations into the four investment categories of Innovation, Process Automation, Management Support, and Infrastructure, and compare them with the

results in our study. DoD managers can also compare current IT portfolio investments with the high-performing agencies or the Agility-focused agencies. Those who are in Cost-focused DoD organizations, like the Defense Finance and Accounting Service, can compare their IT investments with other Cost-focused agencies.

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MOVING TOWARD IMPROVED ACQUISITION OUTCOMES:
THE INTERRELATIONSHIPS BETWEEN CULTURE, COMMITMENT, AND LEADERSHIP

Everett Roper

The impact of organizational culture, management leadership style, and employee commitment on organizational outcomes has long been studied, but no clear answer exists for which concepts most affect acquisition outcomes and increase organizational productivity. A key contribution of this study is the notion that they are interrelated and may work synergistically in improving acquisition outcomes. The author claims that the interaction of these elements, when combined, may produce a total effect that is greater than the sum of their individual elements. A conceptual model was identified and used as the foundation for building hypotheses. Structural Equation Modeling was used to analyze the data gathered, and a path diagram was developed for this study using Analysis of Moment Structures (AMOS).

*image designed by Harambee Dennis »*

Early studies of organizational productivity generally begin with Frederick W. Taylor's (1911) theories of scientific management and, more specifically, division of labor. Taylor's theories included the belief that management's responsibility was to plan work, and workers' responsibility was to perform the assigned work tasks. These principles were implemented in many factories and often increased productivity; however, they also increased the monotony of work and subsequently did little to improve employee commitment or morale. While Taylor may have had the right idea for the time, it can be argued that he did not have the correct approach for today's environment. The lack of worker input and involvement held over as an artifact of scientific management added to worker frustration. Taylor's theory did not take into account external factors such as the leadership style exhibited by management, relationships among the workers, the culture of the organization, the motivation of the workers, or their input. Neither did he consider the differing personalities of workers and managers.

Taylor's principles were developed in the late 1800s, but are still being practiced today. Some managers are working to improve outcomes and boost productivity without realizing that they may be doing just the opposite. If, in an effort to boost organizational outcomes, increase revenue, improve customer service, and drive increased productivity, they constrain their employees, do not seek their input, and consequently stifle creative problem solving, their methods are misguided. Numerous external factors are overlooked by managers who see harder or longer working employees as the only avenue to improvements to efficiency and productivity.

Conceptual Model

The conceptual model for this study is presented in Figure 1. This model shows antecedents of factors that have been found to affect organizational outcomes. Arrows are shown to depict these relationships. Relationships exist between leadership style and culture, suggesting that a manager's leadership affects an organization's culture; between culture and commitment, suggesting that the culture of an organization affects an employee's level of commitment; and between leadership style and commitment, suggesting that a manager's leadership style directly affects an employee's level of commitment to the organization—and an employee's level of commitment affects a leader's style. Further, the belief is that all these concepts affect outcomes. As a result of this model, the following hypotheses were studied.

FIGURE 1. CONCEPTUAL MODEL
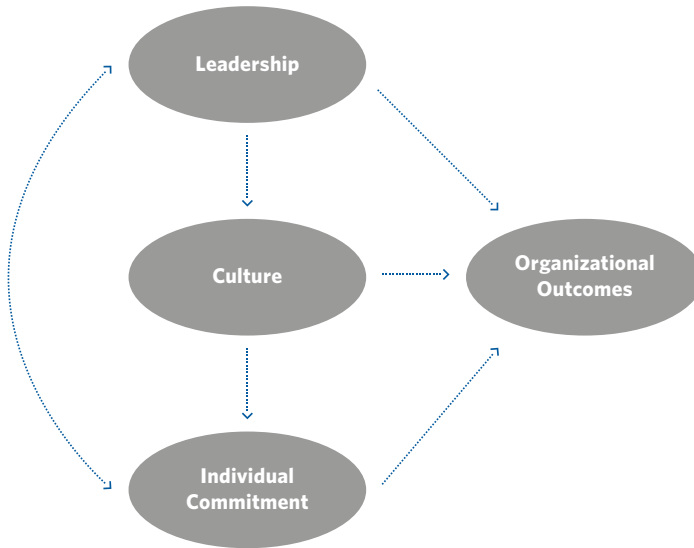
Hypothesis No. 1
No significant relationship exists between employees' individual commitment and culture.

Hypothesis No. 2
No significant relationship exists between employees' individual commitment and management leadership style.

Hypothesis No. 3
No significant relationship exists between employees' perception of management leadership style and culture.

Hypothesis No. 4
No significant relationship exists between employees' perception of management leadership style and organizational commitment.

Hypothesis No. 5
No significant relationship exists between employees' perception of organizational culture and organizational commitment.

Hypothesis No. 6
No significant relationship exists between employees' perception of organizational culture and management leadership style.

Definition of Terms

To situate this study, an explanation of the terms that are central to this study is needed. The following definitions were used:

Culture

Wallach (1983, p. 29) defined culture as: the shared understanding of an organization's employees. Wallach labeled three separate organizational culture types as *bureaucratic, innovative,* and *supportive*. These types can be distinguished as (a) bureaucratic—structured, ordered, regulated, and power-oriented; (b) innovative—results- and risk-oriented; and (c) supportive—collaborative and relationships-oriented.

Leadership

For purposes of this study, Bass's (1985) definition of leadership—the observed effect of one individual's ability to change other people's behaviors by altering their motivations—will be used. Leaders are characterized as one of three types: (a) *transactional*—one who uses rewards as a control mechanism to externally motivate; (b) *transformational*—one who uses rewards to increase commitment and internally motivate; or (c) *laissez-faire*—one who offers no feedback or support.

Commitment

The definition of commitment that was used is: the strength of an individual's identification with and involvement in a particular organization...characterized by three factors: (a) a strong belief in, and acceptance of, the organization's goals and values; (b) a readiness to exert considerable effort on behalf of the organization; and (c) a strong desire to remain a member of the organization (Mowday, Porter, & Steers, 1982, p. 27).

Outcomes

Organizational outcomes are made up of subsets of performance areas, which are attached to each other and that the organization has decided to maximize, which then form a greater system or process (Walker, 2000, p. 1).

Research Methodology

The Organization

The organization used in this study was a large, high-technology organization offering services to the aerospace, energy, and environmental industries. The total population in the business unit was

725 individuals. The pilot survey sample consisted of 38 individuals, and the final survey sample consisted of 164. Employees used in the pilot study did not participate in the final survey.

Survey Instruments

Pre-established surveys were used to obtain measures of organizational culture, management leadership style, and organizational commitment. An additional questionnaire was developed to gather organizational outcomes from managers and top executives.

Culture. Wallach's (1983) Organizational Culture Index (OCI) was used to assess the culture of the organization. The descriptive items of the survey are shown in Table 1. Wallach identified these culture indicators as bureaucratic, innovative, and supportive. The OCI was

TABLE 1. ORGANIZATIONAL CULTURE INDEX

risk taking	I
results-oriented	I
creative	I
pressurized	I
stimulating	I
challenging	I
enterprising	I
driving	I
collaborative	S
trusting	S
safe	S
equitable	S
personal freedom	S
relationships-oriented	S
encouraging	S
sociable	S
structured	B
ordered	B
procedural	B
hierarchical	B
regulated	B
established, solid	B
cautious	B
power-oriented	B

(I)nnovative; (S)upportive; (B)ureaucratic

given to each employee and section manager to rate the culture in their section as well as the division manager or deputy to rate the culture in each section under their control.

Commitment. Mowday, Porter, and Steers' (1982) Organizational Commitment Questionnaire (OCQ) was used to assess the commitment level of the employee. The questionnaire measured motivation, intent to remain, acceptance of goals, and willingness to work hard. An OCQ is classified as an attitudinal measure of organizational commitment.

Leadership. Bass and Avolio's Multifactor Leadership Questionnaire (MLQ) 5X Short Form (1994) was designed for analyzing leaders' self-reported leadership styles—transformational, transactional, or laissez-faire—as well as employees' perception of leaders' styles and commitment to organizational outcomes.

Organizational Outcomes. Management was asked questions designed to measure organizational outcomes. Table 2 lists the questions. These questions were mutually agreed upon by the researcher and the management of the organization. Because of privacy concerns, the organization was not in favor of a more extensive list of questions recommended by the researcher.

TABLE 2. ORGANIZATIONAL OUTCOMES

1.	Percentage of tasks completed on schedule
2.	Average number of critical events found during design review
	2a. Additional time added to schedule as a result?
	2b. Significant budget increase as a result?
	2c. Personnel additions as a result?
3.	Number of proposal iterations
4.	In the past year, how many employees have left the Section?
5.	In the past year, how many employees were replaced in the Section?
6.	In the past year, how many employees were added to the Section?

Reliability and Unidimensionality. A factor analysis was performed on each questionnaire to analyze interrelationships among the questions as well as to explain the variables in terms of their underlying common factors. As a result, a pilot study and subsequent factor analysis for each questionnaire resulted in the elimination of variables that either seemed inconsistent with related responses or appeared to be ambiguous to those taking the survey. Throughout

FIGURE 2. COMMITMENT SCREE PLOT
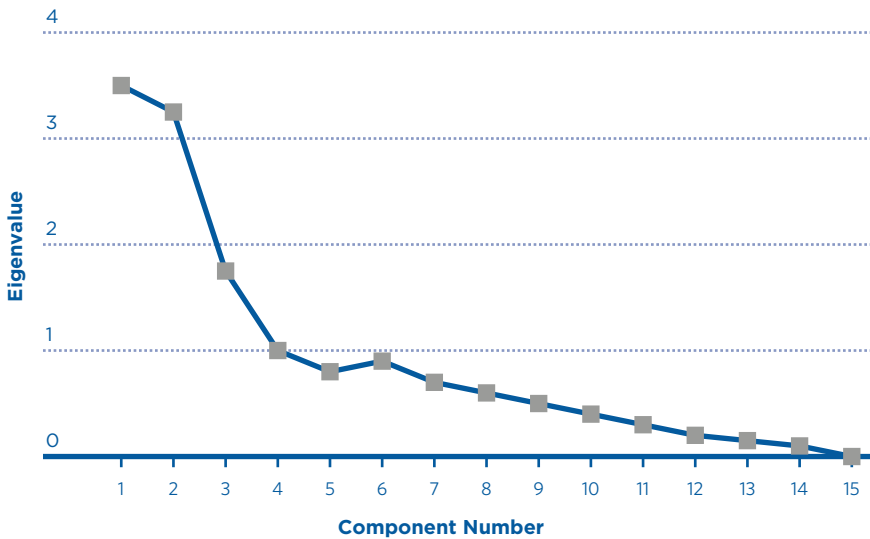
this analysis, validity values less than 0.6 were eliminated. During the analysis, initial results did not provide a clear, simple interpretation of the data. As a result of these issues, a Varimax rotation[1] was applied and several iterations were run after eliminating variables that did not meet the loading threshold. All of the following results show final computational data after rotations are applied. For each analysis, the √'s in the far right column denote variables that should not be discarded since they load on only one factor and are above the 0.6 validity threshold. To support the number of factors for each analysis, the Cattell (1966) Scree Test was also used.

Commitment Factor Analysis. Table 3 shows the commitment factor analysis output. All of the variables loaded on separate factors with

TABLE 3. COMMITMENT FACTOR ANALYSIS—FINAL

	Component		
	1	**2**	**3**
comm1	.957	.238	-.091
comm2	-.319	.909	-.182
comm5	.049	.620	.679
comm6	-.319	.909	-.182
comm8	.957	.238	-.091
comm12	.454	-.183	.592
comm13	-.312	.164	.602
comm14	.957	.238	-.091

a clear division among them. With the exception of comm12, all of the variables exceeded the threshold value. However, comm12 was not eliminated since it was within a few thousandths of the 0.6 threshold value. As a result, these variables were used in the final statistical analysis because of their high loading and significance to the corresponding factor as highlighted in the table.

From the commitment scree plot in Figure 2, it can be seen that the first three factors are worth retaining in the analysis. This is consistent with the number of factors in the final analysis results in Table 3.

Culture Factor Analysis. Table 4 shows the culture factor analysis output. From the culture scree plot in Figure 3, it can be seen that the first four factors are worth retaining in the analysis. This was one factor more than the number of factors determined from the final analysis results in Table 4, which showed only three factors being retained.

TABLE 4. CULTURE FACTOR ANALYSIS—FINAL

	Component		
	1	**2**	**3**
cult2	.678	-.200	-.150
cult7	.700	-.071	-.458
cult8	.446	-.071	.706
cult10	.431	.621	.045
cult13	-.483	-.277	.596
cult14	-.415	.664	.439
cult16	.625	-.542	.046
cult22	.509	.649	-.219

Leadership Factor Analysis. Table 5 shows the initial leadership factor analysis output. These four variables were used in the final statistical analysis. From the leadership scree plot in Figure 4, it can be seen that the first four factors were worth retaining in the analysis. This was inconsistent with the number of factors in the final analysis results in Table 5, which showed only one factor being retained. This caused some concern, but the scree test could be in error since it suffers from subjectivity and ambiguity (Hayton, Allen, & Scarpello, 2004).

Of the many coefficients, Cronbach's alpha (1951) is probably the best known. Cronbach's alpha is regarded as the lower bound on reliability for a set of congeneric measures. It assumes each of the items within the scale contributes equally to the underlying trait.
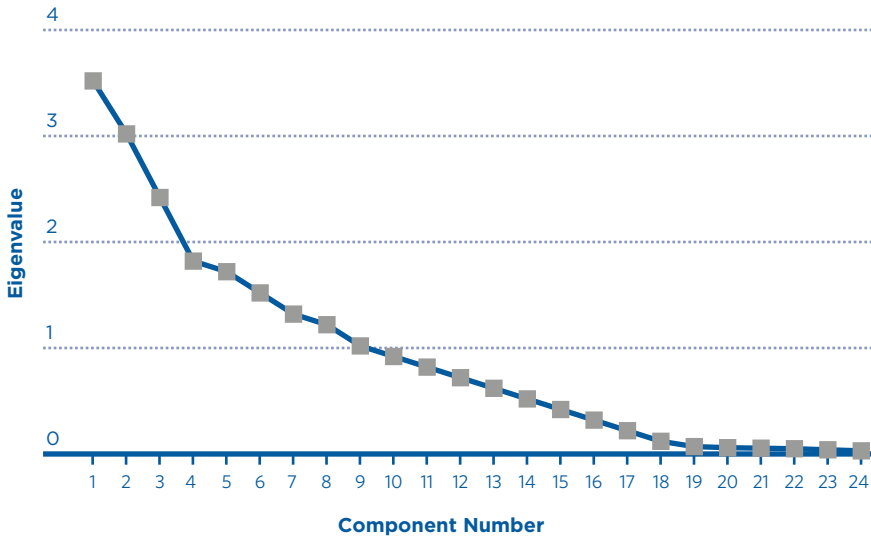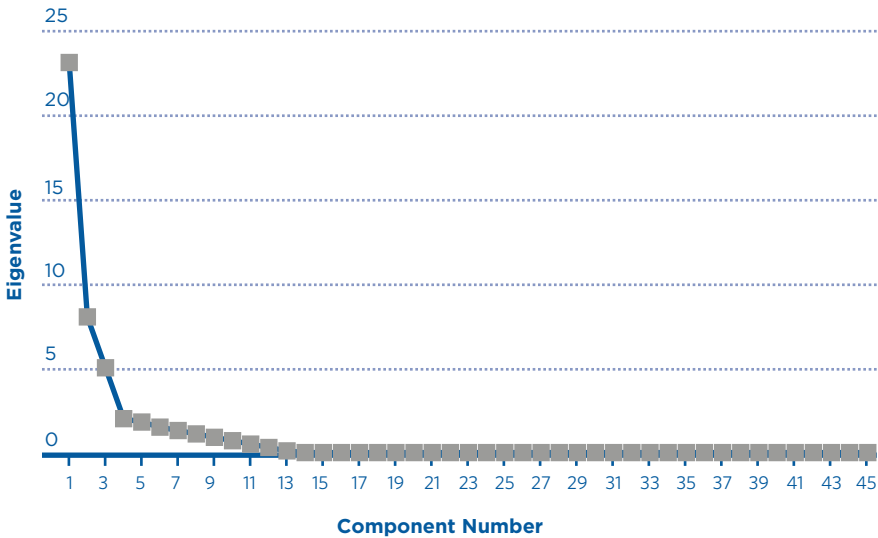
FIGURE 3. CULTURE SCREE PLOT

TABLE 5. LEADERSHIP FACTOR ANALYSIS—FINAL

lead5	.873
lead10	.836
lead15	.876
lead22	.923

FIGURE 4. LEADERSHIP SCREE PLOT

The final Cronbach alpha values for each construct in this study are reported in Table 6. The measures were relatively homogeneous for the construct they purport to measure. Typically, reliabilities greater than 0.7 are considered adequate for measurement analysis (Nunnally, 1978). However, while the bureaucratic culture alpha value was reasonably low, it was accepted since attempts to increase its value reduced the alpha values of the other factors. In the end, the values shown reflect the most stable values.

TABLE 6. SURVEY INSTRUMENT ALPHA VALUES

| Factor	Number of Items	Alpha
Culture (Bureaucratic)	8	0.513
Culture (Innovative)	8	0.695
Culture (Supportive)	8	0.811
Commitment	8	0.64
Leadership	4	0.90

Structural Equation Modeling

This study used structural equation modeling for statistical analysis of data. Structural equation modeling (SEM) is a statistical technique that integrates path and factor analysis. Path analysis, a subset of SEM, deals only with measured variables, and is the statistical technique used to examine causal relationships between two or more variables.

After a thorough review of the literature, it was determined that leadership, culture, and individual commitment all have a direct effect on organizational outcomes. A more extensive literature review also revealed that leadership may affect culture and commitment while culture may only affect commitment. Figure 5 shows the subsequent path diagram for these relationships that were created using Analysis of Moment Structures, or AMOS.[2] As required by SEM, the measured variables are indicated by rectangles, latent variables by ellipses, and error terms by circles. The error terms represent residual variances within variables not accounted for by pathways hypothesized in the model.

With six connections and using a ratio of 20:1 as a guide, at least 120 samples were needed to adequately support the statistical precision of the results. The final results for this study contained 164 samples.

FIGURE 5. AMOS PATH DIAGRAM
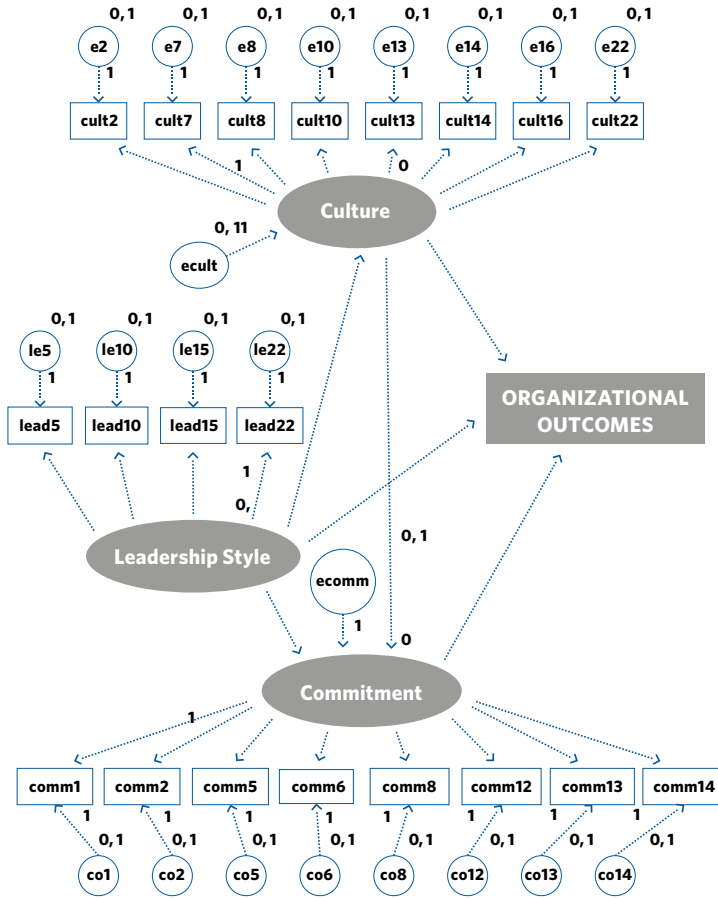
Results

Analysis

Numerous tests exist for assessing how well a model matches the observed data. Chi-square is the most common goodness-of-fit measure. In a full model, there is a direct path from each variable to each other variable. When one or more paths are missing, a reduced model is obtained. In this study, an analysis was performed to see which model is better.

The Chi-square value is 72.2 with 44 degrees of freedom and a p-value equal to 0.005. Since this p-value does not exceed the alpha value of 0.05, the null hypothesis is rejected, indicating that the model does not fit the data adequately.

It should be noted, however, that problems with Chi-square are known to exist. The main drawback with the Chi-square test is that it is sensitive to sample size, becoming more and more likely to reject the null hypothesis as the sample size increases. This is

because as the sample size increases, the Chi-square statistic has a tendency to indicate a significant probability level whereas a decrease in the sample size results in a commensurate decrease in the statistic to nonsignificant levels (Schumacker & Lomax, 2004). Therefore, additional testing was done before drawing conclusions on model fit. One corroborating test of model fit is provided by the Root Mean Square Error of Approximation (RMSEA) statistic—a measure of fit introduced by Steiger and Lind (1980). The RMSEA estimates lack of fit compared to the full model. RMSEA differs from the Chi-square test in that it is sensitive to the number of parameters estimated and relatively insensitive to sample size. The *AMOS 4.0 User's Guide* (Arbuckle, 1999) suggests that an RMSEA value of 0.05 or less indicates a close fit of the model, and an adequate fit exists if RMSEA is less than or equal to 0.08. MacCallum, Browne, and Sugawara (1996) added that RMSEA values ranging from 0.08 to 0.10 indicate mediocre fit, and those greater than 0.10 indicate poor fit. LO 90 and HI 90 values, as shown in Table 7, indicate 90 percent confidence limits on the coefficient while PCLOSE[3] tests the null hypothesis that RMSEA is no greater than 0.05. MacCallum et al. (1996) contend that when a small RMSEA exists, with a wide confidence interval, it can be concluded that the estimated discrepancy value is quite imprecise. This then negates any possibility of determining an accurate degree of fit in the population. In contrast, a very narrow confidence interval would argue for good precision of the RMSEA value in reflecting model fit in the population (MacCallum et al., 1996).

TABLE 7. RMSEA (INITIAL)

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.063	0.035	0.088	0.204
Independence model	0.322	0.305	0.34	0

As noted earlier, PCLOSE is a statistical significance test of the RMSEA and measures the *p* value by testing the null that RMSEA is no greater than 0.05. As shown in Table 7, the RMSEA value of this model is 0.063, indicating that the estimate is adequate. Evidence affirms that the estimate is correct since PCLOSE is 0.204, which is greater than the 0.05 alpha value. Some experts suggest that the PCLOSE value should be greater than 0.5; however, the 0.209 value was accepted since it is greater than the alpha value. As a result, the null hypothesis was not rejected, RMSEA is greater than 0.05, and thus it was concluded that the model fits the data adequately. Additionally, the 90 percent confidence of the RMSEA is within the bounds of 0.035 and 0.088. The upper bound of the confidence

interval was fractionally higher than the suggested cutoff of 0.08, but this was considered mediocre according to MacCallum et al. (1996). Overall, given that (a) the RMSEA point estimate is adequate, i.e., 0.063 < 0.08; (b) the RMSEA point estimate is within the 90 percent confidence interval; and (c) the probability value associated with this test of close fit is PCLOSE = 0.204, it was concluded that the model provides an adequate fit of the data.

To establish greater confidence, an additional goodness-of-fit test was conducted. The Expected Cross-Validation Index (ECVI) is an approximation of the goodness-of-fit that the estimated model would achieve in another sample of the same size. It takes into account the actual sample size and the difference that could be expected in another sample. The ECVI also takes into account the number of estimated parameters for both the structural and measurement models. Application of the ECVI assumes a comparison of models whereby an ECVI index is computed for each model, and then all ECVI values are placed in rank order. The model having the smallest ECVI value exhibits the greatest potential for replication (Byrne, 2001).

In assessing the ECVI results for the model presented here (the default model), as shown in Table 8 the ECVI value of 0.843 for the initial model is compared with the saturated model (ECVI = 0.939) and the independence model (ECVI = 6.313). A saturated model perfectly fits the data because it has as many parameters as there are values to be fit. An independence model on the other hand is one in which two (or more) random variables are independent of one another. Given the lower ECVI value for the default model, compared with both the independence and saturated models, the conclusion is that it represents the best fit to the data. The precision of this estimated ECVI value can also be taken into account by examining the confidence intervals, which range from 0.724 to 1.009. Taken together, these results suggest that the model provides a good fit and represents a reasonable approximation to the population. This conclusion supports the findings of the RMSEA.

TABLE 8. EXPECTED CROSS-VALIDATION INDEX (INITIAL)

Model	ECVI	LO 90	HI 90	MECVI
Default model	0.843	0.724	1.009	0.874
Saturated model	0.939	0.939	0.939	1.013
Independence model	6.313	5.713	6.959	6.335

Next, we examined the reliability of the measures. Bollen (1989) suggests that the Squared Multiple Correlation is an adequate measure for doing so. Fornell and Larcker (1981) suggest that the

TABLE 9. SQUARED MULTIPLE CORRELATIONS (INITIAL)

	Estimate
leadership	0
culture	0
commitment	0.089
comm6	0.928
cult9	-0.345
comm12	0.165
lead22	0.996
lead5	0.772
org outcomes	0.768
comm7	0.351
comm4	0.274
cult11	0.352
cult1	0.717
lead15	0.902
lead10	0.785

magnitude of this coefficient should be greater than 0.5, which implies that more than 50 percent of the variance of the item is related to what is being measured. The squared multiple correlation coefficients are shown in Table 9. The coefficients that meet the 0.5 threshold recommended by Fornell and Larcker (1981) are shown as well as the coefficients that are below the threshold. The coefficients below the threshold were left in the model because removing them caused model instability in other significance tests. Their inclusion in the model allowed for the best fit.

Next, we examined the regression weights to determine if the coefficients are significant. The regression coefficients represent the amount of change in the dependent variable for each one unit of change in the variable predicting it. In Table 10, culture increases 0.013 units for each 1.0 unit increase in leadership. The table displays the estimate, its standard error (S.E.), and the estimate divided by the standard error (C.R.). The p-value tests the null hypothesis that the covariance between two variables is zero in the population from which this sample was drawn.

The regression coefficients in this model were found to be significant with the exception of the culture-leadership and commitment-culture relationships. Of greatest concern was the culture-leadership relationship p-value of 0.868, which is far beyond the 0.05 alpha level. Numerous model revisions were performed in an effort to reduce this value with no success. However, after further

TABLE 10. REGRESSION WEIGHTS (INITIAL)

			Estimate	S.E.	C.R.	P	Label
culture	←	Leadership	0.013	0.076	0.167	0.868	par_10
commitment	←	Culture	-0.172	0.1	-1.724	0.085	par_9
commitment	←	Leadership	0.264	0.099	2.66	0.008	par_11
lead10	←	Leadership	0.889	0.045	19.785	***	par_1
lead15	←	Leadership	1.073	0.035	30.283	***	par_2
cult1	←	Culture	0.598	0.078	7.638	***	par_3
cult11	←	Culture	0.374	0.057	6.579	***	par_4
comm4	←	Commitment	0.581	0.082	7.101	***	par_5
comm7	←	Commitment	0.557	0.072	7.733	***	par_6
org outcomes	←	Leadership	1				
org outcomes	←	Commitment	1				
org outcomes	←	Culture	1				
lead5	←	Leadership	0.894	0.047	19.067	***	par_7
lead22	←	Leadership	1				
comm12	←	Commitment	0.28	0.053	5.304	***	par_8
cult9	←	Culture	1				
comm6	←	Errcomm6	0.291	0.148	1.969	0.049	par_13
comm6	←	Commitment	1				

research, a change to the model was considered. It was determined that the link between culture and leadership be reversed, implying that the commitment level of employees affects the leadership style that the manager portrays rather than management leadership style affecting the commitment of the employees as the literature suggests. In an attempt to stabilize the model, this change was reluctantly made. The path model was changed to reflect this directional change in the commitment-leadership relationship, as shown in Figure 6. The revised model was re-run, and the new regression weights were analyzed.

As shown in Table 11, the regression results in the revised model show a drastically reduced *p*-value of the commitment-leadership relationship to far below the alpha level. However, the culture-leadership relationship increased to 0.461, which was much higher than the previous value of 0.085. As a result, the relationship became nonsignificant. After several modifications and re-analyses, it was finally concluded that this refined model would provide the most stable results. The significant paths are shown in Figure 7. To verify this revised model, all of the previous analyses were redone using this revised model.

FIGURE 6. AMOS PATH DIAGRAM (REVISED)
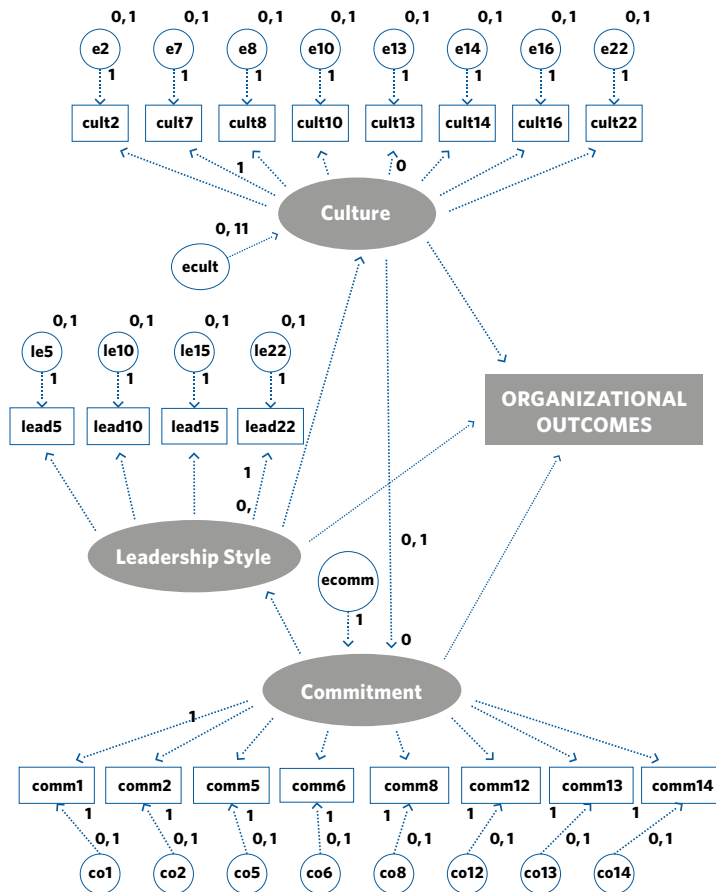
The Chi-square value was reduced from 72.189 in the initial model to 68.529 and the probability level from 0.005 to 0.01. Since this *p*-value does not exceed the alpha value of 0.05, the null hypothesis is rejected. The conclusion is the revised model does not provide an adequate fit of the data. This same conclusion was reached in the initial model and, once again, additional tests were conducted to verify model fit as was done for the initial model.

As shown in Table 12, the RMSEA value in the revised model was reduced from 0.063 to 0.058, which is slightly above the 0.05 criterion for a close fit. Thus, the value was considered to be adequate and provided greater confidence that this estimate is correct since PCLOSE is 0.288. The hypothesis was not rejected since the *p*-value is greater than the 0.05 level of confidence. It is concluded that RMSEA is greater than 0.05. It is concluded that the model fits the data adequately. Additionally, the 90 percent confidence of the RMSEA is within the upper bounds of 0.029 and 0.084. The upper bound of the confidence interval is fractionally higher than

TABLE 11. REGRESSION WEIGHTS (REVISED MODEL)

			Estimate	S.E.	C.R.	P	Label
commitment	←	leadership	0.269	0.098	2.73	0.006	par_10
culture	←	leadership	0.056	0.076	0.737	0.461	par_9
culture	←	commitment	-0.159	0.06	-2.637	0.008	par_13
lead10	←	leadership	0.889	0.045	19.778	***	par_1
lead15	←	leadership	1.072	0.035	30.273	***	par_2
cult1	←	culture	0.599	0.079	7.567	***	par_3
cult11	←	culture	0.369	0.057	6.502	***	par_4
comm4	←	commitment	0.578	0.081	7.109	***	par_5
comm7	←	commitment	0.553	0.071	7.752	***	par_6
org outcomes	←	leadership	1				
org outcomes	←	commitment	1				
org outcomes	←	culture	1				
lead5	←	leadership	0.894	0.047	19.06	***	par_7
comm12	←	commitment	0.278	0.052	5.309	***	par_8
cult9	←	culture	1				
comm6	←	errcomm6	0.275	0.15	1.83	0.067	par_12
comm6	←	commitment	1				
lead22	←	leadership	1				

FIGURE 7. SIGNIFICANT PATHS
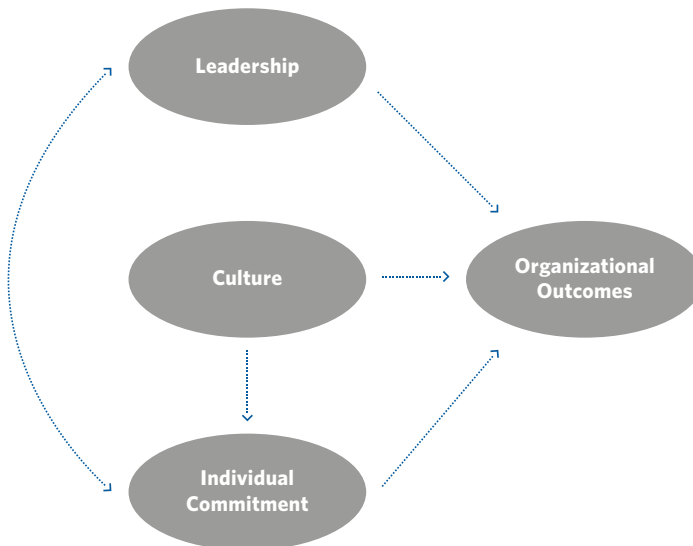
TABLE 12. RMSEA (REVISED MODEL)

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.058	0.029	0.084	0.288
Independence model	0.322	0.305	0.34	0

TABLE 13. SQUARED MULTIPLE CORRELATIONS (REVISED MODEL)

	Estimate
leadership	0
commitment	0.067
culture	0.025
lead22	0.996
comm6	0.934
cult9	-0.362
comm12	0.16
lead5	0.772
org outcomes	0.77
comm7	0.341
comm4	0.267
cult11	0.351
cult1	0.732
lead15	0.902
lead10	0.785

the suggested cutoff of 0.08—considered mediocre according to MacCallum et al. (1996). Given that (a) the RMSEA point estimate is 0.058 < 0.08, (b) the RMSEA point estimate is within the 90 percent confidence interval, and (c) the probability value associated with this test of close fit is PCLOSE = 0.288, the conclusion is that the initially hypothesized model provides an adequate fit of the data.

The Squared Multiple Correlation values in Table 13 of the revised model noted minor changes. Some coefficients meet the standard set by Fornell and Larcker (1981) while others were below the 0.5 threshold, but were left in the model because removing them caused model instability in other significant tests. Their inclusion in the model allowed for the best fit.

Discussion and Conclusions

The first significant relationship among the data collected for this study demonstrated that leadership does in fact affect com-

mitment. It was also determined that commitment affects culture. Both of these conclusions are not surprising since they support the findings in the research literature, which demonstrated that there is a link between these concepts. The effects were both positive and significant implying that the leader has the ability to influence the commitment of the employees and that the commitment level of the employees affects the culture of the organization. The use of regression analysis supported these findings.

Leadership, however, was found to have no significant impact on culture. This was unexpected. Based on the literature, it was believed that leadership styles could have a significant effect on establishing the culture of an organization because of their perceived interconnection. As a result, further study is needed to determine the accuracy of this conclusion, necessitating the need to check to see if these results are consistent for broader ranges of conditions.

Managerial Implications

The implications for managers are many. A common assumption is that the culture within the organization is directly linked to the outcomes of an organization, and that changes to culture traits will impact effectiveness. However, this study provided some preliminary evidence that this presumption alone may not be true. Evidence suggests that different cultures that are sensitive to either external conditions or internal conditions may have a different impact on organizational outcomes. An externally focused culture

type impacts revenue, sales growth, and market share. It is a culture that brings together the elements of mission and adaptability. It is goal sensitive, but it is also ready to quickly react to market or consumer fluctuations (Hastings & Potter, 2004). In an internally focused culture, outcomes are significantly influenced by the extent to which a leader is supportive of followers and includes followers in decision-making processes. Managers must be aware of this and manage both environments effectively to see outcome improvements.

Although the results of this study do not confirm an association between leadership and culture, the literature shows that such a relationship does in fact exist and that associations between leadership styles and organizational outcomes are mediated by some form of organizational culture. In agreement with the literature findings, the author contends that potential solutions to the difficulties associated with changing organizational culture may involve focusing on leadership style. While managing culture is at best difficult, changes to leadership styles may allow changes to culture to be more easily achieved. Thus, an effective manager can influence and manage culture since the impact of poor leadership skills demonstrated by leaders will have an effect on organizational outcomes and subsequently culture. Thus, training in organizational leadership is needed. Leadership training results in many benefits for both managers and employees.

Additionally, organizations have to find new ways to create a committed workforce. Managers need to understand the concept of commitment and which behaviors are displayed by employees committed to the organization (Coetzee, Martins, Basson, & Muller, 2006). Successful organizations today must have managers who motivate and inspire their employees. Successful managers must see themselves not just as bosses, but as performance coaches. A manager must be able to provide employee training, help employees enhance their careers, and mentor them to become the best they can be.

Theoretical Implications

Overall the results supported most of the literature findings of the interrelationships between the engineering concepts; however, conclusive evidence could not be obtained on the effect that these relationships had on organizational outcomes due to the lack of organizational outcome data. Only 10 percent of the responses were returned. This data proved to be inadequate in drawing conclusions on organizational outcomes. This low response was mainly attributed to management's concern for privacy. While the study

did receive support from top management, it appears that mid-level managers were not comfortable providing such confidential data.

Conclusions

The results of this study provided initial support for the presumed relationships among the conceptual model presented in the study and therefore do validate a number of ideas for organizations interested in knowing how to improve organizational outcomes; however, these findings need to be further validated with additional studies on a more diverse population. Organizations and managers may infer from this study that a linkage exists among several of the engineering management concepts presented. The results suggest that a relationship exists between leadership, positive individual commitment, and the right culture. What remains to be proven is if this may indeed lead to heightened organizational outcomes. Thus, while these concepts have long been studied and supported in popular management literature, a key contribution of this study is the notion that they are interrelated and that they may work synergistically in their effect upon organizational outcomes in high-technology organizations. After careful consideration, this researcher hopes that this study may shed light on some new linkage between leadership, commitment, and culture; and recommends that future studies increase the number of subjects from various types of organizations.

Author Biography

Dr. Everett Roper is a Systems Engineer in the Joint Attack Munition Systems (JAMS) Project Office at Redstone Arsenal, Alabama. He is certified in several areas of process improvement including The Personal Software Process (PSP), The Team Software Process (TSP), Capability Maturity Model Integration (CMMI), and Six Sigma (Green Belt). Dr. Roper holds a PhD in systems engineering from The University of Alabama Huntsville.

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ENDNOTES

1. Varimax rotation is often used in surveys to see how groupings of questions (items) measure the same concept. In statistics, a Varimax rotation is a change of coordinates used in principal component analysis and factor analysis that maximizes the sum of the variances of the squared loadings.

2. AMOS (Analysis of Moment Structures) is an add-on module for a computer program called SPSS (originally, Statistical Package for the Social Sciences). AMOS is designed primarily for structural equation modeling, path analysis, and covariance structure modeling. It features an intuitive graphical interface that allows the analyst to specify models by drawing them. It also has a built-in bootstrapping routine and superior handling of missing data. It reads data from a number of sources, including MS Excel spreadsheets and SPSS databases.

3. p of Close Fit (PCLOSE)—The null hypothesis is that the RMSEA is .05, a close-fitting model. The p value examines the alternative hypothesis that the RMSEA is greater than .05. So if the p is greater than .05, then it is concluded that the fit of the model is "close."

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Featured Book

Book Reviewed:
*Building the Trident Network:
A Study of the Enrollment of
People, Knowledge, and Machines*
Author(s):
Maggie Mort
Publisher:
Cambridge, MIT Press
Copyright Date:
2002
ISBN:
0262633620
Hard/Softcover:
Hardcover: 217 pages
Reviewed by:
Dr. Shannon Brown, Associate Professor of National Security Studies, Industrial College of the Armed Forces, Washington DC

Review:

With painstaking detail and an eye for the "road not taken," Maggie Mort explores the history of Britain's Trident submarine program, one of the more complex defense acquisition efforts undertaken by the UK. Initiated in the waning days of the Cold War, the Trident program breathed new life into the shipbuilding community of Barrow, but short- and long-term decisions made by the shipyard's parent company, combined with political jockeying by union leadership and the Barrow Alternative Employment Committee (BAEC), resulted in the slow decline of both the shipyard and the surrounding community.

At the heart of Mort's exploration of the Trident is the concept of "enrollment": the bureaucratic and ideological work of pulling together labor, management, and machines to create a complex network to build submarines. She examines the decisions of Vickers Shipbuilding and Engineering Ltd (VSEL) between the late 1980s and 1998, which included a transition from diverse manufacturing activities to a focus on the defense sector as a "core business." As VSEL was taking these steps, the BAEC—a collective of anti-nuclear and community activists who joined forces with union employees of VSEL—was pushing to broaden the work of the shipyard and refocus workers' energies away from the defense business. Mort adopts the employees' point of view in exploring why BAEC ultimately lost out in its struggles, despite compelling economic arguments in favor of diversification that were supported by key actors in the regional government.

What the employees feared, and what VSEL had to manage as the Trident program proceeded, was "disenrollment"—the flip side of the enrollment coin. Disenrollment takes the form of labor retrenchment, broken ties with supply chain vendors, and management decisions that have the effect of shaping future business opportunities—actions that appeared, from the standpoint of VSEL and elements of the shipyard tradesmen, to make perfect sense. The power struggles that took place in and around Barrow were not simply "public versus private" or "establishment versus activist" confrontations; Mort's nuanced analysis of the Trident program shows how allegiances can change; decisions about technology can shape a workforce; and local politics—and the insecurities expressed by a working community—can derail otherwise rational economic development initiatives.

The acquisition professional will find this case study interesting for a number of reasons. The overarching theme of the book—uncertainty—deserves consideration. The Trident program was marked by uncertainty, and that sense of uncertainty colored the interactions of the BAEC, VSEL, and various union and community leaders. As the Department of Defense faces a wave of reductions in the early 2010s, DoD acquisition professionals can take this book as evidence that acquisition decisions are not made in a vacuum; ultimately, just like politics, all programs are local.

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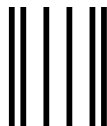
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