Defense AT&L

May-June 2009

A PUBLICATION OF THE DEFENSE ACQUISITION UNIVERSITY

Taking DoD Contracting From Good to Great

Defense AT&L interviews

Charlie Williams

Director, Defense Contract Management Agency

ALSO

Knowledge vs. Experience

Sharpening the Spear Through Innovative Acquisition

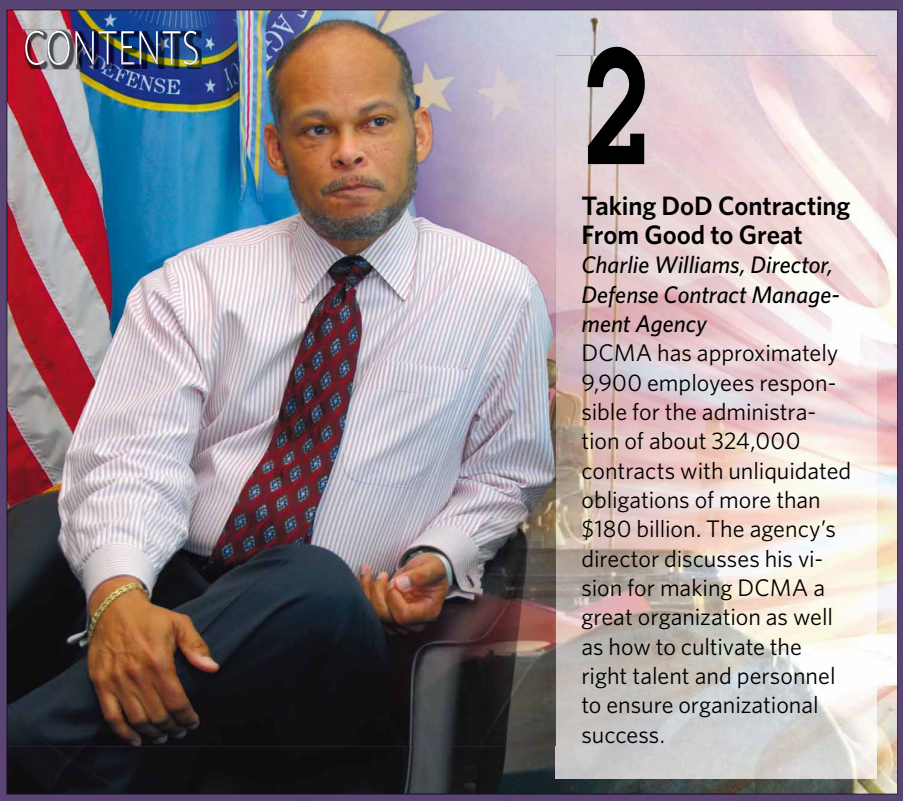
Testing to the Sound of the Guns

On Failure

Leaders as Circus Performers

Synergy: Innovation You Can Measure

CONTENTS



2

Taking DoD Contracting From Good to Great

Charlie Williams, Director, Defense Contract Management Agency

DCMA has approximately 9,900 employees responsible for the administration of about 324,000 contracts with unliquidated obligations of more than $180 billion. The agency's director discusses his vision for making DCMA a great organization as well as how to cultivate the right talent and personnel to ensure organizational success.

20

Testing to the Sound of the Guns

Col. Richard E. Burns, USAF

DoD's Comparative Testing Office sponsors programs designed to rapidly find and test U.S.- and foreign-developed technologies for warfighting use, saving money and, more important, saving lives.

10

Knowledge vs. Experience

Roy Wood

DoD doesn't give an aircraft pilot a class in flying, then deem her fit to fly a multi-million-dollar aircraft. She needs ample on-the-job experience before taking control of the aircraft. The same is true for DoD's acquisition professionals.

24

On Failure

Maj. Dan Ward, USAF; Maj. Chris Quaid, USAF; and Maj. Gabe Mounce, USAF

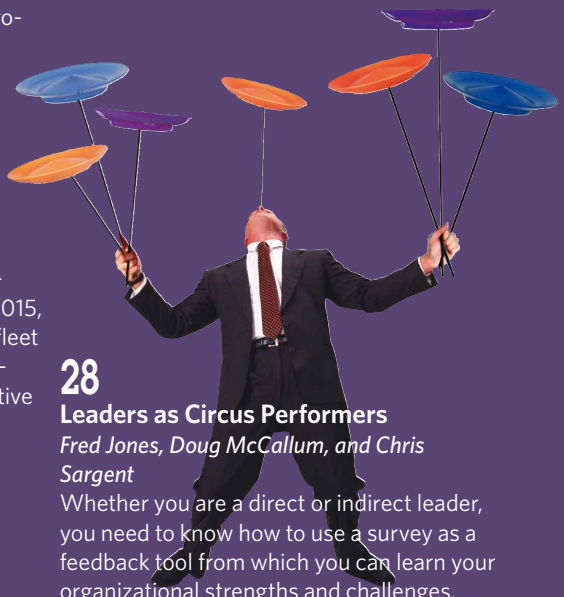
Big DoD projects fail only one way—negatively. But you can set yourself up so failure can actually be a beneficial experience.

15

Sharpening the Spear Through Innovative Acquisition

Jay Bolles, William Broadus, et. al.

The F-5 Adversary aircraft needed to remain in service until at least fiscal year 2015, but a lack of funding wouldn't allow the fleet to remain operational until then. The Adversary Program Office found an innovative solution to the problem.

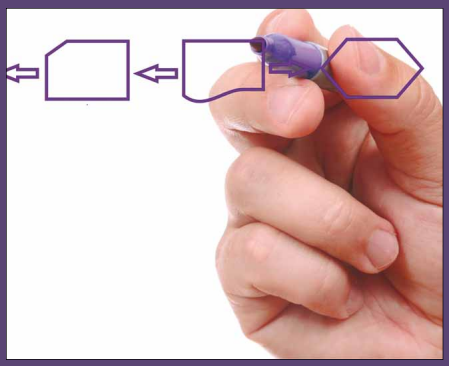


28

Leaders as Circus Performers

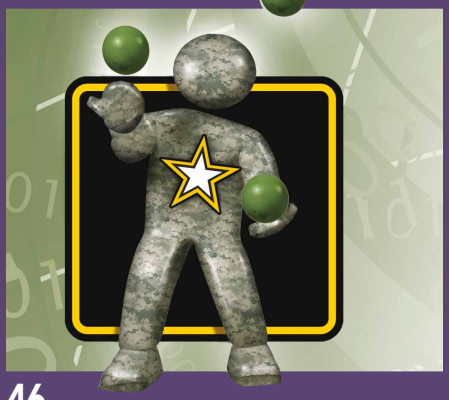
Fred Jones, Doug McCallum, and Chris Sargent

Whether you are a direct or indirect leader, you need to know how to use a survey as a feedback tool from which you can learn your organizational strengths and challenges.



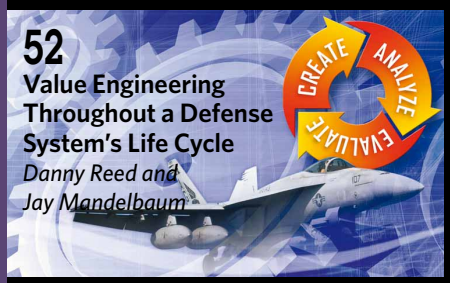
34
Synergy: Innovation You Can Measure
Eugene A. Razzetti
Synergy can be quantified, whereas innovation often cannot, making synergy of greater practical value to DoD. Innovation must be measurably proven at the earliest stages of the acquisition process.

40
Be Willing to Make Changes
Wayne Turk
Whether it's personal or organizational, change is tough on all of us. You need to know how to manage change in ways that will give you the best chance at success.



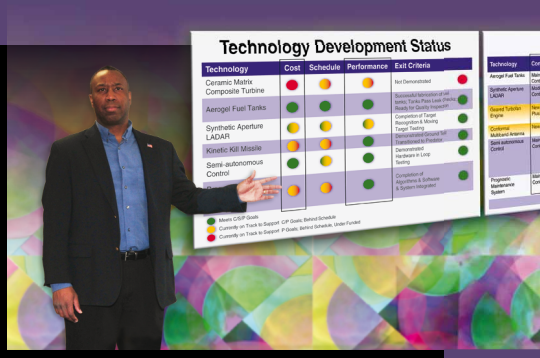
46
Managing Change During an ERP Implementation
Brittany C. Walsh
Having a project office that will manage the process of change is vital to achieving the project's business objectives, as proven by the Army's Logistics Modernization Program software transition.

ALSO



52
Value Engineering Throughout a Defense System's Life Cycle
Danny Reed and Jay Mandelbaum

60
Focusing Sustainment Logistics Toward Capabilities Development: Part II
Charles Borsch



64
Revamping the Science and Technology Management Career Field
Martin Falk and Randy Zittel

DEPARTMENTS

8 13 Theta

71 Around the Acquisition Community

75 Surfing the Net

Defense AT&L

Vol XXXVIII
No.4 DAU 208

Published by the
DEFENSE ACQUISITION UNIVERSITY

Under Secretary of Defense (Acquisition, Technology and Logistics)
John J. Young Jr.

Acting Deputy Under Secretary of Defense (Acquisition & Technology)
Shay D. Assad

DAU President
Frank J. Anderson Jr.

DAU Vice President
Dr. James McMichael

DAU Chief of Staff
Joseph Johnson

Director, DAU Operations Support Group
Dave Scibetta

Director, DAU Visual Arts and Press
Eduard Boyd

Defense AT&L Editorial Staff

Senior Editor, DAU Press • Managing Editor
Carol A. Scheina

Contributing Editors
Christina Cavoli • Judith M. Greig • Collie J. Johnson

Art Director
Paula Croisetiere

Graphic Support
Harambee Dennis • Jim Elmore • Miracle Riese

Letters to the Editor may be e-mailed to datl(at)dau(dot)mil or mailed to the address in the next column. (Please use correct e-mail protocol. We spell out to prevent spam generated by the address in the online magazine.)

Article preparation/submission guidelines are located on the inside back cover of each issue or may be downloaded from our Web site at <www.dau.mil/pubs/damtoc.asp>. Inquiries concerning proposed articles can be made by e-mail to datl(at)dau(dot)mil or by phone to 703-805-2892 or DSN 655-2892.

Subscribe/unsubscribe/change of address: Fill out, sign, and mail the postage-free self-mailer form at the back of this issue, or download the form at <www.dau.mil/pubs/damtoc.asp>.

Privacy Act/Freedom of Information Act
If you provide us your business address, you will become part of mailing lists that are public information and may be provided to other agencies upon request. If you prefer not to be part of these lists, use your home address. Do not include your rank, grade, service, or other personal identifiers.

Defense AT&L (ISSN 1547-5476), formerly *Program Manager*, is published bimonthly by the DAU Press and is free to all U.S. and foreign national subscribers. Periodical postage is paid at the U.S. Postal Facility, Fort Belvoir, Va., and additional U.S. postal facilities.
POSTMASTER, send address changes to:

DEFENSE AT&L
DEFENSE ACQUISITION UNIVERSITY
ATTN DAU PRESS STE 3
9820 BELVOIR ROAD
FT BELVOIR VA 22060-5565

Disclaimer
Statements of fact or opinion appearing in *Defense AT&L* are solely those of the authors and are not necessarily endorsed by the Department of Defense, the Office of the Under Secretary of Defense, Acquisition, Technology and Logistics, or the Defense Acquisition University. Articles are in the public domain and may be reprinted or posted on the Internet. When reprinting, please credit the author and *Defense AT&L*.

Some photos appearing in this publication may be digitally enhanced.

Value Engineering Throughout a Defense System's Life Cycle

Danny Reed ■ Jay Mandelbaum

According to the May 1993 Office of Management and Budget circular A-131, value engineering (VE) is an organized/systematic approach directed at analyzing the function of systems, equipment, facilities, services, and supplies for the purpose of achieving their essential functions at the lowest life cycle

As a research staff member at the Institute for Defense Analyses, **Reed** *leads value engineering and reduction of total ownership cost initiatives for OSD. He previously worked 27 years on manufacturing development for the F-16 program at Lockheed Martin.* **Mandelbaum** *leads technology research in readiness assessments, quality assurance, and systems engineering initiatives for OSD as a research staff member at the Institute for Defense Analyses. He previously spent 30 years in the federal government.*

Figure 1. **Defense Acquisition Management Framework**

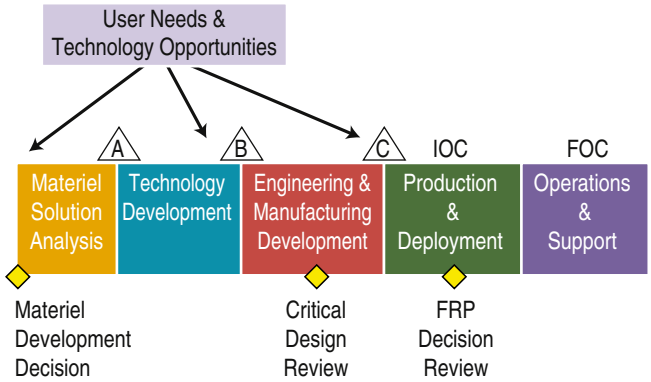
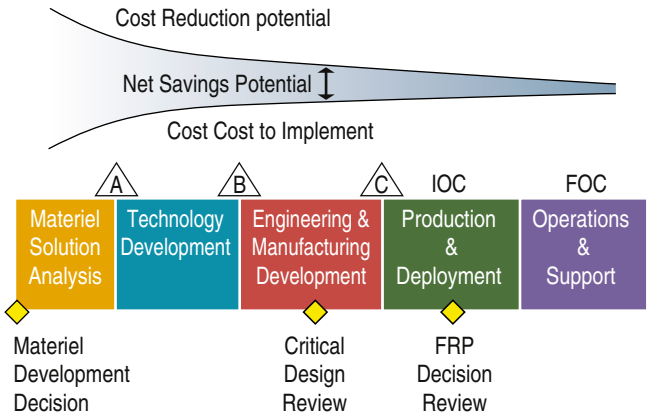


Figure 2. **VE Savings Potential During the Life of a Typical System. (Adapted from E. D. Heller, General Dynamics Corporation)**



cost consistent with required performance, reliability, quality, and safety.

The VE methodology consists of a distinct set of work elements that can be applied to any project. It is a vehicle to carry the project from inception to conclusion. By adhering to certain formalities, the VE methodology ensures that consideration is given to all necessary facets of the problem. The methodology involves an objective appraisal of functions performed by parts, components, products, equipment, procedures, services, and so on—anything that costs money. It is designed to create, analyze, and evaluate alternatives for eliminating or modifying any element that significantly contributes to the overall cost without adding commensurate value to the overall function. Specific recommendations are supported by necessary back-up data, implementing actions, a proposed implementation schedule, and a required follow-up procedure.

There is a relationship between the VE methodology and systems engineering. In the context of a Department of Defense acquisition, systems engineering provides a systematic set of processes to help coordinate and integrate activities throughout the life cycle of a system. Systems engineering offers a technical framework for conducting trades among system performance, risk, cost, and schedule.

The VE/systems engineering relationship is based on VE being an effective technique for making those trades in a way that not only reduces costs but also increases productivity and improves quality-related features of systems, equipment, facilities, services, and supplies. After all, VE is more than cost reduction. VE is a disciplined approach to examining costs and function from every conceivable angle. Cost reduction is just a management approach that focuses on developing cost awareness and cutting those costs. VE challenges all facets of the product or system based upon the function to be performed and identifies the lowest cost alternative that meets the requirements.

As such, DoD policy recognizes the VE methodology as a systems engineering tool for making a significant contribution toward greater economy in developing, acquiring, operating, and supporting the products necessary to fulfill its mission.

This article provides greater detail on the phases of the DoD acquisition process, the role of systems engineering within those phases, and the potential contributions the VE methodology can make to the systems engineering processes.

VE Opportunities During the Defense Acquisition Process

The Joint Capabilities Integration and Development System (JCIDS) supports the Joint Requirements Oversight Council (JROC) in identifying, assessing, and prioritizing joint military capability needs that may ultimately be met with a materiel solution obtained through the acquisition process. The Defense Acquisition Management Framework provides management principles, policy, and procedures for translating DoD mission needs and technological opportunities into system acquisition programs. It is characterized by five phases separated by three major milestone decision points, as depicted in Figure 1. The five phases are:

- Materiel solution analysis
- Technology development
- Engineering and manufacturing development
- Production and deployment
- Operations and support.

The three major milestone decision points are:

- Milestone A—authorizes the technology development phase
- Milestone B—typically a formal program initiation
- Milestone C—approves low-rate initial production.

The full-rate production decision is made after initial operational test and evaluation have been completed. Initial operational capability and full operational capability are achieved as the production units are fielded.

VE is more than cost reduction. VE is a disciplined approach to examining costs and function from every conceivable angle.

While value engineering is applicable at any point in the life cycle, Figure 2 illustrates that the savings potential usually decreases as the program ages. VE should be applied as early as possible in the life cycle. Early VE tends to produce greater savings (or cost avoidance) because at the critical design review, approximately 80 percent of the total costs are committed for typical programs. (Typically, only 20 percent of the costs are incurred.) Therefore, greater opportunities exist for change, and the changes cost less to implement before then.

Even if early opportunities are missed, VE can still be applied. Late in a program, VE is precluded only in those rare instances in which the cost of the VE effort and subsequent implementation would be greater than the savings potential. While later VE normally adds implementation costs and affects smaller quantities, such deterrents may be offset by improved performance and reliability and the savings generated from increased product life. Usually, there is some opportunity for net savings at any stage of a program.

DoD Directive 5000.1 encourages cost savings: "Acquisition programs shall be managed though the application of a systems engineering approach that optimizes total system performance and minimizes total ownership costs." The use of VE and the value methodology can make important contributions to the systems engineering process throughout the life cycle, although certain targets of opportunity may be useful in selecting an appropriate time to apply VE. Such targets of opportunity include situations in which:

- Current system performance or cost does not satisfy the customer
- Advances in technology have system application, resulting in enhanced performance or reduced cost
- The likely savings are high
- VE may be applied easily.

An important prerequisite for applying the VE methodology is properly establishing separate cost and income baselines and data collection practices, enabling more accurate tracking of savings during execution. The following sections describe VE opportunities early in the life cycle, during production and deployment, and during operations and support.

VE Early in the Life Cycle

The most opportune time to apply the VE methodology is early in the life cycle, before production begins, before field or technical manuals are drafted, and before logistic support plans are finalized. Although applications may be more challenging as compared to later in the life cycle, some of the more important benefits are:

- Savings can be applied to all production units.
- Reductions to the high cost of development, the subsequent cost of production, and the consequent costs related to operation and support may be realized.
- Fewer modifications to production lines, tooling, processes, and procedures will be required.
- Fewer drawing changes will be necessary.
- Fewer post-production changes to logistic and support elements such as manuals, maintenance facilities, and spare parts requirements will be needed.

The materiel solution analysis (MSA), technology development (TD), and engineering and manufacturing development (EMD) phases encompass the early part of the life cycle.

VE During Materiel Solution Analysis

MSA begins with the approval of an initial capabilities document, which identifies the needed capability. Alternative concepts for attaining the needed capability have also been developed, and a plan for an analysis of alternatives has been approved. The purposes of MSA are to refine the initial concepts so that a decision on the preferred materiel solution can be made, and to develop a technology development strategy for the preferred materiel solution. MSA presents the first substantial opportunity to influence system design by balancing technology opportunities, schedule constraints, funding availability, performance parameters, and operational requirements.

During MSA, systems engineering ideally provides top-level, iterative, and recursive analytical processes for each alternative materiel solution. Such application of the systems engineering processes can result in a technical evaluation of the operational effectiveness and estimated life cycle costs of the alternative materiel solutions that may provide a materiel solution to a needed mission capability. Tradeoffs among system operational requirements, operational utility, technology maturity, and life cycle costs can lead to a best system solution within allowed constraints. Effectively employing systems engineering will also support a preliminary assessment of the technical and management risk that will be considered in choosing the preferred materiel solution and formulating the technology development strategy.

In the recent past, systems engineering has not had a significant impact so early in the life cycle. Initiatives are under

VE contributes to systems engineering activities by devising alternative means for achieving required functions and developing alternative designs to meet functional needs.

way, however, both to tighten the linkages between the JCIDS process and the acquisition management process, and to begin acquisition-related technical planning earlier in the life cycle. For example:

- The JROC now requires a formal technical risk analysis.
- The Air Force is piloting the disciplined application of systems engineering during the development of concepts that feed an analysis of alternatives.

All such activities lead to a systems engineering plan at or near Milestone A. VE can have a significant role in support of the systems engineering plan during MSA. According to Emerson N. Wells in his article "Cost Effectiveness and Value Engineering: A Comparative Analysis," published in *SAVE International Annual Conference Proceedings* (1968), the analysis of alternatives and associated cost-effectiveness studies can use the VE methodology to analytically evaluate functions and provide a mechanism to analyze the essential requirements and develop possible alternatives offering improved value. In that context, detailed evaluations of the technical requirements of each alternative materiel solution can be made, and their effects on total performance can be determined. Concurrently, the effect on life cycle cost of each alternative being considered is estimated and related to the individual technical requirements. If areas of high cost and high-cost sensitivity are identified, the associated requirement may be examined in relation to its contribution to effectiveness. The requirements identified by those high-cost areas could be examined in detail from a cost-effectiveness standpoint. Based on the aforementioned efforts, the VE function may be used to do the following:

- Constructively challenge the stated needs and recommend alternatives
- Constructively challenge the desired mission performance envelopes to ensure they are necessary and most cost effective
- Ensure that user requirements are well-founded.

VE During Technology Development

A successful Milestone A decision initiates the TD phase. The phase reduces technology risk and determines the appropriate set of critical subsystem technologies to be integrated into a full system. It is a continuous technology discovery and development process that reflects close collaboration between the science and technology community, the user, and the developer. Technology development is an iterative process of assessing technologies and refining user performance parameters. At the end of the TD phase, all critical technologies should have been demonstrated in a relevant environment at the system, subsystem, or prototype level.

During technology development, systems engineering should provide comprehensive, iterative processes to mature the suite of technologies for the preferred materiel solution by:

- Converting critical capabilities into subsystem performance specifications
- Translating user-defined performance parameters into configured subsystems
- Integrating the technical inputs of the entire design team
- Managing interfaces
- Characterizing and managing technical risk
- Transitioning technology from the technology base into program-specific efforts
- Verifying that preliminary designs meet operational needs.

VE can be used to analyze the value of each requirement and the specifications derived from it by comparing function, cost, and worth. By critically examining the cost consequences of requirements and specifications, a VE study can generate answers to the following questions:

- Is the resultant cost effect of each requirement comparable to the worth gained?
- Is the resultant cost effect of the tolerance specified on each requirement comparable to the worth gained?
- Is the resultant cost effect upon the product comparable to the worth gained by the specification?
- Can the specification be tailored to minimize effort and cost?

Such efforts are, in effect, an early application of the principles of a cost as an independent variable (CAIV) analysis, which can help determine whether user requirements and specifications are well-founded and also lead to the relaxation or elimination of requirements/specifications.

VE During Engineering and Manufacturing Development

Formal program initiation usually occurs when the milestone decision authority approves entrance into the EMD phase. In that phase, the program, system architectures, and system elements down to the configuration item-level are defined based on the technology matured during the TD phase. System design requirements and the support concept are refined, and integration and manufacturing risks are reduced.

The EMD phase is divided into two parts: integrated system design, and system capability and manufacturing process demonstration (SCMPD). During integrated system design, systems engineering reduces program risk, identifies potential management issues, and guides design choices by allocating requirements at greater levels of detail. Through the use of systems engineering, the SCMPD effort demonstrates the system performance in its intended environment. Verification at each step confirms that specified requirements have been fulfilled. Validation at the end of the process confirms that the refined solution meets the needs of the user.

As part of the development and refinement of the functional architecture, VE should be used for:

- Identifying the necessary top-level functions for each of the missions considered
- Identifying technical approaches (i.e., design concept) to the missions
- Identifying necessary lower-level functions for each technical approach (the value engineer should place emphasis on eliminating unnecessary design restrictive requirements)
- Evaluating each function in terms of technical feasibility
- Estimating the cost of various functions.

An effective application of the VE methodology will include further analysis of the high-cost functions and the identification of alternative, less costly ways of achieving the same result. When programs view life cycle cost as an independent variable, it should be treated as equally important to performance and schedule in program decisions. Program managers are encouraged to develop a formal CAIV plan as part of their acquisition strategy, which is required at Milestone B. While the implementation steps in a CAIV plan will depend on the type of system and its current stage in the acquisition framework, two of the suggested elements—cost goals and trade-off studies—tie closely to VE. (See *Defense Acquisition Guidebook*, Section 3.2.4, "Cost As an Independent Variable.")

Cost Goals

The CAIV plan would include cost goals for unit production cost and operation and support costs. The unit production cost goal typically would be established for a specified quantity of systems and a specified peak production rate. The operation and support cost goal typically would be an annual cost per deployable unit (e.g., battalion or squadron) or individual system (e.g., ship or missile). The goals should be challenging but realistically achievable.

Tradeoff Studies

Cost, schedule, and performance may be traded off within the trade space between thresholds and objectives documented in the capability development document. Over time, as the system design matures, the trade studies become more refined and specialized.

As part of the definition and refinement of the physical architecture (design), VE should support the system engineering process by helping develop alternative ways of providing the required function with lower production and sustainment costs. The value engineer usually engages in such activities in high-leverage areas. Therefore, the VE process should first identify individual high-cost subsystems or items to stimulate early detection of unnecessary costs in time to take corrective action. Once those high-leverage areas have been determined, the next step is to shape and evaluate alternative designs in relation to the technical requirements, performance limits, subsystem interrelationships, logistics support requirements, and system cost and value. VE contributes to the logistics support analysis as it is used to establish maintenance plans and to ensure that the design process incorporates logistic requirements and cost considerations, including reliability, maintainability, spares, and obsolescence.

Common VE activities during engineering and manufacturing development are:

- Evaluating design concepts from a life cycle cost standpoint
- Eliminating unnecessary design-restrictive requirements established by the user or design community
- Achieving CAIV
- Meeting system requirements at the lowest life cycle cost from a logistics support analysis perspective
- Searching for new manufacturing processes or new materials to be used in the design
- Searching for problems encountered by others who attempted to design similar systems or components
- Defining interfaces between or among functional areas
- Conducting design trades.

During the SCMPD step, VE challenges the need for expenditures on data, number of prototypes, peculiar support equipment, and so on. Initial prototypes are evaluated to identify additional opportunities to improve value. VE efforts at this stage analyze how suppliers can help reduce costs, asking the following questions:

- Have suggestions been invited from prospective suppliers regarding possible value improvement from loosening specification requirements?

- Have all nonstandard parts been identified and approved?
- Can the use of each nonstandard part be adequately justified?
- Can a redesign replace a nonstandard part with a standard part?
- Are the standard circuits, standard components, and standard hardware the lowest cost items that will supply the minimum required characteristics?

Once models and prototypes are built, they must be verified to meet the requirements. VE also supports this testing process by:

- Identifying functions to be tested
- Challenging the need for certain tests based on the functions the tests are designed to serve
- Challenging the tolerances of the tests specified based on the functions the tests are designed to serve
- Determining cost-effective ways to test them.

Finally, as a result of the testing experience, the VE process should look for opportunities to simplify the design for operational use—make the system easier to operate and maintain. Once production begins and the system is fielded, it becomes much more expensive to make these kinds of changes.

VE During Production and Deployment

The production and deployment phase begins at Milestone C. During that phase, the system achieves operational capability to satisfy mission needs. As the integrated components develop into a system, the test and evaluation processes frequently reveal issues that require system improvements or redesign. When the testing environment more closely resembles actual field conditions, the required improvements might be complex and subtle. The initial manufacturing process may also reveal unanticipated problems that may be resolved by changing the product somewhat. Low-rate initial production should result in completion of manufacturing development. Full-rate production delivers the fully funded quantity of systems and supporting materiel and services for the program or increment.

Systems engineering in the production and deployment phase is primarily concerned with analyzing known deficiencies and determining corrective actions. A plan to build, modify, verify, and test the proposed solution is also formulated and approved. The proposed solution to the deficiency is translated to the appropriate hardware, software, or specification changes. Modifications are created, incorporated, and verified in accordance with the approved plan. This product change may include retrofit, since the production process has begun. The impact on system cost, schedules, and performance should also be considered when addressing production incorporation.

VE contributes to these systems engineering activities by devising alternative means for achieving required functions and developing alternative designs to meet functional needs. VE has been extensively applied to evaluate and improve manufacturing processes, methods, and materials, including support equipment, technical data, and facilities, as well as the supply, transportation and handling, maintenance, and training functions. VE projects can be undertaken under certain circumstances:

- Recent developments indicate a potential opportunity for cost reduction
- The future use of the item depends on significant reduction in production costs
- New manufacturing technology and new materials become available.

In addition, as production becomes more mature, VE may support the decision to eliminate quality assurance testing, which often cannot be proposed until considerable experience is acquired and data gathered to prove that it is feasible. VE may also reveal that management reports required to understand a complex situation early in production may turn out to be unnecessary after more experience is gained.

VE During Operations and Support

During the operations and support phase of the acquisition framework, system support is provided to satisfy operational requirements and sustainment needs in the most cost-effective manner over the life cycle. Usage data are collected and analyzed to determine the root cause of any problems encountered. After a risk assessment is conducted, corrective actions are formulated.

In this phase, systems engineering processes support in-service reviews; trade studies; and decisions made about modifications, upgrades, and future increments of the system. Interoperability or technology improvements, parts or manufacturing obsolescence, aging issues, premature failures, changes in fuel or lubricants, joint or service commonality, and so on, may all indicate the need for system upgrade. System disposal is not a systems engineering activity, but systems engineering processes that inject disposal requirements and considerations into the earlier design processes ultimately affect disposal.

After fielding, opportunities for VE may exist for a long time. Product life cycles are being extended; for consumables, there is no sure way to determine the total quantity that will be purchased. Also, in the past, many items that entered the defense inventory were never subjected to a VE analysis. The potential for VE savings on these items is real. Advances in technology or changes in user requirements provide a basis for potential savings.

After a system or item is fielded, changes are often expensive to implement. However, large potential savings

to operation, maintenance, and other logistics functions might justify the investment. Using VE principles supports the development, evaluation, and implementation of such changes within the overall systems engineering process. Within the Defense Department, the following process has been proven to be a successful context for VE:

- Establish cost consciousness in the program
- Establish a cost baseline and identify cost drivers
- Develop a cost-reduction strategy
- Manage cost within the program
- Establish cost goals, objective, and threshold
- Establish meaningful cost-reduction metrics
- Identify and quantify cost-reduction initiatives
- Track implementation of cost-reduction projects
- Measure results against the plan.

VE contributes to every aspect of that process; it is especially suited to the identification and evaluation of cost-reduction initiatives. The evaluation function is extremely important because such initiatives typically include an up-front investment that will be recouped over time.

VE has been used to formulate initiatives to:

- Extend item life by applying state-of-the-art designs, materials, or processes
- Reduce repair costs by achieving the repair function in a more economical manner
- Reduce packaging costs by improving packaging procedures or materials
- Remanufacture and replace legacy systems
- Improve reliability and maintainability
- Use commercial processes, technologies, and commercial off-the-shelf items to reduce cost and improve reliability
- Replace aging engines and engine parts
- Improve supply-chain response time and reduce logistics footprint using direct vendor delivery, commercial maintenance agreements, and virtual prime vendor support
- Initiate reliability-centered maintenance and condition-based maintenance to reduce preventive maintenance costs without affecting corrective maintenance needs
- Reduce the number of people required to operate and maintain by improving usability and maintainability
- Eliminate sole-source procurement.

Seek VE Opportunities

A detailed understanding of the acquisition management framework is not a prerequisite for applying VE. It is presented here to describe when VE should be applied throughout a system's life cycle and to emphasize that the earlier VE is applied, the greater the potential for savings. The VE activities described in this article sometimes take place without using the formal VE discipline. Unfortunately, such informality is often accompanied by uneven or mediocre efforts, especially early in the life cycle, where less data are available. That has led, in part, to a common misconception that VE applies only to production contracts. This article describes many potential VE applications during development. The systems engineering process encouraged tradeoffs among cost, schedule, and performance represent excellent but often missed opportunities for applying VE. It is important to aggressively seek areas to apply VE in these more challenging situations.

Finally, in today's acquisition environment, many systems remain in inventory for a long time because of major modifications or upgrades (e.g., block changes or preplanned product improvements). Therefore, opportunities for large VE savings extend much later into the life cycle. Once again, such opportunities may be missed because of the strong association between VE and production. DoD cannot afford to ignore them in the future.

Note: This article is adapted from the authors' paper, Value Engineering Handbook, *published by the Institute for Defense Analyses (IDA) in September 2006. The paper was based on information in Army Pamphlet 11-3, "Value Engineering" (undated), and DoD Handbook 4245.8-H, "Value Engineering," March 1986. The IDA paper is available at <http://ve.ida.org>, and information for this article is used with the permission of IDA.*

For further information, please see:

OMB Circular A-131, "Value Engineering"
<*http://georgewbush-whitehouse.archives.gov/omb/circulars/a131/a131.html*>

Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3170.01F Joint Capabilities Integration and Development System
<*https://acc.dau.mil/communitybrowser.aspx?id=152771&lang=en-US*>

DoD Directive 5000.01, "The Defense Acquisition System"
<*https://acc.dau.mil/communitybrowser.aspx?id=54706*>

DoD Instruction 5000.02, "Operation of the Defense Acquisition System"
<*https://acc.dau.mil/communitybrowser.aspx?id=44891*>

Defense Acquisition Guidebook
<*https://akss.dau.mil/dag/*>

The authors welcome comments and questions and can be contacted at dreed@ida.org and jmandelb@ida.org.